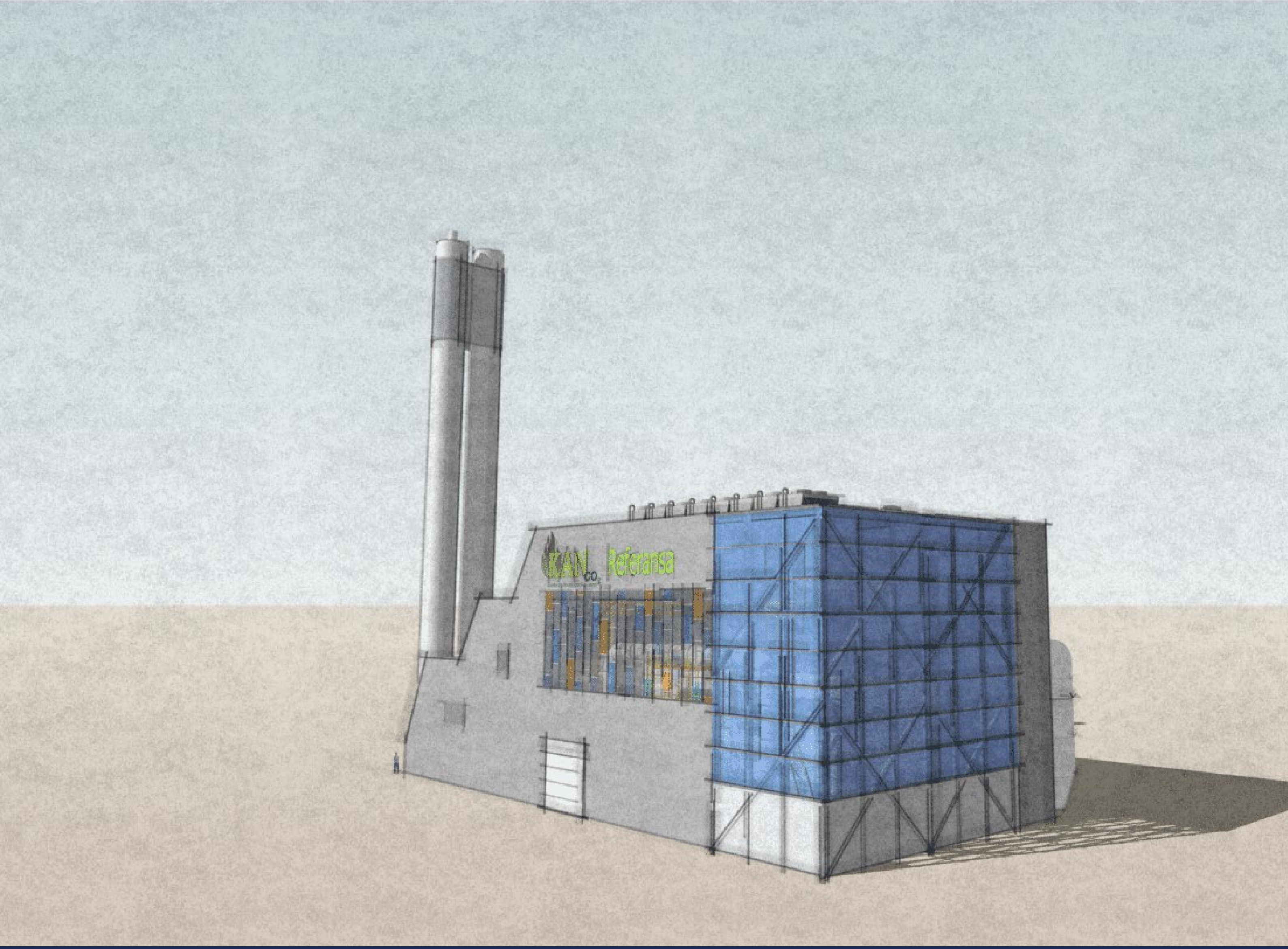

04.09.2025
KAN - Klimakur for avfallsforbrenning i Norge

Baseline study of the value chain of biogenic CO2 from waste incineration - CDR

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Baseline study of the value chain of biogenic CO2 from waste incineration - CDR

Project No.	Document no.
A296701	A296701-COWI-Z-0001

Version	Date of issue	Description	Prepared	Checked	Approved
01	04.09.2025	Report for WP 1.1 to 1.6	JEBC/TIAB/MIFN	AELE	OMMO
			Signature	Signature	Signature
			JEBC Digitally signed by JEBC Date: 2025.09.04 10:58:11 +02'00'	Digitally signed by AELE Date: 2025.09.04 11:49:51 +02'00'	OMMO Digitalt underskrevet av OMMO DN: CN=OMMO, OU=Users, OU=Workstations, OU=COWI Norway, DC=COWI, DC=Net Årsak: Jeg godkjenner dette dokumentet Dato: 2025.09.04 15:26:15+02'00'

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Abbreviations and definitions

Abbreviation	Definition
^{14}C	Radiocarbon (used for biogenic content determination, e.g., via isotope analysis)
BCR	Biochar Carbon Removal
BECCS	Bioenergy with Carbon Capture and Storage
CAPEX	Capital Expenditures
CCS	Carbon Capture and Storage
CCS+	Carbon Capture and Storage Plus (CDR Registry Initiative)
CCU	Carbon Capture and Utilization
CCUS	Carbon Capture Utilization and Storage
CDM	Clean Development Mechanism
CDR	Carbon Dioxide Removal
CEMS	Continuous Emissions Monitoring System
CLIMIT	The Norwegian national program focused on carbon capture and storage technology development
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CCPs	Core Carbon Principles
CRCF	EU Carbon Removal Certification Framework
DACCS	Direct Air Carbon Capture and Sequestration
DOC	Direct Ocean Capture
Drax/Stockholm Exergi	Methodology developed by Drax and Stockholm Exergi (Bio-CCS)
EN 15440	European Standard for Determining Biogenic Content in Fuels
ENOVA	The Norwegian state enterprise, established to promote environmentally friendly energy solutions and a low-emission society.
ESR	Effort Sharing Regulation
ETS	The UK Emissions Trading Schemes
GHG	Greenhouse Gas
Gold Standard	Gold Standard Foundation (standard-setter for climate and SDG projects)
ICAO	International Civil Aviation Organization
ICROA	International Carbon Reduction and Offset Alliance
ICVCM	Integrity of Carbon Removal Integrity Council
IEA	International Energy Agency
IPPC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KAN	Klimakur for avfallsforbrenning i Norge
LCA	Life Cycle Assessment
LCoCCS	Levelized Cost of Carbon Capture and Storage
mCDR	Marine carbon dioxide removal
MRV	Monitoring, Reporting, and Verification

Abbreviation	Definition
MSW	Municipal Solid Waste
NDC	Nationally Determined Contribution
O&M	Operations and Maintenance
OPEX	Operational Expenditures
SBTi	Science Based Targets initiative
SDG	Sustainable Development Goal
SRF	Solid Recovered Fuel
SSO	Storage Site Operator
UNFCCC	United Nations Framework Convention on Climate Change
VCMI	Voluntary Carbon Markets Integrity Initiative
VCS	Verified Carbon Standard
Verra VM0049	Verra Methodology 0049 for BECCS
WtE	Waste-to-Energy

1 Executive summary

The increasing global urgency to mitigate climate change has underscored the importance of innovative solutions in the waste sector, especially as industries seek to decarbonize and align with international frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC). Within this context, the Norwegian waste incineration sector has initiated a collaborative action through the Klimakur for avfallsforbrenning i Norge (KAN), an industrial partnership dedicated to advancing Carbon Capture, Utilisation, and Storage (CCUS) across waste-to-energy (WtE) facilities. This report presents the outcome of KAN's efforts, supported by Climit, to operationalize CCUS in waste-to-energy by enabling the sale of Carbon Dioxide Removal (CDR) credits in the voluntary carbon market.

This study focuses on mapping the regulatory requirements, methodologies, market trends and current pricing mechanism. The study includes also evaluation of case studies and should help defining which actions are needed for KAN to get to the market.

1.1 Regulations

CDR need to support meeting national and international climate goals and the regulatory frameworks at the international, European, and national levels are evolving quickly.

Norway is recognised for its pioneering role in CCS. Yet, no explicit CDR targets on the national level exists, and the overall regulatory landscape remains complex.

The voluntary carbon market (VCM) presents an increasingly important platform for the sale of CDR credits, driven by growing corporate demand. Amongst the criticalities, the most important are credit quality, regulatory uncertainty around the inclusion of CDR and WtE in the EU ETS, fragmentation among CDR standards, lack of comprehensive subsidy mechanisms, no strong linkage between voluntary and regulatory frameworks, public mistrust and challenges in achieving broad social acceptance.

WtE CDR actors need to certify their projects under ICVCM CCP-approved standards, target VCMI-aligned buyers, ensure registry and quantification are ICROA- and ISO-compliant, closely monitor policy developments at both EU and national level, and maintain transparent communication about the type and quality of carbon removals delivered.

KAN projects can and should achieve "EU-certified" status for their CDR through the European Carbon Removal Certification Framework, increasing credibility, market value and eligibility for potential compliance use or subsidies.

1.2 Standards and registries

Standards (also often referred to as programs) are organizations that define the specific rules, requirements, and methodologies for developing, measuring, and generating carbon credits, as well as overseeing the life cycle of carbon instruments. They ensure that credits represent real, additional, and verifiable climate impact. Most of the standards used in the voluntary carbon market today are developed by carbon offset registries, which also track trading and retirement of carbon credits issued under their standards.

Registries are official databases or digital platforms that track the issuance, ownership, transfer, and retirement of carbon credits. They are categorized into two primary types: transactional registries (analysed in this report) and accounting registries, which aggregate information from different transactional registries.

The following standards and transactional registries have been analysed:

- Puro.earth
- Verra/CCS+
- Isometric
- Gold Standard
- Drax/Stockholm Exergi methodology (not a formal registry)

The assessment has focused on their suitability and methodological robustness for WtE. One key finding is that no single standard excels in all areas. This assessment identifies Isometric, Verra and Puro as strong certification options for KAN – each with distinct advantages. A detailed SWOT analysis has been performed (Table 12).

KAN should evaluate selecting a standard already trusted in the Nordic region, which can facilitate smoother project approval. Additionally, standards focused on engineered carbon removals can help matching KAN with buyer willing to buy CDR at a premium price to support their high-quality, transparent, and scientifically robust carbon removals strategies.

Given the diversity within KAN and the evolving carbon removal certification landscape, it is recommended that KAN as a collective pursues a dual or even a multi-certification strategy – actively engaging with the suggested standards. From a seller's perspective, early engagement and dialogue with multiple registries is practical; final registry selection can remain flexible until the market/contract crystallizes (as learned from the Hafslund Celsio and Stockholm Exergi cases).

1.3 Monitoring, Reporting and Verification (MRV)

The leading CDR methodologies and registry schemes applicable to WtE plants with CCS have been analysed in terms of eligibility for WtE projects, technical and operational compliance requirements, monitoring and verification (MRV) protocols, data and digital infrastructure needs, alignment with international and regional regulations, and required documentation for certification.

Based on the analysis, some focus area connected to MRV that need to be documented are:

1. **Project Registration and Baseline Documentation,** including a detailed characterization of feedstock composition, emphasizing biogenic fractions, the baseline GHG emissions inventory without carbon capture and a description of the CCS technology.
2. **Feedstock and Biogenic Fraction Verification,** based on several methods but with but ultimate with traceable chain-of-custody.
3. **Carbon Capture and Emissions Monitoring,** to document the quantity of CO_2 captured, verifiable by third parties.
4. **CO_2 Transport and Storage Documentation,** with emphasis again on the chain-of-custody, LCA and the post-injection monitoring.
5. **MRV Records,** based on a monitoring plan, including third-party verification statements and audit reports. Emphasis from all the registry is on the continuous, high-frequency emission measurement and reporting.
6. **Digital Traceability and Data Management Logs,** documenting the chain-of-custody tracking from waste feedstock inflow to final CO_2 storage.

Each scheme has its nuances within the same main topics and rely on internationally recognized standards and regional regulations. There are overlapping requirements in the main standards analysed, particularly around MRV, chain-of-custody, and LCA documentation. These might pose some challenges and need to be evaluated together with the selected certification strategy (as introduced in section 1.2).

1.4 Price and market

This report examines the evolution of CDR credit prices, providing an overview of historical trends and recent market developments. Current and future market demand, including identification of the main buyers and sellers is presented. Finally, Norway's potential for BECCS is discussed, relative to other countries.

Since 2019, the market for CDR credits has undergone rapid growth and maturation. Traded volumes and diversity of supply have increased each year. CDR credit prices have also been characterized by considerable volatility, although additionality is extremely important in this respect.

Policy and regulatory frameworks play a defining role in shaping the business case for CCS and CDR credits from WtE operators. An analysis shows that unless technology costs are significantly reduced for the KAN members, the break-even price for biogenic CDR credits is likely to remain significantly above the level of the Norwegian CO_2 tax. This also highlights the need for greater public funding for CDR within the WtE sector in Norway, raising investment levels to match those seen in countries like Denmark and Sweden. Increased public support for CDR in WtE would help accelerate technological development, strengthen Norway's competitiveness in the evolving European energy landscape, and enable the sector to achieve ambitious climate and sustainability targets.

The current voluntary market is dominated by leading technology and finance companies, with few leading buyers focused on securing credits for near-term climate targets. New buyers from hard-to-abate sectors will emerge as we close in towards 2030.

Nordic suppliers, and Norwegian projects in particular, are regarded as high-quality, reliable providers of durable removals. While the theoretical capacity of the Norwegian BECCS potential is modest (2–3 $MtCO_2$ per year), Norway distinguishes itself through advanced project maturity, robust regulatory frameworks, and well-developed storage infrastructure.

KAN members can take advantage of these aspects but must develop strong MRV systems and take the opportunity to be amongst the first movers.

1.5 Case studies and best practices

Three leading CDR projects in the Nordics – Hafslund Celsio Oslo CCS (Norway), Ørsted Kalundborg CO_2 Hub (Denmark), and Stockholm Exergi BECCS Stockholm (Sweden) are analysed. The lessons learned are especially relevant for scaling carbon removals in Norway's WtE sector and provide insights into how public support, private demand, and credible certification come together to make CDR projects viable.

Hafslund Celsio Oslo CCS project is part of Norway's Longship demonstration project and is made possible through a public-private partnership. It presents possibly the largest source of valuable learnings for KAN:

- Detailed due diligence from potential buyers should be expected. It will require thoroughness, patience, and attention to detail.
- Credible documentation for both the biogenic and fossil fractions of CO_2 is critical, in order to satisfy due diligence and build trust.
- The due diligence extends to the entire value chain (including storage, and full LCA documentation), reflecting the expectation for transparent, high-integrity credits.
- Financial additionality is, for the current market, very important for the buyers. It will support price negotiations.
- While the agreement with CDR buyers is to sell the CDR through a register, no final decision is yet performed - Hafslund Celsio Oslo CCS project is in dialogue with multiple registers.
- Risk-sharing contractual discussions are to be expected for the first-of-its-kind projects.
- Neutral jurisdiction (neither US nor Norwegian) can be used to accommodate both parties.
- First movers benefit from a market with buyers interested in CDR credits that can be delivered before 2030.

Ørsted's Kalundborg CO_2 Hub project demonstrates the value of blending public subsidies, private carbon credit sales, and company investment to make large-scale carbon removal possible. Certification of credits (e.g. Verra) boosts credibility and attracts international buyers like Microsoft, bringing premium prices and private demand. Public guarantees reduce project risk and support financing, something Norwegian projects could replicate through similar national schemes. Building long-term partnerships with dedicated corporate buyers also creates price stability and investor confidence. Finally, by integrating with existing regional CCS infrastructure, projects can lower costs and operational complexity, offering further advantages for Norwegian waste incineration plants.

BECCS Stockholm's experience shows that blended finance, early and meaningful corporate buyer engagement, a market-enabling subsidy scheme – instead of a direct government purchase procurement – and strong government-industry collaboration on for instance co-design of the support scheme tailored to the WtE sector are essential ingredients to launch carbon removal projects at scale.

1.6 Internal Roadmap for Norwegian WtE plants

Building credibility for biogenic CO_2 crediting, as well describing what work needs to be performed by each individual KAN member in their project need to be prioritised to maximise the chances to fulfil requirements that would enable CDR issue.

The work needed should be described in a technical work description package that can be implemented at late as possible in a project, but before Final Investment Decision. This technical work description package will enable KAN members to quantify the net amount of CO_2 removed, how embodied emissions are accounted for (LCA), how additionality is documented and how to address MRV and other required systems to be able to issue CDR.

The roadmap ownership of this roadmap should be collaborative – all KAN members are stakeholders and play crucial roles in defining the governance as well as implementation of the roadmap in their projects/plants. Through piloting, KAN can gain insight and correct the course of the roadmap as necessary.

In the meanwhile, KAN should continue advocacy activities for obtaining public fundings.

1.7 Conclusion

KAN is making a significant effort in advancing the Norwegian waste sector's response to climate challenges. By systematically addressing the methodological, technical, and market requirements for CDR credit sales, and by embedding robust LCA across its operations, KAN is creating a foundation for credible, market-ready negative emissions.

The framework and tools developed through this project will support KAN members in delivering real, verifiable CDR credits on the road to net zero.

2 Introduction

2.1 Background

Klimakur for avfallsforbrenning i Norge (KAN) is an industrial collaboration between Norwegian waste incineration plants with activities related to enhancing collaboration on CCUS. The partners work together to contribute to increased information sharing and better solutions around CCUS for the waste industry, and to realize carbon capture and storage from waste incineration plants.

KAN has received support from CLIMIT in several phases, and it is currently working on phase 3 of their project. Phase 3 is focused on mapping the opportunities related to the "value chain for biogenic CO_2", to continue communicating what is needed to realize CCUS by waste incineration, and to look at solutions for transport and storage.

As part of the value chain mapping, KAN is therefore working on two fronts for enabling the sale of Carbon Dioxide Removal (CDR) credits by its members:

- **CDR:** CDR are credits produced by CCS projects that verify and certify the quantity and quality of CO_2 removal. On this front, KAN want to understand what it takes to ensure CDR for sale in the market. KAN needs to perform a baseline study mapping the regulatory requirements, methodologies, market trends and current pricing mechanism. The study includes also evaluation of case studies and should help defining which actions are needed to get to the market.
- **LCA:** LCA (Life Cycle Assessment) evaluates and quantify the environmental impacts of a project throughout its entire life cycle. LCA are necessary to be able to certify the CDR credits. KAN wants to perform a comprehensive assessment for a waste to energy plant with carbon capture and district heating connection. The case study "KAN referansa" should be included, as it is considered representative of the plants of the KAN members.

  The LCA needs to be prepared so that is according to the principles used by accepted standards and methods, i.e. requirement from the different CDR registries. An excel based tool that can be used by each KAN member need also to be developed, together with a report describing the methods, approach, assumptions and results.

This report addresses the work with the first front, the CDR part of the study.

2.2 COWI's approach

For the study, which took place from May 2025 to end-August 2025, the work was broken down into different work packages. The table below illustrates the overall content of these work packages. The work packages in the report are by nature intertwined and overlapping and require various analytical perspectives.

Task/scope	COWI Responsibility
Work package 1.1 **Regulatory framework conditions**	Gain a clear understanding of the regulatory framework conditions. Conduct a desk study of existing policy and legislation in Norway and important international agreements that guide CDR efforts, including Monitoring, Reporting, Verification (MRV) requirements. Perform an analysis to identify any regulatory risks that could hinder the issuance of biogenic credits.
Work package 1.2 **International certification standards**	Evaluate international certification standards and organizations, that provide methodologies and protocols for quantifying, verifying, and certifying carbon removals. Identify and compare relevant certification and registry platforms, standard-setters by using different criteria such as eligibility, credibility, process, cost, market access.

Task/scope	COWI Responsibility
	Recommend a feasible certification route for KAN.
Work package 1.3 **Mapping of measures, monitoring and documentation**	Map and assess the technical and operational modifications Norwegian WtE plants need for CDR credit certification and to develop standardized MRV and documentation procedures aligned with relevant regulations and certifications standards.
Work package 1.4 **Internal actions and roadmap for Norwegian WtE plants**	List internal actions Norwegian WtE plants must undertake to issue and sell biogenic CO_2 credits. Preparation of a collective strategic roadmap for KAN from current operations to participation in the biogenic CO_2 credit market.
Work package 1.5 **Price analysis and market trends**	Map prices for different categories of biogenic CO_2 credits such as BECCS and DACCS. Overview of potential buyers and demand for biogenic CO_2 credits and what is driving demand. Outline the status of Norwegian BECCS projects and benchmark its potential biogenic CO_2 market volume against European and global BECCS projects on factors like technological and commercial maturity, planned/realized capacity, etc. Collect scenarios for CDR prices in 2030 and compare it to the expected carbon tax, which we see as a price floor for the willingness to pay for BECCS projects.
Work package 1.6 **Case studies and best practice**	Analyse success criteria and lessons learnings from current projects, in which biogenic CO_2 credits have been an instrumental part of the business case.

2.3 The structure of the report

This report is divided in chapters, with each part presenting the work performed by each work package.

Part 1 (Executive summary) presents the main features of the baseline study including the overall findings for KAN. Part 2, current part, is the introduction. Part 3 (Regulations) addresses the regulatory framework conditions for the CDR market, including international and national regulation, the voluntary carbon market and compliance-driven markets. Parts 4 and 5 (Standards and registries; Monitoring, Reporting and Verification) review the different private standards and registries on the voluntary carbon market, comparing their MRV requirements, strengths and weaknesses. Parts 6 and 7 (Price and market and Case studies) analyse the CDR market trends, price outlooks, and market potential for KAN, while also highlighting learnings from three recognized removals projects (Ørsted's Kalundborg CO_2 Hub, Hafslund Celsio's Oslo CCS and Stockholm Exergi's BECCS Stockholm project). Lastly, part 8 (Road map) presents a potential roadmap directed by KAN for ultimately issuing and selling CDR credits.

Section 9 presents the supporting references developed for this baseline study.

3 Regulations

3.1 Introduction and structure

Carbon dioxide removal (CDR) has become an increasingly critical component in strategies to meet international and national climate targets. In the context of Norway's waste-to-energy sector (WtE), CDR – especially removal via capture and storage of biogenic CO_2 – offers a pathway for both substantial emissions reductions and the creation of high-integrity climate credits. Sale of CDR is also a vital part of the potential financing schemes for the WtE industry. However, the regulatory landscape remains complex and is rapidly evolving at the international, European, and national levels.

Before delving into the technical details of individual carbon removal standards and methodologies, it is essential to have a solid understanding of the overarching regulatory frameworks that govern the field. The regulatory landscape also influences certification choices discussed later in "Standards and Registries". This is particularly important because regulatory frameworks define the rules of the game and establish which activities qualify as carbon removal, what types of storage are considered permanent, and which pathways are eligible for incentives or recognition in compliance and voluntary markets. Without a clear grasp of these rules, it is easy to misinterpret or overlook important requirements embedded in specific standards.

For operators and developers – such as WtE plant owners – understanding the regulatory landscape ensures that project development aligns with national and international climate goals, subsidy schemes, or reporting requirements. It allows for strategic planning, such as identifying opportunities for integrating carbon capture and storage (CCS) and positioning the sector to benefit from emerging markets or policies.

The aim is to ensure an understanding of the "big picture" before moving into the complexities of detailed standards, methodologies, and operational challenges – providing both a strategic overview and a practical guide for WtE operators involved in carbon removal. This Regulation part of the report is structures as follows:

This section opens with overview of the regulatory frameworks governing carbon removal. It sets out the importance of understanding global, European, and national rules. In 3.2. the evolution of the international climate regime is described – tracing the shift from a primary focus on emission reductions (Kyoto Protocol) to the integration of engineered CDR technologies under the Paris Agreement. The relevance of Article 6 mechanisms for international carbon markets and the potential implications for WtE operators are explained. Section 3.3 analyses the EU's regulatory approach, including the Emissions Trading System (ETS), the Fit-for-55 package, and especially the upcoming Carbon Removal Certification Framework (CRCF) [1]. Section 3.3 also discusses how EU-level policy is increasingly shaping CDR pathways and certification opportunities for Norwegian WtE projects.

Section 3.4 focuses on Norway and reviews national climate legislation, policy instruments, subsidy schemes, and current challenges in formulating explicit CDR targets. It highlights the interplay between Norwegian and international rules and the strategic implications for domestic WtE operators. Section 3.5 describes the structure and functioning of the Voluntary Carbon Market (VCM) detailing the journey from project development to credit sale. Attention is given to the interactions between VCM, emerging international standards, and national regulatory frameworks.

Section 3.6 unpacks the major "meta-standards" shaping CDR integrity and quality – ICVCM, ICROA, and ISO – but also standards that work on the demand side of the CDR voluntary market such as VCMI and SBTi. It compares their roles, approval processes, and relevance for project developers, focusing on how they interact with both regulated and voluntary markets. At the end of section 3.6 practical takeaways are provided for CDR actors in the WtE sector.

Section 3.7 introduces some of the emerging rating agencies and their role in validate the quality and integrity of carbon removal credits beyond the requirements in the various standards.

The final section, 3.8, identifies key regulatory, market, and social barriers to issuing CDR credits, such as standards fragmentation, policy uncertainty, and public acceptance risks. This chapter synthesizes current risks and outlines where project developers should focus to de-risking their business models and ensure robust compliance and credibility. Especially the risk concerning monitoring, reporting and verification (MRV) is be detailed and analysed closer in section 5. The report also addresses how KAN partners can deal with these risks and what it means for their certification efforts.

3.1.1 Summary and key findings

This section provides a condensed summary of key findings regarding regulatory framework conditions.

At the global level, there has been a clear evolution from the Kyoto Protocol's focus on emission reductions to the Paris Agreement's more integrated approach, which explicitly recognizes carbon removals as necessary for climate stabilization. Article 6 of the Paris Agreement now enables international cooperation and carbon trading mechanisms that include CDR. Within the EU, the ETS currently prioritizes emissions reductions, but the inclusion of CDR, Bioenergy with Carbon Capture and Storage (BECCS), and the WtE sector is under review. In parallel, the EU's Carbon Removal Certification Framework (CRCF), set to take effect from 2026, will introduce stricter certification criteria for high-quality removals.

Domestically, Norway is recognized for its pioneering role in CO_2 capture and storage infrastructure – for example, the Northern Lights project – although it has yet to set dedicated CDR targets. Existing policy tools include CO_2 taxation, which currently provide stronger incentives for the capture of fossil CO_2. Unlocking full-scale deployment of CDR at WtE plants will require additional subsidies and regulatory clarity, particularly in line with successful reverse auction models implemented in other Nordic countries.

The voluntary carbon market (VCM) presents an increasingly important platform for the sale of CDR credits, driven by growing corporate demand. However, VCM has faced concerns about credit quality and trust. Meta-standards such as the ICVCM's Core Carbon Principles (CCPs), ICROA, ISO, SBTi, and VCMI have become important for ensuring credit integrity. ICVCM's CCPs now serve as the benchmark for high-quality credits.

To further enhance trust, new rating agencies – such as BeZero, Sylvera, and Calyx Global – provide additional third-party assessments of credit integrity, much like rating agencies in traditional financial markets. These add an extra layer of transparency and quality assurance by evaluating projects on parameters such as additionality and permanence.

A number of risks and barriers remain, including regulatory uncertainty around the inclusion of CDR and WtE in the EU ETS, fragmentation among CDR standards, lack of comprehensive subsidy mechanisms, no strong linkage between voluntary and regulatory frameworks, as well as public mistrust, especially regarding the distinction between biogenic and fossil CO_2 in WtE – and challenges in achieving broad social acceptance.

Given this context, it is recommended that WtE CDR actors certify projects under ICVCM CCP-approved standards, target VCMI-aligned buyers, ensure registry and quantification are ICROA- and ISO-compliant, closely monitor policy developments at both EU and national level, and maintain transparent communication about the type and quality of carbon removals delivered.

Table 1 summarized the framework instruments presented in this chapter, together with how they are relevant for KAN.

Table 1: Summary of key findings, regulations

Framework instrument	Description	Intended effect	Relevance for KAN
Article 6, Paris Agreement	International mechanism allowing countries to cooperate to achieve climate	Facilitate international carbon trading for	Opens the possibility for Norwegian WtE/CCS CDR projects to generate credits

Framework instrument	Description	Intended effect	Relevance for KAN
	targets, enabling and removals to be counted and traded.	removals, with robust MRV.	for use in Norway's NDCs or for international buyers, provided MRV aligns with rules.
EU Emission Trading System (ETS)	EU cap-and-trade system for GHGs, now under review for potential inclusion of CDR (not currently covered for biogenic emissions/WtE sector). Sets obligation for fossil CO_2 emitters.	Incentivize emissions reductions through market pricing and a decreasing cap; potentially cover removals post-2030.	Future inclusion of CDR (esp. BECCS/WtE) could create a regulated demand and new revenue for KAN's carbon removal projects.
EU Carbon Removal Certification Framework (CRCF)	New EU-wide voluntary standard (from 2026) for certifying high-quality carbon removals (permanence, additionality, etc.)	Harmonize and legitimize CDR credits, provide strict MRV and transparency, and build trust in removals.	KAN projects can achieve "EU-certified" status for CDR, increasing credibility, market value and eligibility for potential compliance use or subsidies.
Integrity of Carbon Removal Integrity Council (ICVCM)	Sets global Core Carbon Principles (CCPs) for carbon credit integrity and comparability in the voluntary market; double-tick certification of standards and methodologies for supply side.	Raise integrity and trust in VCM credits, enable a global "premium" label for high-quality credits.	CDR credits with CCP label are more attractive to buyers, command premium prices, and provide assurance of robust project governance for KAN's activities.
Voluntary Carbon Markets Integrity Initiative (VCMI)	Sets best-practice guidelines for corporate claims using carbon credits; focuses on demand-side (credibility of offset/neutrality claims, not standard-setting for credits themselves).	Build trust in company/brand climate claims, encourage credible and responsible use of carbon credits.	Ensures that using CDR credits in corporate climate strategies is legitimate, raising demand for KAN's high-integrity removals among "VCMI-aligned" buyers.
International Carbon Reduction and Offset Alliance (ICROA)	Industry association promoting best practice for CDR project developers and offset providers; approves standards but not projects; sets a baseline for integrity and transparency.	Standardize industry integrity, assure buyers of baseline project quality, facilitate market access.	KAN projects certified via ICROA-approved standards gain easier market access and meet recognized minimum quality for buyers/ investors; not equivalent to regulation.
Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)	International aviation compliance scheme (offsets sectoral emissions growth) Deals with the demand side of the voluntary market	Create a regulated, aviation-driven demand for high-integrity carbon credits, supporting global climate goals and incentivizing supply of credible CDR.	Drives demand for high-integrity credits; indirect influence on voluntary market and project design; raises baseline for credit quality globally
International Organization for Standardization (ISO)	Sets technical standards for GHG accounting and MRV (ISO 14064 family), widely referenced in methodologies and regulatory/project design.	Ensure robust, comparable quantification and third-party verification of GHG removals.	Provides a credible framework for GHG accounting used in third-party verification for any removal claim.

3.1.2 International and national frameworks

As a signatory to the Paris Agreement, Norway is committed to the UN's greenhouse gas (GHG) accounting rules, which require precise tracking and reporting of both fossil and biogenic CO_2 emissions and removals [2] . For WtE facilities, this international regime permits carbon removals if biogenic CO_2 is captured and securely stored, moving removals from theoretical potential to a recognized, reportable pathway.

At the national level, these international commitments are reflected in Norwegian climate policy – via the Climate Act and the National Budget [3] – which drive both emissions reductions and the pursuit of negative emissions. Norway uses a mix of CO_2 taxation, innovation funding (for instance through Enova and CLIMIT), and regulatory standards to guide and encourage WtE plants to adopt carbon capture and storage (CCS), including for biogenic fractions. The Norwegian Environment Agency, an authority under the Ministry of Climate and Environment, has put forward proposals to promote CDR. Among their recommendations are the introduction of a reversed CO_2 tax and financial incentives that reward the removal of each tonne of CO_2 [4].

3.1.3 EU Regulations

On a European level, all European member states are subject to the fit-for-55 package, which is a series of regulatory agreements directed at reducing EU emissions by at least 55% by 2030 relative to 1990. In July 2025 the EU Commission proposed an amendment to the European Climate law, recommending a 90% reduction target for 2040 [5].

The Return of International Credits in EU Climate Policy

In July 2025, the European Commission proposed strengthening the European Climate Law with a 90% emissions reduction target for 2040. The proposal introduces new flexibilities, including the use of high-integrity international carbon credits for compliance between 2030 and 2040, and support for domestic permanent removals within the EU ETS.

Specifically, the Commission suggests that up to 3% of 1990-level EU emissions could be offset using international credits under Article 6 of the Paris Agreement. According to the carbon rating agency, BeZero, this could represent up to 460 million tons of CO_2 - potentially making the EU the largest sovereign buyer of such credits by 2040 [6].

However, the problem for CDR credits is that carbon removal is currently priced significantly higher than regular emissions allowances. Until the price gap narrows, companies will naturally choose the more affordable option, that is reduction emission credits.

Norway, as a member of the European Economic Area, is aligned with the EU's climate strategy, including key pillars such as the Fit-for-55 package and the drive toward a 55% reduction in GHG emissions by 2030, with a prospective 90% reduction target for 2040. While waste incineration emissions are not yet fully covered under the ETS, WtE with CCS – particularly for biogenic CO_2 – comes under the Effort Sharing Regulation (ESR) and is anticipated to benefit from future inclusion in the broader regulatory framework as European rules mature.

In May 2024, the EU Commission adopted an Implementing Regulation updating the templates for Member States to report their climate action data [7]. This refer to the emissions inventory reporting templates that EU Member States are required to use to submit their GHG emissions and removals data to the European Commission (and also under the UNFCCC/Paris Agreement).

The inclusion of BECCS removals in the new inventory templates means Norway can now explicitly report negative emissions from BECCS projects in its official climate inventories – just as EU member states can. This ensures that Norway's progress toward its climate ambitions – including its own 2030 Nationally Determined Contributions (NDCs) and 2050 carbon-neutrality goal – can transparently include engineered carbon removals from BECCS. CCS projects in Norway can now have their BECCS component formally recognized as a negative emission in Norway's official reporting. This could increase incentives for further BECCS deployment, both for meeting national targets and potential participation in international carbon markets or bilateral offset arrangements.

Another very important development is the Carbon Removal Certification Framework (CRCF), expected to apply from 2026 [8]. The CRCF introduces rigorous provisions for measuring, reporting, and verifying carbon removals, and will be crucial for Norwegian WtE operators aiming to certify and monetize removals credits – especially as additionality, durability, and transparency become mandatory standards.

3.1.4 The Voluntary Carbon Market and Corporate Demand

Finally, removals also take place on a corporate level, because of companies seeking to adhere to strategic goals. Companies accept offsetting activities through biogenic carbon removals, for instance through biogenic carbon capture and storage from WtE plants. Recent example is Hafslund Celsio selling CDR credits to Microsoft and the Frontier Buyers Coalition. This has created a market for voluntary carbon removal credits, where carbon removal companies sell removal credits to corporate entities. This market exists alongside other reduction schemes, currently with no direct regulatory coverage. However, the market is affected by national and regional subsidies to biogenic carbon capture.

3.2 Global level: From Kyoto to Paris

When the United Nations Framework Convention on Climate Change (UNFCCC) was first adopted in 1992, its main objective was to stabilize greenhouse gas concentrations at a level that would avoid dangerous climate change [9]. The convention recognized the potential role of carbon “sinks and reservoirs” such as forests and soils in absorbing carbon, but the emphasis of early climate policy was firmly on preventing and reducing emissions rather than on actively removing carbon dioxide from the atmosphere. At this stage, engineered carbon removal solutions were not on the agenda, and even land-based removals were only generally acknowledged – not operationalized through concrete policy mechanisms.

The introduction of the Kyoto Protocol in 1997 [10] marked a significant development in international climate policy by setting binding emission reduction targets for industrialized countries and launching new international market mechanisms such as the Clean Development Mechanism (CDM). Under the Kyoto Protocol, wealthier (industrialized) countries committed to making modest reductions in their greenhouse gas emissions. In contrast, lower-income (developing) countries were not required to make binding emission cuts. However, they could still participate by developing emission reduction projects. These projects allowed developing countries to generate carbon credits by, for example, building renewable energy facilities instead of fossil fuel power plants. Wealthier countries could then purchase these credits to help meet their own emission reduction targets under the Kyoto Protocol. The central issue, from a policy perspective, is that while total pollution might decrease, the CDM focuses on where these reductions are made rather than reducing emissions uniformly across all countries.

Example of Clean Development Mechanism under the Kyoto Protocol [11]

For example, if Europe committed to reducing its emissions under the Kyoto Protocol but chose to buy an emissions offset from a wind farm project in China, the emission reduction would occur in China rather than in Europe. This means Europe could emit more, as long as an equivalent reduction happened elsewhere. The overall level of global emissions would not necessarily fall, but rather the location of the reductions would shift from one country to another.

This approach reflected the design of the 1997 Kyoto Protocol, which aimed to take an initial, incremental step toward reducing global pollution by giving countries flexibility in how and where they achieved their emission targets.

While the CDM offered financial incentives to reduce emissions and support sustainable development, their focus remained largely on emissions reductions rather than removals.

Carbon removals began to enter the policy framework through the Kyoto Protocol's rules for "Land Use, Land-Use Change, and Forestry" (LULUCF) [12]. Parties could count certain removals – such as those from afforestation and reforestation – toward their emission targets. However, strict rules were applied to ensure environmental integrity, given concerns about measurement uncertainty, permanence (the risk of carbon being released back into the atmosphere), and leakage (emissions shifting elsewhere). Importantly, the policy scope remained limited to biological sinks and engineered CDR technologies such as BECCS or DACCS had little visibility or recognition within Kyoto's architecture.

3.2.1 Engineered CDR technologies enter the picture

The Paris Agreement of 2015 [13], which is the current international agreement that regulates international climate mitigation, ushered in a completely new era for both international climate policy and carbon removal. The overall goal of the Paris Agreement is temperature stabilization, which is codified in an agreement that almost all countries have signed onto.

Unlike the Kyoto Protocol, Paris required every country – developed and developing alike – to set their own climate pledges, known as Nationally Determined Contributions (NDCs). Critically, the agreement set a global goal to "achieve a balance" between anthropogenic emissions by sources and removals by sinks in the second half of this century. By introducing the concept of net zero, and by implication even net negative emissions, Paris elevated the importance of carbon removal, both through natural processes and engineered solutions.

Considering the Partis Agreement's focus on stabilizing global temperatures, it becomes clear that the world needs to move away from the current offset approach, where one party claims to have avoided emissions so that another can emit more. The offsetting approach born under the Kyoto Protocol does not deliver the total emission reductions that climate stabilization requires, and therefore focus need to shift toward carbon removal, making it the primary – and eventually the only – valid way to compensate for any remaining, unavoidable emission.

The Paris framework not only recognized the need for a broad portfolio of mitigation measures but explicitly included CDR as part of the solution to achieve deep decarbonization, particularly for offsetting residual emissions from hard-to-abate sectors. The Paris Agreement requires all parties to put forward NDCs. The required national contributions vary from one state to the other, and states have the prerogative to implement national legislation as they see it fit to reach their contributions, through for instance taxation or funding.

With the Paris Agreement, it became possible for countries, including Norway to count carbon removals towards its NDC under the Paris Agreement, provided these removals are measured, reported, and verified according to agreed international standards.

3.2.2 Article 6 and carbon credit mechanisms

Further strengthening this direction, Article 6 of the Paris Agreement [14] established new mechanisms for voluntary cooperation, including the exchange of mitigation outcomes between countries. Crucially, these mechanisms allow for both emission reductions and removals – including technological CDR – and set the stage for the development of high-integrity international carbon markets with strict rules for environmental integrity and credible measurement, reporting, and verification (MRV).

Article 6 of the Paris Agreement establishes a framework for international cooperation on climate action, which holds important implications for the WtE sector, especially in relation to CDR and emissions trading. This marked a major evolution in global carbon markets. Countries can now participate either through bilateral trading arrangements (Article 6.2) or through an UN-supervised global mechanism (Article 6.4).

Article 6.2 enables bilateral trading of emissions reductions or removals through Internationally Transferred Mitigation Outcomes (ITMOs). For the WtE sector, this means that countries hosting waste incineration projects with carbon capture capabilities could potentially sell emissions reduction or removal credits to buyer countries seeking to meet their climate targets. This mechanism can facilitate investments in advanced technologies and capacity-building for WtE facilities, particularly in developing countries. However, since Article 6.2 operates through decentralized agreements without standardized oversight or robust accountability measures, WtE projects face risks related to inconsistent quality and credibility of traded credits.

On 17th of June 2025, Norway and Switzerland signed a bilateral agreement under Article 6.2 of the Paris Agreement [15]. The agreement creates a legal framework for the cross-border transport and permanent storage of CO_2 between the countries and aims to generate early insights into regulatory frameworks, monitoring and reporting, and to support the development of a sustainable commercial market for CDR. If other countries seek similar arrangements as Switzerland, there may be increased demand and development of Norwegian CO_2 storage capacity, creating potential commercial opportunities for domestic capture projects, including WtE. In total, nearly 100 bilaterial deals have been signed under the 6.2. mechanism. Deals are spread across the world, with Japan, Singapore and Switzerland being the top 3 credit buying countries [16].

Article 6.4 introduces a centralized mechanism under the UNFCCC to generate and trade high-quality carbon credits between countries and private actors. This offers the WtE sector an opportunity to participate in a more regulated marketplace with established methodologies transitioning from the Clean Development Mechanism (CDM). Nevertheless, no specific methodologies for novel carbon removal technologies, such as those integrating carbon capture with WtE, currently exist under Article 6.4. Furthermore, the lack of minimum thresholds for permanence or unit quality raises concerns about "race-to-the-bottom" dynamics, where cheaper, potentially less durable removals (e.g., temporary nature-based solutions) could undermine higher-integrity technologies such as BECCS or carbon capture linked to WtE. This could impact market value and investment incentives for carbon removal within the WtE sector.

Looking ahead, the evolution of regional frameworks – such as the European Union's regulatory approach – may play a decisive role in shaping how WtE projects navigate carbon credit markets and compliance mechanisms under Article 6. For WtE operators and policymakers, understanding these nuances will be critical to leveraging international cooperation opportunities while ensuring environmental integrity and fostering sustainable sector growth.

3.3 EU Regulatory Framework

The European Union's regulatory framework plays a pivotal role in shaping CDR policy across Europe, directly influencing how WtE installations with carbon capture can contribute to climate goals. As a significant regional player with ambitious climate targets, the EU provides an overarching policy architecture that establishes binding rules, standards, and incentives to govern CDR activities, including those within the WtE sector.

3.3.1 Emission Trading Scheme (ETS)

The EU ETS is a key tool for reducing greenhouse gas (GHG) emissions in line with the EU's binding climate targets, including achieving climate neutrality by 2050 at the latest [17]. The ETS is designed to incentivise emission reductions, not removals. Emissions from the combustion of biogenic waste are zero rated under the EU ETS and do not create an obligation to surrender allowances (plants with 100% biomass combustion of biogenic waste are out of scope for the ETS), and therefore there is currently no benefit under the EU ETS to capturing biogenic CO_2.

If biogenic CO_2 remains outside the scope of the EU ETS, Norwegian WtE plants have no economic incentive to capture and store the biogenic fraction of their CO_2 emissions – once waste incineration is included in the ETS, which it currently is not. Only captured and stored fossil CO_2 can avoid incurring costs under the ETS.

Norwegian WtE plants are currently subject to a specific national fossil-based CO_2 tax. In 2025, it is 908 NOK/tonne, which is 75% of the general CO_2 tax on 1,210 NOK/tonne fossil CO_2 [18]. However, from 2026, WtE plants will be subject to 100% of the general CO_2 CO_2 = 1,405 NOK/tonne fossil CO_2. In 2030, this will be increased to above 2,400 NOK/tonne (2025-prices). These higher taxation rates increase the economic incentives for WtE plants to capture and store their fossil CO_2, as they can avoid these taxations costs by establishing and implementing CCS. However, as shown in part 6, estimated CCS costs in 2030 are projected to be higher than the tax savings.

3.3.2 Integration of CDR and WtE in the ETS

The EU Commission has been mandated to assess by 2026 if and how CDR could be accounted for and covered by emissions trading [19]. The Commission is actively exploring several policy options to effectively incorporate permanent carbon removals into the EU's climate governance architecture. The EU ETS stands out as one of the most powerful instruments to expand CDR from its current early-stage development into a gigaton-scale industry. In 2023 alone, the ETS generated auction revenues exceeding €43.6 billion [20]. To put this in perspective, just 20% of the revenue from the 2023 ETS auctions is greater than the total amount of CDR procured globally to date.

The Commission has opened a call for evidence and public consultation on the upcoming reviews of the EU ETS and the Market Stability Reserve (MSR). The deadline to submit input was 8th July 2025 [19] . The call covers several topics, including whether to include CDR and WtE in the scope of the ETS. By 31st July 2026, the European Commission is required to submit a report to the Parliament and the Council on the possibility of integrating negative emissions technologies (NETs) into the EU ETS. This should explore how emissions removed from the atmosphere can be safely and permanently stored, and how these negative emissions can be accounted for and covered by emissions trading without compromising necessary progress in reducing emissions. By the same date, the Commission will also have to assess and report on the possibility of including the WtE sector in the ETS with a view to including it from 2028.

The ETS has been effective in reducing emissions in the EU and its impact has evolved over time. Since its launch in 2005, it has played a central role in the EU's climate policy by setting a cap on total emissions from power plants, industrial facilities, and aviation within the system. By gradually lowering this cap, the EU ETS has created a financial incentive for companies to reduce emissions and invest in cleaner technologies. As part of the EU's plan to cut emissions by 55% by the year 2030 (known as the "Fit for 55" package), the ETS rules are being reformed. One key change is that the total amount of allowances – which allow companies to emit CO_2 – is being reduced faster than before. This means fewer permits will be available over time, making it more expensive to pollute and encouraging companies to lower their emissions quicker.

If current trends continue steadily, the total limit on emissions allowed under the ETS will shrink to nearly zero within about 20 years. This means companies covered by the ETS – including those in Norway's WtE sector (which is currently not part of the EU ETS) – will face increasingly strict caps on how much CO_2 they can emit.

While this tightening cap is essential for reaching climate goals, it also brings some new challenges. As the number of available emission permits becomes very limited, prices can become unpredictable and may fluctuate wildly. This can make it harder for companies to plan and invest in affordable ways to reduce their emissions.

Historically, the price of EU ETS allowances has ranged between 65 and 90 euros per ton, but projections from BloombergNEF indicate that the price could rise to 150 euro per ton by 2030 [21]. In comparison, the price of high-integrity CDR credits today is often in the range of 200–400 euros per ton, highlighting a significant gap that needs to be bridged if carbon removal is to play a major role in the ETS going forward

One possible solution being explored is to allow companies to meet part of their emissions obligations by purchasing what are known as "carbon removal allowances." These allowances would represent verified removal of CO_2 – meaning that instead of just reducing emissions, companies could pay for carbon to be permanently taken out of the atmosphere. For sectors like WtE, this could be very important as part of financing.

If carbon removal allowances become part of the ETS, Norwegian WtE plants could sell verified removal credits to companies struggling with expensive emission cuts, creating a new revenue stream. This approach could help companies and sectors with high costs for reducing emissions find a more affordable path to reach net-zero emissions. At the same time, it would encourage greater investment in permanent carbon removal technologies, which in Norway's case, means expanding the potential for WtE plants equipped with carbon capture to contribute significantly to climate goals.

Currently, the development of such carbon removal technologies in Norway depends heavily on government subsidies and companies voluntarily buying CDR credits. Integrating these removals into a regulated market like the EU ETS would provide a stable and predictable demand, helping scale up these technologies and supporting Norway's transition to a low-carbon future.

3.3.2.1 Recommendations KAN could make to the EU before ETS integration

Based on the analysis above, this section outlines key recommendations that KAN could present to the EU ahead of integrating the WtE sector into the ETS. The focus is both on identifying considerations that would support and benefit WtE operators, and on highlighting potential measures or design choices that should be avoided to prevent unintended negative impacts on the sector as a whole:

KAN should advocate for a gradual and predictable phase-in of the WtE sector into the EU ETS. Allowing stepwise integration will give operators the necessary time to plan investments, scale up carbon capture and removal technologies, and avoid abrupt financial shocks or disruptions that could threaten the stability of ongoing operations.

It is essential that biogenic CO_2 removals are fully recognized and incentivized within the ETS. The ETS framework must specifically acknowledge CO_2 captured and stored from biogenic sources as negative emissions, enabling the generation of tradable credits or allowances. This will establish the economic foundation for WtE-based carbon removal projects and promote further climate innovation in the sector.

KAN should also recommend a close synchronization between new ETS obligations and reliable funding mechanisms, such as reverse auctions and targeted subsidies. This coordination ensures that WtE installations are not burdened with unfunded mandates; instead, they will receive the necessary financial support to cover investment costs – especially during early-stage deployment of CCS infrastructure.

A clear and consistent approach to monitoring, reporting, and verification (MRV) is also critical. KAN should urge the adoption of standardized, EU-wide protocols for MRV, harmonized with ISO and forthcoming EU CRCF requirements. This ensures that both biogenic and fossil CO_2 capture are robustly measured, verified, and fairly credited, reducing uncertainty and administrative complexity for project developers.

Finally, KAN should emphasize the importance of avoiding a double burden with existing CO_2 taxes. Any new ETS-related obligations must replace – not add to – current national CO_2 taxation on waste incineration, in order to prevent redundant cost burdens on WtE operators for the same emissions.

The most relevant consideration for benefiting WtE players and avoiding harm to the sector is to ensure a fair and effective integration of the WtE sector into the EU ETS, it is crucial to avoid excessive administrative burdens by keeping compliance and reporting requirements as streamlined and harmonized as possible. This means steering clear of unnecessary WtE-specific obligations that would complicate operations or significantly raise transaction costs for operators.

Equally important is the need to prevent negative incentives for the circular economy. The design of the ETS should not inadvertently encourage increased waste incineration simply for the sake of generating removals credits, nor should it penalize plants that are responsibly managing unavoidable, non-recyclable waste. Safeguarding waste prevention, recycling, and reuse must remain top priorities.

Another vital recommendation is to maintain flexibility in removals recognition. WtE operators should be allowed to aggregate and trade their carbon removals credits across both voluntary and compliance markets, maximizing their ability to access diverse revenue streams and adapt to future changes in market demand.

3.3.3 European Carbon Removal Certification Framework

In February 2024, the European Parliament and the Council of the European Union reached a provisional agreement to move forward with the creation of the EU Carbon Removal Certification Framework (CRCF). This voluntary regulatory framework aims to set out high-quality standards for certifying high-quality carbon removals, with an initial focus on BECCS and DACCS. At the Carbon Removal Expert Group Meeting the 10th of July 2025, it was made clear, that WtE is covered by the Delegated Act established the certification methodology for BECCS and DACCS [22]. MRV is a core element, and the framework sets out criteria for monitoring that go beyond climate impacts. The framework differentiates between three types of carbon removal activity: permanent carbon removal, temporary carbon storage in long-lasting products, and temporary carbon storage from carbon farming.

3.3.3.1 Principles in the framework

To uphold both transparency and credibility in certifying carbon removals, the CRCF sets some key principles: First, CRCF requires that all carbon removal activities undergo independent verification. Additionally, an EU-wide registry for carbon removals is expected to be established by 2028. Meanwhile, registries from the voluntary carbon market, and government bodies will store information and must be able to interoperate. There are no details yet on how they will operate.

Second, to be certified under the framework, CDR activities must meet criteria in four areas: quantification, additionality, long-term storage and sustainability – called QU.A.L.ITY criteria.

1. **Quantification**: All carbon removals must be clearly measured, monitored, and reported to show real and verifiable climate benefits.
2. **Additionality**: Activities must deliver removals that go beyond what would have happened under existing laws and standard practices; only truly additional removals count. The draft delegated act assumes automatic additionality across permanent removal activities and does not list any regulatory or financial additionality testing
3. **Long-term storage**: The validity of certificates depends on how long the carbon is stored – promoting solutions that ensure the removed carbon stays out of the atmosphere for a meaningful period.
4. **Sustainability**: Carbon removal projects must also support broader sustainability goals, such as climate change adaptation, circular resource use, protecting water resources, and biodiversity preservation.

Figure 1 below illustrates the overall CRCF certification process. The process is modelled closely based on the rules for sustainable biomass under the EU RED. Much of the terminology is inspired from EU RED terminology instead of the Voluntary Carbon Market.

The EU Commission sets the overall rules by developing certification methodologies and officially recognising public or private certification schemes. By 2028, as earlier mentioned, it will also operate the central CRCF registry, issuing certified units. Member states and National Accreditation Bodies will be responsible for accrediting or recognising the certification bodies that audit and verify operators' activities, acting as a bridge between EU policy and national implementation. Then, there are the certification schemes (called standards/registries in the voluntary carbon market), who will overseeing the entire certification process: registering activities, appointing and supervising certification bodies, maintaining a registry, and issuing certified units until the central EU registry is established. Then comes the certification bodies (called verification/validation bodies in the voluntary carbon market), who are independent third parties tasked with carrying out certification and re-certification audits of operators. The certification bodies will issue certificates of compliance, ensuring operators meet the defined standards. Finally, there are the operators such as the KAN members, the entities that will carry out carbon removal activities. They join a recognised certification scheme, develop required activity and monitoring plans, undergo audits, and – if successful – receive certified units for their activities.

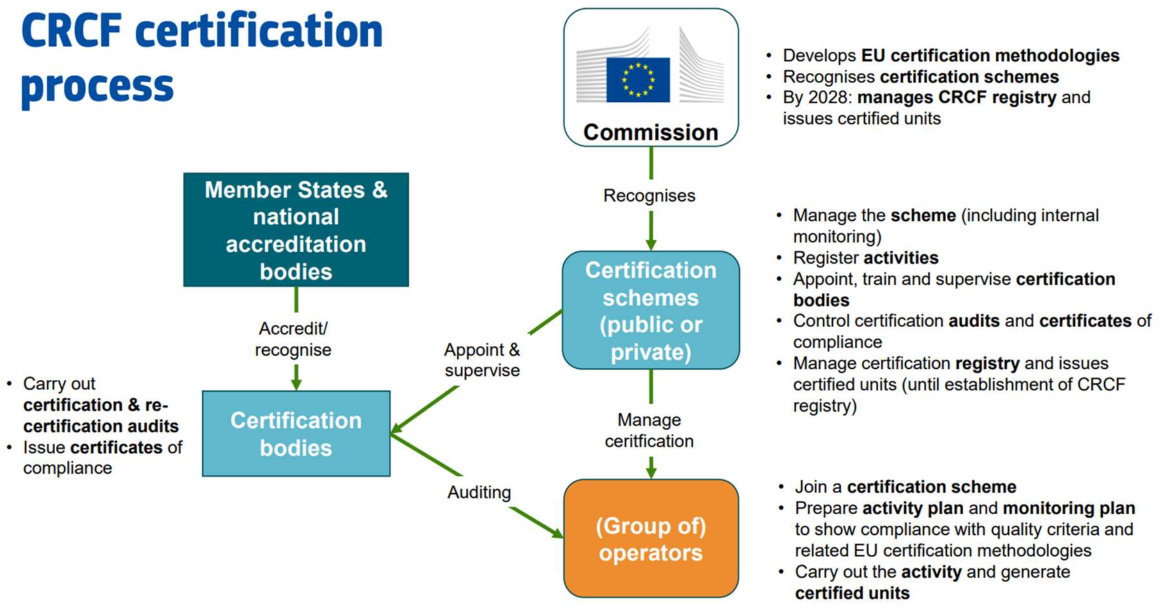

Figure 1: The CRCF certification process.

3.3.4 Green Claims Directive

The EU Commission's Green Claims Directive was proposed in March 2023 as part of the EU's broader effort to combat "greenwashing," where companies exaggerate or misrepresent their environmental impact [23]. The directive aims to ensure that any environmental claims made by businesses about their products or services – such as "climate-neutral" or "eco-friendly" – are substantiated with credible, scientific evidence and undergo independent verification. This includes claims made on product labels, advertisements, and other forms of consumer communication.

The Green Claims Directive is intended to promote transparency and protect consumers, while also creating a level playing field for businesses genuinely committed to sustainability. Under the proposal, companies must conduct life cycle assessments for their claims and provide documentation accessible to consumers and authorities. Claims must be clear, accurate, and not misleading, with specific requirements for how environmental benefits are communicated.

The Green Claims Directive in principle offers a critical opportunity to increase confidence in the voluntary carbon market (VCM) and further supports its positive development. However, negotiations on the final text of the Directive were cancelled on 23 June 2025 following an announcement from the Commission of its intention to withdraw its proposal. Reports cited in the media indicate that the announcement came in response to a letter from the European People's Party (EPP), the largest group in the European Parliament [24]. While the EPP expressed general support for measures to combat greenwashing, they argued that the Green Claims Directive's requirements were too burdensome, complex, and costly. Their main objection centred on the proposed mandate for third-party verification of environmental claims. With the EU currently prioritizing the reduction of administrative burdens, the withdrawal of the proposal highlights broader political disagreements over the extent to which the EU should regulate corporate sustainability efforts.

In its current form, the directive falls short of supporting and increasing confidence in the VCM. Firstly, the directive's guidelines on how corporations should engage with the VCM remain vague. There is little clarity on the standards or verification required for the use of carbon credits in corporate claims. This ambiguity means the GCD has, so far, missed a key chance to improve the integrity of the VCM and set clear policy signals that would boost investor confidence in high-quality carbon credits.

If and when the EU continues to resume negotiations and potentially revise the directive, there is still an opportunity to establish thoughtful, robust parameters for the use of carbon credits in green claims. Taking lessons from both the successes and flaws of the voluntary carbon market would allow the

GCD to better support claims backed by high-integrity credits, further encouraging sustainable corporate behaviour and investment.

Moreover, while policymakers work towards stricter consumer protection through explicit and accurate labelling, it is equally important to give companies much-needed clarity on what can – and cannot – be claimed in relation to carbon credits.

In conclusion, the effectiveness of EU policy will depend on whether it provides credible, consistent, and transparent rules that encourage voluntary climate action rather than stifle it. A well-designed Green Claims Directive can support ambitious climate goals by motivating both consumers and corporations to pursue meaningful sustainability – instead of simply discouraging action through bureaucratic uncertainty or regulatory gaps.

3.4 Norwegian CDR-related regulation

Contrary to the rest of the Nordics, Norway has not set an ambitious net-zero target. Instead, they are aiming for close to zero emissions (90-95% reductions) in 2050. Norway does not have any CDR targets yet [25].

However, Norway has been among the first to provide large subsidies to drive the development of a full-scale CCS value chain including carbon capture at two-point sources and transport and storage at large scale. The country has so far focused on supporting the concrete Longship project, which aims at capturing CO_2 and developing transport and infrastructure around the Northern Lights offshore storage site with approximately NOK 22 billion in public support. On 17th of June 2025, the Norwegian Ministry of Energy approved the development plan for the expansion of Northern Lights. Northern Lights phase 2 entails an increase of developed injection capacity to over 5 million tonnes of CO_2 per year [26].

Norwegian climate policy largely centres on the use of CO_2 taxes and emissions trading systems. By assigning a price to emissions, the policy not only creates direct incentives to reduce emissions but also promotes investment in research and development for future emissions reduction strategies. Although GHG taxes in Norway do not cover biogenic CO_2, they still encourage the development and deployment of technologies and projects across various CDR pathways.

For instance, Norway imposes a CO_2 tax on waste incineration, which applies to the fossil-derived portion of CO_2 emissions from incineration plants. CO_2 that is captured and stored from these processes is exempt from the tax. Since some of the CO_2 emitted by Norwegian incineration plants originates from biogenic sources, this exemption may indirectly promote carbon removal by incentivizing the capture and storage of both fossil and biogenic CO_2.

The large-scale deployment of CDR at WtE facilities in Norway will require subsidies to support the initial expansion of the waste incineration sector. Subsidy mechanisms are particularly crucial during the early stages of project development to facilitate investment decisions. Public support schemes, such as reverse auctions implemented in Denmark and Sweden, have proven effective in ensuring projects to go ahead. Compared to CDR credits, subsidies provide a stable cash flow, which helps companies build investor confidence, demonstrate predictable revenue streams, reducing risk and secure attractive long-term financing.

Norway would benefit from adopting similar subsidy initiatives. In fact, the Norwegian parliament has instructed the government to develop a carbon removal support scheme inspired by auction models currently used in Denmark, Sweden, Germany, the Netherlands, and France. The Norwegian Environment Agency – a government body under the Ministry of Climate and Environment – has proposed a reversed CO_2 tax, where monetary rewards are granted for every tonne of CO_2 removed [3]. They also recommend coupling national CDR policies with the option to trade CDR credits in the voluntary carbon market. The publication of reports regarding the current work on this front, due in August 2025, is unfortunately delayed.

To address barriers related to private-sector access to capital, the Norwegian government could strengthen its collaboration with national development banks, such as Norwegian Export Credit

Guarantee Agency (GIEK), to offer specialized concessional financing and loan guarantees. These financial instruments help reduce investment risks for private-sector entities, thereby mobilizing the significant private capital needed to build and scale up capital-intensive CDR infrastructure.

3.5 Voluntary Carbon Market (VCM)

The Voluntary Carbon Market (VCM) is the term used to describe the private sector market where businesses, organizations, and individuals choose to buy and sell carbon credits representing reductions or removals of GHGs from the atmosphere. Each carbon credit is a unit, a certificate that represent one ton of CO_2 equivalent. This market operates independently of regulatory requirements, and there is no standardized definition of the VCM. The market is broadly understood as a platform through which actors offset their emissions on a voluntary basis. The VCM is connected to the Paris Agreement and Article 6 in that the crediting of removals within the VCM is governed by private carbon standards. While national regulatory authorities may establish rules for VCM activities, they do not participate in certifying removals nor in the issuance of carbon credits. Nonetheless, activities within the VCM can contribute to countries' efforts to meet their commitments under the Paris Agreement.

Additionally, to avoid double claiming of removals some market actors seek approval of VCM activities under Article 6 of the Paris Agreement. In that case, VCM activities need to comply with the Paris Agreement Article 6 rules.

Overall, the VCM constitutes a relatively small segment, estimated to represent just 2% of total carbon trading, with the remaining 98% dominated by compliance markets such as emissions trading schemes [27]. While emissions trading schemes primarily involve the exchange of emission allowances, the VCM focuses exclusively on carbon credit. Although the VCM represents a relatively small portion of overall carbon trading, it plays an important role by allowing businesses to exceed their mandatory decarbonization commitments.

Following a rapid expansion in 2021-2022, the VCM faced significant criticism in 2023. In January of that year, publications such as The Guardian and Die Zeit highlighted a study revealing that over 90% of rainforest carbon credits traded on the VCM were deemed worthless [28]. This criticism largely centred on concerns about the additionality of the credits – that is, whether the credited emissions reductions would have occurred without the financial incentives provided by the carbon market.

This heightened scrutiny regarding the integrity of the VCM has sparked demands for stronger quality control measures and more consistent regulatory frameworks. In response, stakeholders within the VCM have developed various standards to define what qualifies as "high-quality" carbon credits. Notable examples include the Core Carbon Principles by the Integrity Council for the Voluntary Carbon Market, the Carbon Credit Quality Initiative's scoring tool, and the Oxford Principles for Net Zero Aligned Carbon Offsetting.

The voluntary market has yet to adopt a universally accepted definition of quality, including common criteria include independent third-party validation and verification, accurate quantification of emissions reductions, high permanence, additionality, and the inclusion of sustainable development benefits and safeguards.

The lack of a standardized quality definition may have hindered sales of carbon credits from projects with higher environmental integrity, which typically command premium prices. While numerous organizations – from standard setters to quality rating agencies – provide guidance and assessments, many are still in early stages of applying these frameworks specifically to CDR credits.

3.6 Meta-standards

This section describes the role and function of "meta-standards", which is understood as quasi-regulatory frameworks, codes or "best practice" organizations in the Voluntary Carbon Removal Market. They are to be distinguished from specific standards and registries such as Puro, Verra, etc., who define the rules, requirements, and methodologies for developing, measuring, and verifying carbon projects. Meta-standards do not issue credits, manage projects, or provide project-level methodologies themselves. Instead, they assess, endorse, or provide guidelines that specific standards can – and should – align with.

3.6.1 ICVCM

The Integrity Council for the Voluntary Carbon Market (ICVCM) is an established non-governmental body from 2021 in response to an international initiative focused on scaling carbon finance [29]. It was recognized that, to effectively expand carbon markets, there was a need to enhance their comparability, integrity, and consistency. These improvements are intended to improve the quality of carbon credits and make carbon markets more transparent and reliable, thereby facilitating greater investment

The problem addressed was the fragmented and niche nature of the VCM, and the purpose of the ICVCM was to set a global benchmark for high integrity, enhancing comparability and consistency across the market.

In 2023, the ICVCM released a set of Core Carbon Principles (CCPs) after consultation with stakeholders, researchers and policymakers. The CCPs are supported by a comprehensive assessment framework that demonstrates how they underpin high-integrity, consistent, and comparable carbon markets. There are ten principles in total, all well-recognized among carbon market participants, illustrated below:

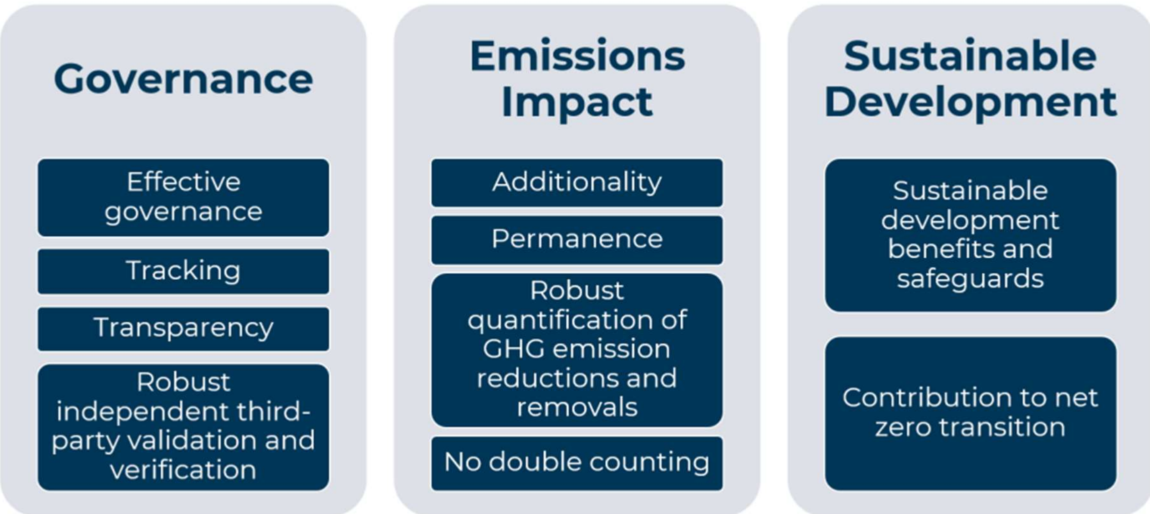

Figure 2: Core Carbon Principles (source: The Integrity Council for the Voluntary Carbon Market (ICVCM)).

Four of the principles focus on the operation of carbon crediting programs, specifically examining governance structures, risk management within registries, transparency, and the application of third-party verification. Collectively, these factors provide a governance foundation that ensures market integrity.

Another set of four principles addresses the measurement of outcomes in individual carbon projects. Key elements assessed include additionality and permanence (evaluating whether emission reductions and removals are genuinely above business-as-usual scenarios and how the risk of reversal is managed), as well as safeguards against double counting and over-crediting. The framework emphasizes the use of conservative estimation methods to avoid issuing more credits than warranted – an issue that has posed challenges in the past.

The final two principles relate to areas where the market has historically lacked coordination, transparency, and progress: sustainable development benefits and net zero contribution. These principles advance holistic and effective approaches to human rights, free prior and informed consent, environmental safeguards, and support the global transition to net zero emissions.

The ICVCM utilizes a double tick approach to evaluating both carbon crediting programs and their associated methodologies. This multi-step process is informed by multi-stakeholder working groups and expert consultations, ensuring that diverse experiences and learnings from across the carbon market are incorporated into ongoing improvements.

The assessment process is aligned with a detailed rulebook developed through extensive stakeholder consultation. It involves evaluating whether programs and methodologies meet the established Core Carbon Principles (CCPs). These assessments take into consideration real-world implementation challenges and evolving best practices, with particular attention paid to integrity, risk mitigation, and opportunities for further refinement.

Programs and methodologies may receive approval – sometimes with conditions – or may be rejected if significant issues are identified. Commonly, programs rejected at first submission are encouraged to address deficiencies and reapply. Upon approval, specific carbon credits may be labelled with the CCP mark, signalling to buyers that these credits meet the highest standards of integrity and comparability

Key areas of assessments
In May 2025, the ICVCM released its Continues Improvement Work Program (CIWP), which brings together leading market experts and key stakeholders to evolve, harmonise, standardise, and modernise the supply of high-integrity carbon credits [30].

The report shows that methodological questions about permanence – making sure that the carbon removed represented by a carbon credit are maintained over time – are central to many debates within carbon market. The CIWP has examined a range of innovative strategies for managing permanence and mitigating reversal risk, including the implementation of monitoring and compensation periods, the establishment of pooled buffer reserves, the development and application of reversal risk assessment tools and procedures, as well as the utilization of insurance products and mechanisms.

Another point of concern at the methodology level is the demonstration of additionality and the robustness of supporting evidence. Many methodologies have been rejected due to insufficient documentation showing that projects would not have occurred in the absence of carbon finance. Other common areas of scrutiny include the management of reversal risk and the accuracy of emissions accounting, particularly the use of conservative calculations to prevent over-crediting.

At the program level, transparency is a concern. The ability of carbon crediting programs to publish comprehensive information about project operations and decision-making processes has been highlighted as critical for building market confidence. As a result, programs have been encouraged to enhance public disclosure around projects, methodologies, and internal governance.

3.6.2 VCMI

Another key industry organization focused on addressing and responding to the quality concerns in the voluntary market, is the Voluntary Carbon Markets Integrity Initiative (VCMI). The focus of VCMI is on establishing standards and guidelines for what constitutes a credible and responsible claim when companies use carbon credits. Their work seeks to answer questions such as: *How should companies use carbon credits as part of their decarbonization strategies? What kinds of claims about carbon neutrality or climate impact are genuinely meaningful and not misleading?*

This is a fundamentally different challenge than ensuring the environmental integrity of the underlying carbon credits themselves. While the VCMI’s work on clarifying the appropriate role for carbon credits in corporate climate action is important – especially for preserving trust and preventing “greenwashing” – it essentially addresses the demand side of the voluntary carbon market: the claims and communications that companies make to consumers, investors, or regulators.

Contrary to the ICVCM, the VCMI is not dealing with the supply side of the voluntary carbon market. Until the environmental integrity, additionality, and overall quality of carbon credits are robustly ensured, improvements in how companies communicate their use of credits can only go so far. Without a reliable supply of high-quality credits that deliver real, additional, and permanent emission reductions or removals, even the most carefully regulated claims will lack substance.

3.6.3 ICROA

While ICVCM and VCMI are kinds of oversight councils focused on established robust global threshold for the carbon removal market, ICROA (International Carbon Reduction and Offset Alliance) is an industry association of carbon removal providers and sellers aiming to promote corporate net zero delivery alignment with the Paris Agreement goals. The ICROA Programme was established in 2008.

Engagement with ICROA gives access to a vetted group of market participants with a shared commitment to quality but does not guarantee acceptance of credits by governments or regulatory frameworks. For example, Microsoft seems to prefer ICROA-endorsed registries. For project developers, aligning CDR projects with ICROA best practices delivers market benefits and stronger positioning for future regulatory changes – but always in partnership with an approved carbon standard. It is in this regard important to treat ICROA's Code as a form of "minimum bar" for quality, transparency, and buyer confidence, and they differ significantly from ICVCM, who acts more as a market regulator by defining eligibility standards through the CCPs that methodologies and programmes must meet to be considered credible.

ICROA Approval is obtained annually through an independent third-party compliance audit based on the ICROA Code of Best Practice. The Code sets out requirements and guidelines for high integrity and is continuously updated to encompass best practices.

Project developers cannot submit their project to ICROA for approval but can instead use an ICROA-endorsed standard to develop, verify, and issue their credits. If credits originate from such a standard and meet all its requirements, they are regarded as ICROA-compliant for the purposes of buyers and ICROA members.

ICROA does not verify credits directly or operate its own registry. Instead, it conducts an approval process for third-party standards. If a standard meets ICROA's quality benchmarks, ICROA members are allowed to use and sell credits issued under that standard and can market them as being ICROA-approved. At the moment, standards such as Puro.earth, Verra's Verified Carbon Standard, Gold Standard, Isometric (although conditional [31]) and Rainbow have been ICROA-approved.

3.6.4 CORSIA

CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) was established as an international mechanism under the International Civil Aviation Organization (ICAO) to cap and offset the growth of emissions from international aviation. It is seen as a bridge between the voluntary carbon market and compliance markets; although called "voluntary" in terms of participation for member states in the pilot and first phases, for airlines it is, in practice, a compliance obligation.

Its primary function is to require airlines to offset growth in CO_2 emissions above 2020 levels by purchasing eligible carbon credits. CORSIA thus acts principally as a buyer-side demand driver, though its standards for eligibility also exert supply-side influence by setting which projects and credits are accepted.

CORSIA does not certify or issue credits itself. Instead, it runs intakes and approves third-party crediting standards (like Verra and Gold Standard) and specific project types/methodologies as eligible for use by airlines under the scheme. Credits must meet CORSIA's criteria to ensure quality, additionality, permanence, and prevention of double counting.

The scheme is moving from the pilot to the compliance phase, with the second phase (2027 onward) being fully mandatory for eligible countries/flights. From 2027, all international flights will be subject to offsetting requirements except for less developed countries, with a few exceptions. CORSIA's demand signal is significant – by increasing certainty about which units are eligible and how to meet future obligations, it encourages project deployment, investment, and brings secondary market activity (including trading and derivatives).

There is a major focus on interoperability between CORSIA, voluntary registries, and potentially Article 6 registries (under the Paris Agreement), so that credits can more easily qualify for multiple regulatory uses. Digitization is key, with the hope that projects are registered, tracked, and retired through advanced, interconnected registries, improving both market efficiency and integrity.

3.6.5 ISO

One of the most widely used international standards for carbon accounting is the ISO 14064 family. Compared to ICVCM and ICROA, ISO is a standard that proves a technical framework for specifying GHG quantification and monitoring. It is not a market or quality regulator in the way the ICVCM is. The ISO standard has been quite fundamental for developing or adapting carbon removal methodologies under various registries.

The ISO 14064 standard is published by the International Organization for Standardization (ISO) and consists of three parts:

- **ISO 14064-1:** Quantification and reporting of GHG emissions and removals at organizational (company/facility) level.
- **ISO 14064-2:** Quantification and reporting of GHG emissions and removals at project level.
- **ISO 14064-3:** Provides requirements and guidance for the verification and validation of GHG assertions, i.e., emissions reports or project claims. This part is typically used by third parties who check that the project or entity's emissions/removals claims are accurate, reliable, and compliant with 14064-1 or 14064-2.

Many carbon credit standards and registries use ISO 14064-2 as a foundation or reference point to ensure technical robustness and international consistency in project-level GHG quantification. However, ISO 14064-2 does not set out detailed criteria or step-by-step procedures for carbon removal projects. Instead, it presents broad, general requirements for quantifying, monitoring, and reporting removals from projects. This means that while it sets out a solid framework, project developers still need to refer to additional, often sector-specific, methodologies/protocols to determine exactly how quantification and monitoring should be carried out in practice.

3.6.6 Science Based Target Initiative

The Science Based Targets Initiative (SBTi) is a widely recognized standard setter guiding companies in setting climate targets that are aligned with the latest climate science. Although not a government regulator, SBTi operates as a sort of voluntary regulatory body for the private sector. It was established by respected environmental NGOs – not by the offsets industry itself – which gives its standards a high degree of credibility and impartiality in the sustainability world.

SBTi has rapidly become the de facto authority for rating and assessing the validity of corporate climate commitments. Almost 10,000 companies have emissions reduction targets validated by the SBTi, however less than 50 of them have so far purchased durable carbon removal [32]. Its main role is to evaluate whether companies' emission reduction targets are scientifically robust and consistent with achieving a long-term, net-zero emissions future. Companies participate in SBTi's process voluntarily to demonstrate climate leadership, respond to stakeholder pressure, and increase their credibility with investors and the public.

A key element of SBTi's standard is its firm position on the use of carbon offsets. SBTi has long made it clear that buying carbon credits cannot be counted toward a company's official progress on reducing its greenhouse gas emissions for any of the three scopes:

- **Scope 1:** Direct emissions from a company's own operations,
- **Scope 2:** Indirect emissions from purchased electricity, heat, and steam,
- **Scope 3:** All other indirect emissions up and down the company's value chain (such as suppliers and end-users).

In short, SBTi says that companies cannot “zero out” these emissions by relying on offsets. To be SBTi-compliant, companies must actually reduce emissions from their operations, energy purchasing, and value chain.

However, SBTi also recognizes that carbon credits can play a positive role in climate action – just not by substituting for the work of reducing once's own emissions. SBTi encourages companies to pursue what they call “beyond value chain mitigation”: efforts that go further than the immediate footprint, such as funding carbon credit projects. These actions are considered valuable and are encouraged by SBTi, but they do not count towards a company's core emissions targets.

3.6.7 Comparison and key take aways for KAN

This section compares the different meta-standards described in sections 3.6.1 to 3.6.6. There are several differences in terms of role, focus, scope, what they approve and how they work.

For example, ICVCM, ICROA and CORSIA share the overarching goal of promoting integrity and credibility in carbon markets but differ in their specific roles and functions. ICVCM and ICROA work on the supply side of the voluntary market, while the VCMI and CORSIA work on the demand side. While ICVCM is primarily focused on setting global standards for carbon crediting programs and the credits they issue, ICROA specialises in accrediting carbon offset providers and market participants. CORSIA is entirely addressing emissions and global market-based measures from a particular sector, international aviation.

The findings are summarised in Table 2.

Key takeaways for KAN include:

- Make sure to certify under a standard with current ICVCM CCP approval status.
- Look for VCMI-aligned credits and collaborate with buyers that has adopted the VCMI's carbon integrity claims.
- Make sure the chosen registry is ICROA-approved.
- Ensure that project quantification and MRV-processes align with ISO requirements, using ISO compliant templates for project design and MRV.
- Collaborate with companies/potential CDR buyers that have climate targets approved by the SBTi.

Part 4 elaborates on these take aways and describe in detail the different relevant standards and methodologies, while part 5 maps the MRV requirements for WtE installations.

Table 2: Comparison of meta-standards.

	Role	Focus	Scope	What it approves	How it works	Relevance for KAN
ICVCM	Independent oversight body and “market regulator”. Deals with the supply side of the voluntary market.	To set a global quality benchmark through Core Carbon Principles (CCPs) for all standards and methodologies.	Sets integrity/quality threshold, but does not issuing credits like a carbon standard, developing credit-generating projects or providing an infrastructure to purchase credits like a registry.	Standards/registries and methodologies against CCP’s. Grants CCP label.	“Double tick” evaluation – checks both the registry/program and the methodology against CCPs.	Offers a pathway to “premium” credit status. Projects should certify with a standard that has ICVCM’s CCP label.
VCMI	International non-profit organization. Deals with the demand side of the voluntary market.	Focusing specifically on the credibility and integrity of corporate claims related to the use of carbon credits.	VCMI addresses the crucial question of what kind of claims companies can responsibly make when using carbon credits.	Under VCMI’s Claims Code, companies can use carbon credits to make “Carbon Integrity” claims, to accelerate global net zero above and beyond science-aligned emissions cuts.	Provides guidance on how companies can make voluntary use of carbon credits as part of credible, science-aligned net-zero decarbonization pathways.	Raises the integrity of carbon removal credits substantially.
ICROA	Industry association and best practice advocate for CDR actors.	Promotes industry quality and best practices.	Sets bode of best practice – minimum requirements – not a granular technical rulebook.	Endorses standards. Does not approve projects or run a registry.	Annual third-party audit for ICROA Best Practice Code compliance; buyers and members rely on this for trust.	Assures the use of a recognized industry-wide standard, helping with market access. But not regulatory approval.
CORSIA	International aviation compliance scheme (offsets sectoral emissions growth). Deals with the demand side of the voluntary market.	Ensuring credible, additional emission cuts for airline emissions.	International flights, specific offset eligibility, not a registry or project standard.	Approves eligible programs, not individual projects or standards.	Annual airline reporting; Technical Advisory Body reviews; only approved credits accepted for compliance.	Drives demand for high-integrity credits; indirect influence on voluntary market and project design; raises baseline for credit quality globally.
ISO	Developer of global technical standards. Not a direct market actor. Provide technical frameworks for GHG. Removal measurement, monitoring and reporting.	Provide technical frameworks for GHG removal measurement, monitoring and reporting.	Broad, general requirements; not a registry of removal methodology itself.	Sets requirement for quantification and verification of GHG removals at project level.	Projects/organizations follow ISO’s framework; third parties can verify compliance via 14064-3.	Provides a credible framework for GHG accounting used in third party-verification for any removal claim.

	Role	Focus	Scope	What it approves	How it works	Relevance for KAN
SBTi	Science-based target setting for companies. Corporate net-zero targets, prioritizing real emission reductions, later limited use of removals.	Corporate net-zero targets, prioritizing real emission reductions, later limited use of removals.	Sets what "net zero" means for corporate action – very strict on removals/credits until residuals remain.	Approves company emission reduction targets and net-zero commitments as science-based if criteria are met.	Companies submit targets, SBTi reviews and validates; ongoing updates to methods; engagement with businesses & NGOs.	SBTi is the reference for credible climate strategies and net-zero target setting; benchmark for best practice & compliance.

3.7 Credit rating agencies

As the voluntary and compliance carbon markets expand, the need for reliable, transparent, and high-integrity carbon removal credits becomes increasingly pressing. In response, a new generation of specialized rating agencies – such as BeZero Carbon, Sylvera, and Calyx Global – has emerged. They offer independent assessments of the quality and integrity of carbon projects. This development mirrors the critical role played by credit rating agencies in traditional financial markets, where independent ratings underpin investor confidence, set industry benchmarks, and promote transparency.

An additional layer of integrity check
Beyond the existing quality controls performed by standard-setters such as ICVCM and project verifiers, these independent rating agencies add an extra, vital layer of integrity check. Their assessments go beyond the minimum requirements of carbon standards, subjecting projects to rigorous, third-party scrutiny using transparent, science-based methodologies. By acting as an independent "second opinion," they help to uncover issues that may be overlooked in the initial certification process and provide buyers with a higher level of confidence in the environmental claims associated with carbon removal credits.

Much like Moody's, S&P Global, and Fitch in the financial sector, carbon rating agencies systematically evaluate and score carbon removal projects on a range of criteria including additionality, permanence, leakage, co-benefits, and transparency.

For example:

- **BeZero Carbon** [33] utilizes a multi-factor risk assessment, scoring credits on their likelihood of delivering claimed emission reductions or removals.
- **Sylvera** [34] leverages satellite monitoring, AI, and comprehensive project reviews to deliver dynamic and evidence-based ratings.
- **Calyx Global** [35] offers scorecards that assess projects against international benchmarks and the latest science.

3.8 Regulatory risk and barriers for issuance of CDR credits

Based on the analysis of the regulatory framework conditions, several barriers and risks can be derived. KAN members will need to be aware of them and mitigate them before entering the market of carbon removal and issuance of CDR credits.

In this chapter, we describe these risks. The risk and barriers identified in this chapter are derived from qualitative desk research combined with direct COWI insights from CCS and BECCS projects. The barriers are mainly identified in the areas of regulations, MRV and social acceptance.

- **Regulations:**
  - Lack of CDR targets and subsidy schemes for capture.
  - Uncertainty regarding CDR integration in the EU ETS.
  - Uncertainty regarding integration of WtE in the EU ETS.
- **MRV:**
  - CDR standards fragmentation.
  - Conflicts of interests inherent in the structure of the VCM.
  - Potential conflicts in ICVCM and ICROA's multi-stakeholder approach.
- **Social acceptance:**
  - Public mistrust of waste incineration + CCS.
  - Risk of public/stakeholder confusion of fossil vs. biogenic CO_2.

3.8.1 Uncertainty regarding carbon removal integration in the EU ETS

Integrating carbon removals into the EU ETS could have different financial implications for WtE plants. Firstly, it could lead to increased administrative costs (setting up extra MRV mechanisms). Secondly, it will lower potential national government subsidies to counterbalance the ETS savings.

Thirdly, full integration of biogenic CO_2 and removals into the ETS would mean WtE operators could either receive carbon allowances (which they could sell) or would no longer need to surrender allowances for the emissions they capture and store. This can make WtE+CCS projects more financially attractive – especially if the price of carbon allowances is higher than the cost of capturing and storing each tonne of CO_2. As the price of allowances increases, the financial motivation for investing in BECCS becomes stronger, which could encourage more WtE operators to adopt these technologies and help scale up the market for carbon removals.

However, the lack of regulatory clarity about exactly how and when carbon removals will be integrated into the ETS creates a risk premium. The problem in the near term is, that there is a significant price gap between carbon allowances in the ETS and CDR costs – CDR costs are significantly higher than the price of emitting fossil CO_2 in the ETS. Direct integration is not economically viable today. Prices need to converge for ETS integration to drive meaningful demand, and this will probably take several years.

The EU Commission has therefore proposed a purchasing programme for carbon removals to try to bridge the price gap between the EU allowances and the CDR costs through scale and strategic purchasing. Three proposals have been discussed each representing a different model of public-private collaboration: an EU coordinated Buyers Club, an EU Removals Fund, and a Centralized Procurement Agency.

3.8.2 Uncertainty regarding inclusion of Waste-to-Energy in the EU ETS

By July 2026, the Commission is due to assess and report on the feasibility of including municipal waste incineration installations in the EU ETS from 2028. This “kicking the decision down the lane” creates different sources of uncertainty. Firstly, the EU ETS price is determined by market dynamics and can fluctuate due to various factors (policy changes, energy prices, market sentiment, etc.). For waste incineration facilities, this means uncertainty not only over the level of future carbon costs, but also over their volatility – making long-term planning and investment decisions riskier. Secondly, the relationship between the existing national carbon tax and the possible future ETS obligation is unclear. Will the national tax be removed, will it coexist with the ETS, or will it be adjusted? This affects both near-term and long-term investment planning.

3.8.3 Lack of CDR targets and subsidy schemes for capture

Norway is the only Nordic country that has not yet adopted a net-zero decarbonization target. Despite the significance of CDR, Norwegian climate policy does not clearly define the role of CDR, nor does it set dedicated targets for removals.

To provide clarity and direction, Norwegian policymakers should explicitly recognize CDR as essential for achieving both net-zero and net-negative emissions and establish specific, measurable CDR volume targets. The absence of such targets creates uncertainty among industry, investors, and civil society about the government’s commitment to utilizing CDR as a necessary tool for reaching climate neutrality and, ultimately, climate positivity.

Furthermore, no government subsidy support for BECCS projects have yet been proposed by the government. The lack of long-term funding certainty represents a barrier for issuance of CDR credits in Norway. Unlike projects that reduce fossil CO_2 emissions, carbon removal activities within the WtE sector do not receive financial incentives through national carbon taxation of emission trading schemes and have no regulated marketplace for their product.

Long term government-guaranteed income, for instance in form of “reverse auction subsidies[1]” now being implemented in Denmark and Sweden, could provide businesses with predictability and facilitate effective project implementation from the project owner’s perspective. The state subsidies should be possible to combine with CDR sales in the voluntary carbon market. Additional income from the sale of carbon removal credits could make it possible to realize projects with higher costs than the support level allows.

3.8.4 CDR standards fragmentation

CDR credits are certified by standards and registries. They develop specific methodologies for which projects are eligible to generate CDRs and how the carbon removals must be monitored, reported and verified. There are many private CDR standards with several distinct methodologies, but the standards do not harmonize their methodologies.

For example, all credible standards mandate financial additionality as a fundamental requirement; however, they vary in how rigorously this criterion is evaluated – some apply very detailed investment analysis, while others rely more on qualitative analyses of barriers. Additionally, standards differ in their methodologies for calculating carbon removal volumes, which can result in the same project receiving different certified CDR amounts depending on the chosen standard.

Another key area of difference among standards is rules on double counting and double claiming – some standards place limits on the ways claims can be made (these areas of differences and their implications for KAN are explained in detail in part 4.

This lack of methodological harmonization can create uncertainty in the market and among buyers about which certification reliably represents high-quality CDR. It remains to be seen, whether the EU’s effort on established a set of overarching harmonized quality criteria with the CRCF can provide some consistency across standards over time.

3.8.5 Need for alignment between ICVCM’s CCPs and government policy regulations and principles

The global effort to mitigate climate change necessitates robust, transparent, and high-quality systems for carbon removal. As earlier describes, The Integrity Council for the Voluntary Carbon Market (ICVCM) has made significant strides toward this objective through its development of the Core Carbon Principles (CCPs), which set out rigorous standards for carbon credit integrity, including environmental and social safeguards, additionality, permanence, and robust quantification.

However, to maximize the effectiveness and credibility of carbon removal credits, it is crucial to establish a stronger alignment and linkage between these voluntary standards (CCPs) and government regulation and principles such as the European Carbon Removal Certification Framework (CRCF). Currently, the voluntary carbon market and government-led systems often operate in parallel, with limited coordination. This fragmentation can undermine market confidence, create opportunities for "double counting" or substandard credits, and ultimately dilute the climate impact of carbon removal initiatives.

3.8.6 Conflict of interests among standards

Today, many carbon credit standards and registries play several roles at once, and there is no clear separation of roles or responsibilities. It is rather a one-stop shop. The role of many registries such as Puro, Verra, Gold Standard, etc. design and maintain the methodologies that define what is eligible for carbon credits and how credits are quantified; they also approve and register projects, issue credits, and manage the ultimate retirement, transfer and/or cancellation of credits; and they

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[1] Selects carbon removal providers through competitive bidding; winning bidders receive fixed subsidies per ton of verified CO_2 permanently stored. Examples include Swedish BECCS reverse auction (Stockholm Exergi) and Danish CCS reverse auction (Ørsted).

are typically funded by fees paid by the suppliers per issued credit (some registries are trying to solve this conflict of interest-problem such as Isometric).

This creates a conflict of interests in the sense that registries profit more the more credits they issue, which creates a financial incentive to approve more projects, even if the quality and climate benefits are questionable. They may be less strict with scrutiny, additionality or monitoring requirements if that would reduce the number of projects or credits, and hence their income.

For Norwegian WtE suppliers considering the creation and sale of CDR credits, these conflicts of interest underline the importance of selecting registries with robust governance, transparency, and independent oversight and choosing standards that feature “firewalls” between project approval/issuance and revenue, public oversight panels, rotation of verifiers, and published audit trails.

3.8.7 Public mistrust in incentives

Finally, engineered approaches such as BECCS often encounter varying degrees of scepticism, primarily rooted in perceptions of technological complexity, higher costs, or association with industrial activities (such as oil and gas) historically viewed as contributing to environmental degradation.

One concerning factor contributing to mistrust is the presence of incentive structures that unintentionally encourage counterproductive behaviour. This refers to the incentive structure where capturing and storing carbon from waste incineration might unintentionally encourage increased waste generation or waste incineration, undermining broader climate and environmental goals.

The public and environmental stakeholders can be concerned that CCS technologies in general might be used to justify the continuation or expansion of waste incineration – perceived as a polluting activity – rather than prioritizing waste reduction and circular economy practices. This creates scepticism about whether CCS/CDR truly contributes to net climate benefits or merely postpones or masks deeper systemic changes. This dynamic can lead to a perception that CCS creates a “license to pollute” or “false solutions,” reducing acceptance of these technologies and increasing opposition, protests, or political resistance. People may question whether CCS projects are genuinely part of a sustainable climate strategy or just a financial mechanism benefiting operators.

3.8.8 Risk of public/stakeholder mistrust of distinction between fossil vs. biogenic CO_2

The idea that “CO_2 is CO_2” is common – but for climate accounting, the origin is critical.

For WtE projects, buyers, decision-makers, the media, and the public may not fully understand – or may be misinformed about – the difference between capturing biogenic CO_2 and fossil CO_2. This confusion can create scepticism if the project does not clearly communicate what type of CO_2 is being removed, leading buyers to question the credibility of the project’s climate claims. Should news of over-crediting or misclassifying fossil CO_2 as biogenic emerge, it can undermine trust and harm the reputation of both the project and the wider WtE sector. If stakeholders perceive that carbon removal credits from WtE are simply masking fossil emissions, this may trigger backlash from regulators and advocacy groups, putting the sector’s license to operate and access to carbon markets at risk.

4 Standards and registries

4.1 Scoping of the CDR certification landscape

4.1.1 Introduction and structure

This part of the report builds on the regulatory landscape outlined in part 3, providing a detailed assessment of certification standards essential for navigating the regulatory and market requirements.

As Norway's WtE sector moves toward large-scale deployment of CCS, credible certification of captured and stored CO_2 is becoming increasingly crucial. Certification provides not only market recognition and access to new revenue streams but also underpins environmental integrity, investor confidence, and alignment with both Norwegian and EU policy frameworks. In a rapidly evolving carbon removals market, a variety of certification schemes and methodologies have emerged – each with differing requirements, credibility, and suitability for WtE with CCS.

This part 4 of the report aims to guide KAN's members in selecting robust, future-proof certification options for carbon removal activities. By systematically comparing leading international certification standards, the part hopefully provides a foundation for informed strategic decisions on a feasible certification pathway.

Section 4.1 opens with a scoping and overview of leading international CDR standards and registries, with a focus on their relevance for KAN. It ends with conclusive remarks that reflects key findings, which are then elaborated and detailed in all other chapters.

Section 4.2 introduces the evaluation framework, describing the criteria for evaluating the standards' overall credibility, market access and cost model. Section 4.3 presents the assessment of key methodological differences among the standards, by introducing criteria such as quantification, additionality, double counting, and permanence – which we define as "methodological robustness".

Section 4.4 explores other new standards on the horizon and new methodological developments that may affect market opportunities for future WtE CCS projects.

Finally, section 4.5 discusses the results and recommendations, intended to inform and advance a strategic decision-making process within KAN regarding which pathway to pursue for carbon removal certification.

4.1.2 Selection of registries and standards

First and foremost, it is important to clarify what constitutes a standard and a registry to ensure a mutual understanding, which is especially important in such a complex and relatively new field like carbon removals:

- **Standards (also often referred to as programs)** are organizations that define the specific rules, requirements, and methodologies for developing, measuring, and generating carbon credits, as well as overseeing the life cycle events of carbon instruments such as verifying that carbon credits are issued based on approved methodologies when emission removals occur. They ensure that credits represent real, additional, and verifiable climate impact. Most of the standards used in the voluntary carbon market today were developed by carbon offset registries, which also track trading and retirement of carbon credits issued under their standards.
- **Registries** play a vital role for standards by facilitating the issuance, tracking, and management of carbon credits throughout their entire life cycle. They are official databases or digital platforms that track the issuance, ownership, transfer, and retirement of carbon credits. As a crucial part of carbon market infrastructure, they allow national and state authorities to

collect detailed information on activities that reduce emissions. Registries are vital for ensuring transparency and preventing double-counting. Registries employ a wide variety of standards to issue carbon credits, often with at least some public engagement opportunities. Some registries develop methodologies/protocols themselves, appointing expert workgroups to engage with registry staff and protocol proponents. Others allow protocol proponents to submit their own methodologies for review and registry approval.
Carbon registries became essential for transparency and accountability in emission reduction efforts following the Kyoto Protocol's ratification in 1997 (see section 3.2). As the first global agreement with binding emissions targets, the Protocol required a system to monitor progress, leading to registries that track the issuance, transfer, and retirement of carbon credits. This ensured emissions reductions were transparent and verifiable.

With the rise of voluntary carbon markets and the Paris Agreement's Article 6 in 2015, carbon trading evolved to include bilateral trades (Article 6.2) and an UN-supervised global mechanism (Article 6.4). For a deeper discussion on the regulatory framework guiding these developments and infrastructure choices, see section 3.

Carbon registries can be categorized into two primary types: transactional registries and accounting registries:

- **Transactional registries:** Registries managed by specific standards or national programs to issue, track, transfer, and retire carbon credits. They ensure environmental integrity through project management, serialization, and other advanced tools. This is the type of registry that are analysed in this report.
- **Accounting registries:** Registries that aggregate information from different transactional registries into one platform but do not issue credits themselves. An example of an accounting registry is the Singapore International Carbon Credit Registry (ICCR), which tracks mitigation outcomes from independent standards deemed eligible by the National Environment Agency of Singapore [36].

The following standards and transactional registries have been selected, based on the tender material from KAN and COWI's own considerations:

Puro.earth
Puro.earth is a leading standard and registry specializing in engineered carbon removal, with a portfolio focused on measurable, durable storage solutions such as biochar, BECCS, and mineralization. The Puro standard applies exclusively to carbon removals, and they describe themselves as the first carbon removal standard for engineered carbon removal methods in the voluntary carbon market. WtE Inclusion is not natively supported, and it is currently possible only via custom methodology if robust waste composition evidence can show permanence and biogenic proportions.

It is recognized for its rigorous criteria for additionality and its emphasis on digital and auditable MRV processes. Puro is headquartered in Helsinki, Finland, and was founded in 2019. It is partly owned by Nasdaq.

Verra/CCS+
Verra is the world's largest and most widely adopted carbon credit standard and registry, offering a broad array of standards and methodologies – including several that directly address carbon removal from BECCS facilities. Of relevant in this context is the Verified Carbon Standard (VCS), which is a standard for project-based accounting, verification, and certification of GHG emission reductions and removals. Verra is headquartered in Washington D.C, United States, and was founded in 2006.

Verra, together with the CCS+ Initiative[2], has an industry-led initiative to develop CDR methodologies. In April 2025, they released a new set of modules and tools under its VCS standard

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[2] CCS+ methodologies are published under the Verra VCS Standard, meaning CCS+ does not have its own registry. Projects using CCS+ protocols are verified, registered, and issued credits

[37] to support robust measurement and certification of CCS projects. These modules provide updated guidance on project boundaries, MRV procedures, leakage risk, and crediting rules, making it easier for various CCS project types – such as industrial and WtE facilities – to generate high-integrity carbon credits under VCS.

Verra VCS (VM0049) explicitly includes BECCS from WtE where biogenic content can be separated and robustly evidenced. Fossil-derived C emissions are not creditable.

Isometric
Isometric is a relatively new standard and registry founded in 2022, based in the UK. They claim to have the world's most rigorous rules for CDR. Like the other standards, Isometric offers two core products: a carbon removal registry and a collaborative science platform. They partner with leading scientists and engineers to develop open, peer-reviewed protocols for CDR pathways – including direct air capture, BECCS, and innovative WtE CCS processes.

Isometric recently released a paper detailing how integrating CCS from WtE facilities can produce CDR credits in the UK [38] even for plants with mixed waste feedstocks as long as the biogenic fraction is reliably quantified. The paper argues that WtE with CCS has the potential to generate durable high quality CDR credits, and that there is a path to conducting rigorous MRV for WtE facilities with CCS, that would allow the issuance of high-quality credits from their operations.

Gold Standard
Gold Standard is an internationally renowned certification standard and registry known for its rigorous approach to environmental integrity and sustainable development, particularly in nature-based climate solutions and community projects. Founded in 2003 by WWF and other international NGOs, it sets high benchmarks for quality across carbon credits, focusing on both emission reductions and removals, and is recognized for stringent additionality, stakeholder consultation, and sustainable development requirements.

It can be interpreted that Gold Standard excludes incineration of mixed municipal solid waste (MSW) for CDR, due to:

- Exclusive focus on biomass fermentation and bioenergy combustion with CCS.
- Policy view that credits for WtE activities may conflict with waste hierarchy and risk environmental integrity.
- Eligibility and additionality challenges (WtE MSW may already be operational, non-additional)
- Permanence and leakage uncertainties (variable waste, difficulties in storage validation)
- SDG potential misalignment
- Though, there is the possibility of being eligible on a base-by-case basis through application documentation.

BECCS projects are eligible only with pure, well-characterized biomass (biogenic) waste streams.

Drax/Stockholm Exergi methodology
Finally, the Drax/Stockholm Exergi methodology represents a pioneering approach to certifying carbon removals from large-scale BECCS projects in the energy sector, developed and piloted in Nordic flagship facilities such as the Stockholm Exergi Värtan BECCS project. Drax/Stockholm Exergi are not a certification scheme/standard as such and therefore do not hold widely recognized credibility labels (such as ICVCM, ICROA, or CORSIA). Their primary role has been to develop and pilot a BECCS methodology for a specific project. While their experience can offer valuable technical insights and practical case studies for KAN, they cannot be used directly as standard or registry for issuing or selling marketable carbon credits. Therefore, they will not be evaluated and benchmarked against the four other standards, and the methodology is included in the assessment of methodological robustness across the relevant methodologies.

It is important to highlight that leading Nordic WtE operators, Hafslund Celsio and Stockholm Exergi, have initiated a dialogue aimed at developing a CDR methodology covering WtE with

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through Verra's VCS. Therefore, Verra's VCS and CCS+ should be considered together, as CCS+ methodologies are formally adopted and credited exclusively through Verra.

waste-derived biogenic content, specifically tailored to the unique features and challenges of the WtE sector. This is a significant step with potential far-reaching implications – not only for their own projects but for the wider WtE industry, both in the Nordics and internationally.

4.1.3 Summary and key findings

This section provides a condensed summary of key findings. It is based on comparative assessment of the leading carbon removal certification standards, focusing on their suitability and robustness for WtE and CCS projects. The analysis is structured around two main types of criteria: evaluation criteria (including the sub criteria credibility, market access, and cost model) and methodological robustness (encompassing quantification, additionality, double counting, and permanence).

One key finding is, that no single standard excels in all areas – each offers a different mix of strengths and trade-offs.

This assessment identifies Isometric, Verra and Puro as strong certification options for KAN – each with distinct advantages.

Verra stands out for its broad scope, mature market infrastructure, and strong track record, including in the Nordics and for large-scale BECCS projects. However, to date, Verra/CCS+ has not piloted or validated a full-scale WtE-specific CDR methodology, though its CCS+ VM0049 protocol does explicitly support waste-derived biogenic feedstocks (further explored in section 5, MRV).

In contrast, both Puro.earth and Isometric appear to be further advanced in providing methodologies that are applicable to WtE projects. For example, Isometric has published a white paper on the potential for scaling CDR in the WtE sector [38]. While focused on the UK, the papers offer critical lessons relevant to KAN's ambitions in Norway.

Waste feedstock characteristics

The Isometric UK paper discusses the distinct nature of waste feedstock compared to biomass, which is a crucial consideration when assessing the carbon removal potential of WtE projects. Unlike biomass, which is purposefully cultivated, harvested, and processed for energy production, KAN's facilities combust mixed residual municipal waste, which primarily serves as an essential societal function – managing residual waste that would otherwise accumulate in landfills or the environment. This fundamental difference influences regulatory treatment and documentation requirements.

Waste incineration occurs regardless of energy recovery needs, making it a core public service rather than a purely energy-driven activity. Consequently, WtE projects generally face less stringent documentation demands than dedicated biomass energy projects, reflecting the unavoidable and essential nature of waste management. However, ensuring the environmental integrity and transparency of WtE-based carbon removal projects depends on fulfilling specific criteria.

First and foremost, strict sorting of waste feedstock is mandatory to confirm that only residual, non-recyclable materials are incinerated. This excludes recyclables or materials that could be diverted to higher value uses, preventing the misclassification of feedstock and avoiding unintended negative environmental impacts such as resource depletion or displacement of recycling flows. Furthermore, thorough documentation of customer profiles and the geographical provenance of the waste is necessary. These records verify that waste genuinely constitutes residual waste streams and clarify the scope and boundaries of the waste management service provided.

Meeting these criteria is pivotal not only for regulatory compliance but also for maintaining transparency and reinforcing the environmental credibility of carbon credits or removals generated by WtE projects. Since residual waste incineration addresses an indispensable public function, the governance approach for such projects must balance the need for robust monitoring with pragmatic recognition of the sector's unique operational context.

Additionally, since many standards today are built for single-source, traceable biomass, they do not necessarily recognize or specify how to treat the biogenic content of mixed waste. For KAN's CDR claims to meet customer requirement and credibility and acceptance in the international carbon markets, rigorous quantification of the biogenic fraction must be ensured in every crediting period, and they must install biogenic CO_2 monitoring equipment. This investment requirement is further described in part 8, Internal actions and roadmap.

Another point from the Isometric UK paper is that – unlike BECCS projects – waste incineration facilities such as KAN receives payment (gate fees) to accept and process waste, reflecting the public service role of Norwegian waste management. As Isometric points out, this financial model can affect the "additionality" of carbon removal claims. If gate fees increase due to tighter recycling targets or landfill restrictions, KAN's business case for CCS could theoretically become robust even without carbon credit income. Standards will scrutinize whether CDR revenue is truly essential for project viability. KAN's pathway is to maintain transparent accounting of all income streams (gate fees, energy/heat sales, future CDR credits) and regularly reassess financial additionality, ensuring claims remain robust as market and policy conditions evolve.

Conclusions
Table 3 and Table 4 compare the standards across key criteria. Drax/Stockholm Exergi methodology is not evaluated and benchmarked against the four other standards; however, some elements of the methodology are presented in this section. Puro and Isometric have strong endorsements and use conservative approaches to emissions quantification; Isometric is growing in market presence and leads in tailoring methodologies to the WtE sector. Verra has the largest market, especially in the Nordics, but higher conflict risk in supplier payment. Gold Standard is fully endorsed by ICVCM, ICROA and CORSIA but less present in engineered CDR and the Nordics, with a more liberal emissions approach. All standards require additionality; however, Puro seems less detailed in terms of financial additionality. The standards also differ in permanence requirements.

Table 3: Comparative analysis, registries, evaluation criteria.

	Puro	Verra	Isometric	Gold Standard
Credibility	ICROA-endorsed; CDR-specialized.	Full ICVCM, ICROA, CORSIA endorsement.	ICROA/CORSIA-endorsed; strict, science-based; growing.	Full ICVCM/ICROA/CORSIA endorsement.
Market access	Used by key buyers, strong in the Nordics.	Largest, most liquid; Nordic experience	Gaining traction among buyers; UK flagship; early in Nordics.	Less presence in engineered CDR and in the Nordics.
Incentive structure	Supplier-pays; moderate conflict risk.	Supplier-pays; high conflict risk.	Buyer-pays; low conflict risk.	Supplier-pays; high conflict risk.

Table 4: Comparative analysis, registries, methodological robustness.

	Puro	Verra	Isometric	Gold Standard
Quantification	Ex ante determination, conservative on embodied emissions.	Ex post determination, conservative on embodied emissions.	Ex post determination, conservative on embodied emissions.	Ex post determination, more liberal on embodies emissions (accounted as zero).
Additionality	Less detailed on financials.	Requires detailed investment analysis.	Requires detailed investment analysis.	Requires detailed investment analysis.

Double Counting	Strict on both double counting and -claiming.	More relaxed on double claiming (compliance).	Strict on both double counting and -claiming.	Strict on both double counting and -claiming.
Permanence	No buffer pools, no project-specific risk assessment.	Buffer pools, project-specific risk assessment.	Buffer pools, no project-specific risk assessment.	Buffer pools, project-specific risk assessment.

4.2 Evaluation of leading CDR certification schemes

4.2.1 Evaluation criteria

To systematically assess the suitability and overall performance of different standards or KAN's WtE CCS projects, this section presents a set of evaluation criteria chosen specifically for this purpose. Applying these criteria aims to ensure a structured and transparent comparison of available certification options, supporting a well-informed recommendation for KAN's future certification strategy. The criteria have been selected by COWI.

Credibility and integrity: Credibility and integrity reflect a standard's international recognition, the robustness of its standards, and the level of trust it commands among credit buyers, policymakers, and the broader carbon market. For KAN, this means prioritizing standards that hold endorsements from authoritative bodies such as ICVCM, ICROA, CORSIA's eligibility list (for a deeper discussion of these endorsements, see section 3.6). These endorsements serve as strong proxies for high integrity and future-proof compliance, ensuring that credits are widely accepted and resilient against evolving regulatory and buyer requirements.

Incentive structure: This criterion refers to the underlying incentive structure in the standard's business models, which directly affect the integrity of carbon removal certification for project developers like KAN. This criterion assesses who pays for certification (supplier vs. buyer) and the risk of conflicts of interests and other misaligned financial incentives arising from the revenue model, as this is seen as a potential barrier for issuance of CDR credits.

Market access: Market recognition and access describe the degree to which a certification scheme is trusted by key buyers, proven through flagship projects, and established across regions relevant to KAN's sector. This criterion evaluates how widely credits from a given registry are accepted and traded, the calibre and diversity of regular buyers, and the registry's track record of supporting successful WtE and CCS projects.

A registry with strong market access is characterized by repeat purchases from leading global companies and financial institutions, reflecting both commercial confidence and broad acceptance. Issuance volumes, the existence of flagship projects, and demonstrated experience in Scandinavia further signal the maturity, liquidity, and local relevance of a standard.

4.2.2 Credibility and integrity

KAN should prioritize certification routes that offer the highest international credibility. The presence of endorsements from ICVCM (CCP), ICROA, and CORSIA can be viewed as strong proxies for credibility and integrity in the carbon market. According to Hafslund Celsio, who has negotiated a credit agreement with Microsoft, Microsoft and Frontier focused on ICVCM and ICROA-approved standards. This point is further developed in "Case studies and best practice".

Table 5: Credibility and Integrity across standards.

	ICVCM (CCP)[3]	ICROA	CORSIA
Puro	Assessment in progress	Yes	Assessment in progress
Verra	Yes	Yes	Yes
Isometric	Yes	Yes	Yes, conditional approval

[3] ICVCM assesses both the standards (programs) and the credits. Assessment of a standard is conducted to establish if they meet the criteria to become CCP-Eligible. Once a standard is CCP-Eligible, individual categories of carbon credits issued under that standard are then evaluated to determine if they qualify to be labelled as CCP-Approved.

	ICVCM (CCP)[3]	ICROA	CORSIA
Gold Standard	Yes	Yes	Yes

Verra and Gold Standard score highest on credibility, as they are fully recognized by ICVCM, ICROA, and CORSIA. This means credits issued under these registries will be widely accepted by buyers and are most "future-proof" against evolving market and policy requirements.

Puro.earth is well-established and ICROA-endorsed, with assessments by ICVCM and CORSIA in progress. While it currently may have slightly less recognition than Verra and Gold Standard, it remains a reputable option – especially for engineered and technology-based removals, which may be highly relevant to KAN's sector.

Isometric has rapidly obtained both ICROA endorsement and conditional CORSIA approval, with ICVCM assessment underway. While newer, its swift progress indicates it is on a credible path and may soon provide an additional robust option.

Key takeaways for KAN include:

- Verra, Gold Standard and Isometric have all high certification credibility.
- Puro is a preferred standard among major clients like Microsoft. However, obtaining full recognition from ICVCM and CORSIA is recommended to further enhance its credibility.

In summary, KAN will maximize international credibility and future market options by selecting registries with clear endorsement from ICVCM, ICROA, and CORSIA. This approach will minimize market and reputational risks and support the broadest range of credit buyers.

4.2.3 Market access

Market access for carbon removal credits is shaped not only by the number and profile of buyers, but also by operational track record, regional relevance, and the degree of alignment with both voluntary and emerging compliance markets. "Regional relevance" here primarily refers to the degree to which a particular standard is recognized, accepted, and fits within the regulatory, policy, and market context of a specific region (for example, the Nordics). A standard without "regional relevance" might face more barriers – regulatory uncertainty, lack of trust from local buyers, or not being considered legitimate for compliance or local climate strategy needs.

Table 6 summarizes major market-facing criteria for each certification. It is based on data from CDR.fyi [39] combined with desk research from the standard's public registries. Top buyers – ranging from leading technology companies (Microsoft, Shopify), to global consultancies (BCG), to financial institutions (Swiss Re, JP Morgan) – signal the depth of market trust in each platform. The repeated use of Puro and Verra by these buyers supports their credibility and signals openness to innovative engineered removals.

Flagship projects demonstrate operational experience in certifying large-scale removals, especially those directly or indirectly relevant to WtE CCS such as Isometric, selected as standard by the UK's largest WtE CCS project.

Credit issuance volume is an indicator of market maturity: Verra remains the global leader in terms of total credits, but only a fraction are true removals, while Puro and Isometric, though smaller, provide niche focus for carbon removal credits.

Regional registry acceptance – e.g., official use in Norway or other Nordic countries – facilitates public trust and project acceptability, streamlining project permitting and corporate buyer engagement for Nordic players.

Table 6: Market recognition and access among standards.

	Puro	Verra	Isometric	Gold Standard
Buyer Base	Microsoft, Shopify, BCG, Fortum LGT, Bank	Microsoft, Frontier, Shopify, Swiss Re, BP, Shell	Frontier, BCG, Carbon Direct, Shopify, JP Morgen, Microsoft	Swiss Re, Microsoft, Ikea, SAP, South Pole[4]
Flagship projects	-	Ørsted Asnæs/Avedøre	Enfinium Parc Adfer	-
Recognition as CDR Registry in the Nordics	Yes, Denmark (biogas)	Yes, Denmark (BECCS)	No	No
Volume/number of credits issued	Over 1 Mt CDR credits since 2019	Over 1,3 bn reduction and removal credits since 2006	Close to 25,000 tonnes of CDR credits since 2022	371 Mt of reduction and removal credits since 2003

Verra is the world's "default" registry for carbon credits – with a vast and diverse array of corporate customers spanning tech, energy, and financial services. However, not all credits are carbon removals; the majority are emission reductions. Verra and CCS+ has recently been selected by Ørsted as the standard for certifying the BECCS project at the biomass facilities Asnæs and Avedøre and therefore has a strong Nordic position [40].

Puro.earth is more narrowly focused, specializing in engineered and permanent removals. Its top buyers, many of whom appear across other registries, are particularly active in CDR. Puro's specialized approach – evidenced by its adoption by the circular bioeconomic company BioCirc [41] – puts it in a strong position for innovative, policy-attuned Nordic projects.

Isometric is already gaining attention among high-profile buyers for its scientific rigor and focus on removals, though its historical footprint and market liquidity are not yet proven at larger scales. The selection of Isometric by Enfinium Parc Adfer (a leading UK WtE CCS project) demonstrates huge potential, if not yet established Nordic engagement [42].

Gold Standard is highly credible, but mainly in the context of nature-based and smaller-scale projects. The registry is historically less involved in large-scale engineered removals or Nordic CDR demonstrations, as reflected by the lack of a prominent flagship in this space.

Volume leadership lies with Verra and Gold Standard, who together account for the vast majority of credits issued globally – but few of these are removals. Puro and Isometric, although issuing fewer credits, focus exclusively on removals, which are of direct and increasing interest to policy and compliance-driven corporate buyers.

The breadth of methodology coverage is also a crucial factor when comparing standards. Together, Puro.earth and Isometric account for approximately one-third of all published methodologies and protocols relevant to durable, engineered carbon removal [43]. Puro.earth currently offers five approved methodologies, whereas Isometric has three certified protocols and three additional protocols in development, reflecting both organizations' commitment to expanding and diversifying their support for high-integrity CDR projects. However, options for certain project types – such as WtE CCS – may require adaptation or custom development, particularly as market expectations and regulatory frameworks continue to evolve rapidly in Europe and the Nordics.

Key takeaways for KAN:

[4] South Pole retires credits on behalf of end buyers.

- For KAN, selecting a standard already trusted in the Nordic region can facilitate smoother project approval, alignment with local regulatory expectations, and engagement with regional buyers. Puro and Verra stands out here.
- For KAN, there is a fundamental trade-off between choosing a specialized carbon removal standard or opting for one with a broader scope and a longer track record. Specialized standards such as Puro and Isometric are more focused on engineered carbon removals and attract buyers looking specifically for high-integrity, long-duration storage solutions. Credits issued under these standards may command a premium price, especially among buyers prioritizing high-quality, transparent, and scientifically robust carbon removals for their climate strategies. In contrast, Verra and Gold Standard have much broader credit portfolios, mainly built around reductions or avoidance. This may mean that CDR-specific credits are less differentiated in terms of quality. This can dilute the price premium achievable by engineered removal projects, as buyers in these registries may prioritize volume or flexibility over the strictest scientific standards for removals.

4.2.4 Incentive structure

As KAN consider the certification of carbon removal via CCS, understanding the standard's revenue models and potential conflict of interests is important, as this can impact project bankability, scale-up potential, and market attractiveness.

Two major conflicts of interest play a central role: first, many carbon registries, which are tasked with independently verifying supplier's claims, are directly compensated by those very suppliers, undermining their impartiality. Second, these registries earn revenue based on the volume of credits issued, creating a strong financial motivation to approve as many credits as possible. Together, these incentive structures encourage overcrediting and contributes to a credibility crisis facing carbon registries.

Zooming in on the revenue model, which fundamentally addresses who pays for the certification (the supplier vs. the buyer of credits), reflects a key point of divergence between the standards.

Most standards use a supplier-pays model where the suppliers bear the up-front and ongoing costs of account opening, validation/verification, credit issuance/transfer, and registry administration. Isometric stands out, as they charge the buyers verification fees, independent of the number of credits ultimately certified. Additionally, registry fees are decoupled from volume, shifting incentives away from registries overissuing credits to sustain their own fee base.

Having a supplier-pays model could potentially create an inherent conflict of interest risk (i.e. certifying credits to please fee-paying suppliers). Both Verra and Gold Standard is assessed to have a high conflict of interest risk, while especially Isometric – and to some degree Puro – has a lower conflict of interest risk, by disconnecting payments from suppliers.

Under the Isometric model, buyers pay a flat verification fee that is determined by the size of their order, regardless of how many credits are eventually issued. This ensures, assumingly, that Isometric has no financial incentive to overcredit, helping to align the company's interests with those of buyers and uphold rigorous scientific standards. More specifically, under the Isometric model, fees are calculated according to the size of the buyer's order, so for instance, a buyer seeking 100 tonnes would pay the same fixed fee as one purchasing 100,000 tonnes; the invoiced amount does not change if fewer credits are issued than anticipated.

The conflict of risk under Puro is assessed to be higher than Isometric, but lower than the other standards. This is because, that Puro on the one side has a model, where their registry is dependent on credit issuances quantities, but on the other side, recently decoupled the verification and auditing fees from both the number of issued credits and their sale price. By basing fees on reported tons of CO_2 removed submitted by the suppler, rather than when the credit is issued, Puro claims to minimize any possible conflict of interest between suppliers and auditors.

Table 7: Incentive structure.

	Revenue model	Conflict of interest risk
Puro	Supplier-pays	Moderate
Verra	Supplier-pays	High
Isometric	Buyer-pays	Low
Gold Standard	Supplier-pays	High
Drax/Stockholm Exergi	Supplier-pays	High

The revenue model and associated conflict of interest risk can potentially shape how buyers, investors, and regulators perceive the credibility and financial viability of carbon credits. When standards depend primarily on supplier payments, there is a heightened risk that certification processes may be perceived as less impartial, potentially undermining buyer trust and reducing willingness to pay a premium for those credits. This perception can also translate into greater caution among financiers, who may view credits from high-risk registries as less reliable collateral for investment. Conversely, standards where buyers finance the certification process, such as Isometric, generally demonstrate lower conflict of interest risk, which can enhance both buyer confidence and regulatory acceptance. As scrutiny of credit quality and integrity continues to increase in both voluntary and compliance carbon markets, standards with transparent, lower-risk revenue models are likely to be favoured by corporate buyers with robust climate commitments and by policymakers establishing long-term frameworks for CDR.

To date, however, we have not seen strong evidence that buyers are especially concerned about conflict-of-interest risk tied to the revenue model when selecting credits or platforms. Market behaviour suggests that factors such as availability, price, and methodological rigor currently outweigh the perceived impartiality of the certification process. Nonetheless, as market maturity and regulatory scrutiny increase, these risks could become more prominent in buyer and investor decision-making.

4.3 Assessment of methodological robustness among standards

Methodological Robustness

COWI has introduced an overarching category, Methodological Robustness, to evaluate whether carbon removal methodologies deliver reliable, transparent, and credible climate outcomes. Drawing on some of the key high-quality international quality principles like ICVCM's Core Carbon Principles, COWI has selected four methodological criteria: quantification, additionality, double counting, and permanence. Together, these ensure only verifiable and durable removals are credited.

- **Quantification:** Uses conservative and complete methods to accurately measure removals.
- **Additionality:** Ensures removals go beyond business-as-usual and only occur due to carbon credit incentives.
- **Double Counting:** Prevents the same removal from being counted or claimed more than once.
- **Permanence:** Requires long-term storage of removals, with measures to address and compensate for any reversal risk.

This structured approach allows for a rigorous comparison of methodologies, supporting well-informed decisions for KAN's carbon removal certification. The methodologies assessed are listed below:

- Puro.earth, Puro_Geologically_Stored_Carbon_Methodology [44].
- Verra VCS (VM0049), VM0049 Carbon Capture and Storage, Verra [45].

- Gold Standard, Applicability Scope Expansion to the Methodology for BFCCS [46], Biomass Fermentation with CCS, and Eligibility requirements for MSW incineration activities [47].
- Drax/Stockholm Exergi, Methodology for permanent removals with sustainable BECCS [48].

Methodologies are, in this context, understood as specific, detailed protocols or calculation "recipes" that tells project developers how to measure and prove the climate impact of a particular type of project.

4.3.1 Quantification

Quantification is a core principle in carbon removal accounting. It sets out exactly how much carbon is removed and ensures credited results are real, measurable, and comparable. For WtE with CCS, robust and transparent quantification underpins the integrity of carbon credits and market trust.

This section compares how the leading standards define and apply quantification, focusing on key principles for quantification, credit issuance rules (ex ante or ex post determination), and accounting of cost-driving emissions such as embodies emissions.

General Principles for Quantification of CDR Credits
For KAN, understanding how standards quantify carbon removal is essential for robust accounting and credible credit generation. All major standards require projects to calculate the net amount of CO_2 removed by deducting supply chain emissions, leakage, reversals, and, where needed, applying discounts for uncertainty.

Puro.earth and Isometric only award credits for net removals (not reductions), focusing on the biogenic fraction and requiring full deduction of related emissions and conservative treatment of uncertainty[5].

At present, Isometric's new protocol affects only a small segment of the carbon market. However, if this approach were to be adopted more widely, it could have significant consequences that extend well beyond projects involving wastewater alkalinity enhancement.

Verra and Gold Standard allow crediting for both removals and emission reductions, with Verra applying a biogenic/fossil split tool and requiring discounts if uncertainty is high. Gold Standard emphasizes comprehensive life cycle assessment and strict handling of risks and uncertainties. Drax/Stockholm Exergi's methodology is similar, crediting only geologically stored biogenic CO_2, and deducting all direct and indirect project emissions.

In summary, while each standard uses slightly different rules and tools, all require transparent, science-based calculation of net carbon removals to ensure environmental integrity and credible credits.

Ex ante vs. Ex post credit issuance
A key choice for KAN is whether credits are issued upfront based on projected removals (ex ante) or only after actual, verified CO_2 removal (ex post). Ex ante issuance allows earlier sales, aiding project finance, but is often viewed as less robust by buyers and regulators – potentially leading to discounts or extra risk requirements. Most standards, including Verra, Gold Standard, and

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[5] However, it is worth noting that in April 2025, Isometric introduced a new protocol for issuing CDR credits for projects that enhance wastewater alkalinity. Interestingly, and somewhat unexpectedly, this protocol allows projects to earn CDR credits simply by reducing emissions – without increasing the amount of carbon removed from the atmosphere compared to what would have happened anyway. According to CarbonPlan [78], this is the first time a CDR methodology has openly permitted credits for activities that do not boost carbon removal beyond the baseline. This blurs the widely accepted distinction in the market between credits for avoided emissions and credits for real carbon removals.

Isometric, only allow ex post issuance. Puro is an exception, permitting ex ante credits with clear identification and risk protocols to align with ICVCM requirements.

To COWI's knowledge there are no buyers or compliance schemes who *explicitly disallow* ex ante credits.

Key take away for KAN:

- Ex post crediting is best practice for credibility and compliance. Ex ante issuance can help project cash flow but may face market scepticism. If pursuing ex ante (e.g., with Puro), robust risk management and transparency are essential.

Embodied emissions
Embodied emissions are the emissions from producing and installing project materials and equipment. Accurate accounting is important for credible climate claims. Puro, Isometric, Gold Standard, and Drax/Stockholm Exergi require inclusion of these emissions for new infrastructure but exclude preexisting facilities; all of them use established LCA data. Verra generally sets embodied emissions to zero by default but allows stricter accounting if required by buyers or regulators. Using standards with strong data requirements enhances credibility for KAN.

Table 8: Embodied emissions, comparison.

	Treatment of embodied emissions	Data sources for emission factors
Puro	Included at each stage of the activity boundaries. Preexisting facilities excluded.	LCA databases, local or official sources; 20% uncertainty applied to other sources unless specified by the publisher.
Verra	In principle accounted as zero. However, deviations from the methodology can be formally requested in order to get carbon approvals. Preexisting facilities excluded.	No specific data requirements; suggests IPCC, official, supplier, or peer-reviewed sources, plus third-party LCAs. Different parameters may use different databases, not always standardized LCA.
Isometric	Included at each stage of the activity boundaries. Preexisting facilities excluded.	Independently verified LCA databases (e.g. Ecoinvent/GaBi), national inventories, gov. sources; supplier data as fallback.
Gold Standard	Included at each stage of the activity boundaries. Preexisting facilities excluded.	Recognized LCA databases, peer-reviewed literature, government sources, regional data when available.
Drax/Stockholm Exergi	Included at each stage of the activity boundaries. Preexisting facilities excluded.	Authoritative, peer-reviewed LCA databases, IPCC.

4.3.2 Additionality

Additionality is a foundational principle in carbon removal accounting. It ensures that certified carbon removals represent climate benefits that would not have occurred under a business-as-usual scenario. For WtE with CCS, robust demonstration of additionality is critical for market acceptance, investor confidence, and access to premium voluntary and compliance credit markets. This section compares how the leading standards define and assess additionality, with emphasis on important elements of additionality such as regulatory, financial, and common practice requirements.

Regulatory additionality
Regulatory additionality means that a project must not be required by law or regulation. If mandated, it fails the additionality test.

Puro.earth, Verra, Isometric and Gold Standard explicitly disqualify projects that fulfil legal or regulatory obligations. Projects must disclose relevant legal mandates, with this verified during independent audits (typically at least every five years). Timing also plays a role here in the application of the regulatory additionality requirement – if credits are issued before a potential regulation mandate on CCS on WtE comes into effect, those credits remain valid, and additionality is not reassessed retroactively. Regulatory additionality affects newbuild projects or major expansions post-regulation, not projects already built and registered.

Furthermore, they all require that the prospect of earning revenue from carbon credits was considered in the project's investment decision, demonstrating that carbon market income was a factor before the project was initiated.

Drax/Stockholm Exergi echoes this approach but clarifies that state subsidies or support do not constitute a regulatory mandate unless the project is legally compelled to operate/built.

Key takeaways for KAN:

- Currently, both Norwegian and EU legislation do not mandate the installation of CCS on WtE plants. This means that KAN members' CCS projects are considered "regulatory surplus," easily meeting the regulatory additionality criterion required by all major carbon standards. As such, credits generated from these projects are eligible for certification and sale, adding vital revenue streams to support investment decisions.
- If Norway (or the EU) were to introduce regulations requiring CCS installation on WtE plants, the additionality situation would fundamentally change – but only for projects making their investment decision after the regulation comes into effect. For these future projects, regulatory additionality would not be met, since the emissions removals would occur because of the legal mandate, not because of carbon credit incentives. However, projects that have already been registered and validated under existing rules before the regulatory change would not be retroactively affected, and their previously issued credits would remain valid.

Financial additionality

Financial additionality means that a project must demonstrate it is not financially viable – i.e., would not proceed – without the added incentive of carbon credit revenues. Simple "cash flow gap" or cost summaries are not acceptable for large, complex projects like WtE CCS.

Puro.earth requires a comprehensive investment analysis, using metrics such as Internal Rate of Return (IRR), Net Present Value (NPV), Return of Investment (ROI) or payback periods to prove credit revenues are essential for the project's financial close.

Verra, Isometric and Gold Standard set a high bar for financial additionality, mandating detailed investment analyses and/or benchmarking against sectoral norms. Full investment cases are needed, accounting for all income streams (gate fees, energy sales of electricity and heat, public support). Regular re-validation may be required if financial parameters change substantially (e.g., gate fees rise).

Drax/Stockholm Exergi relies only on an independent Auditor Financial Statement, a less rigorous documentation threshold.

Key takeaways for KAN:

- KAN members should anticipate the need to assemble detailed investment documentation and be prepared for external scrutiny – especially as multiple revenue streams and potential policy supports are involved. For WtE CCS projects, investment cases are uniquely complex due to the blend of revenue streams that underpin project economics. Gate fees and energy sales are foundational for these facilities, yet each adds nuances – and challenges – to demonstrating financial additionality for carbon credit certification. For example, investment documentation must detail historical and projected gate fee income, contract terms, and how these fees impact cash flow. Auditors will assess whether gate fees alone could cover CCS costs, and if significant increases – such as higher municipal rates for decarbonization – might reduce the need for carbon credits.

Common practice
Common practice means ensuring that projects are not already the norm in an industry or region; only non-commercialized ("early mover") solutions are eligible.

Puro uses a 16% national market penetration threshold, applied to projects with a Technology Readiness Level (TRL) of 8 or 9, meaning that if a project's technology is implemented in more than 16% of comparable source facilities in the sector and country, the activity is considered common practice and is thus not additional. Verra has a slightly higher threshold at 20% market penetration. Isometric and Gold Standard both apply a 20% threshold but add a cap of three similar projects in the region/country. More specifically, if there are no more than 3 similar projects in the region/country, the project is considered additional. Drax/Stockholm Exergi has no common practice requirement.

Key takeaways for KAN:

- CCS is not yet common practice at Norwegian WtE plants, so early KAN adopters meet this test. However, requirements such as the "three similar projects" trigger (Isometric, Gold Standard) could soon become an issue as the sector matures.
- Once three Norwegian large-scale WtE CCS projects are operational and certified, subsequent projects may no longer qualify under these standards unless they can show meaningful differences that set them apart from the initial projects. Later KAN adopters may need to demonstrate significant differentiation (e.g., unique technology, business models) to maintain eligibility. This might include unique CCS technologies, novel capture methods, larger scale, different waste streams, or innovative business and financing models

Table 9 below summarizes the findings on additionality:

Table 9: Additionality across certification schemes.

	Regulatory additionality	Financial additionality	Common practice
Puro	Yes	Yes, investment analysis	Yes, 16% threshold
Verra	Yes	Yes, detailed investment analysis	Yes, 20% threshold
Isometric	Yes	Yes, detailed investment analysis	Yes, 20% & ≤3 projects
Gold Standard	Yes	Yes, detailed investment analysis	Yes, 20% & ≤3 projects
Drax/Stockholm Exergi	Yes	Yes, auditor statement only	No requirement

4.3.3 Double counting

Double counting – when the same CO_2 removal is claimed more than once – undermines carbon credit integrity. For KAN's WtE projects, risks include both Norwegian authorities and third parties seeking to claim the same removals. International standards use various mechanisms to prevent double counting:

- **Double Issuance:** Issuing multiple credits for the same removal across schemes.
- **Double Use:** The same credit being claimed by multiple buyers or entities.
- **Double Claiming (compliance):** Both national inventories and credit owners claim the same removals[6].

[6]The ICVCM does not consider a country's Nationally Determined Contribution (NDC) an enforceable domestic compliance mechanism; but as a high-level, international pledge that countries report on through the UNFCCC process.

- **Double Claiming (other schemes):** Credits being counted in multiple environmental markets (e.g., as both a carbon and a renewable energy credit).

Corresponding Adjustments and Double Claiming: The Debate

A key policy question for carbon removals with international buyers is whether credits should only be recognized if the host country (e.g., Norway) provides a corresponding adjustment – meaning that the removals are subtracted from the host country's own Nationally Determined Contribution (NDC) under the Paris Agreement, to avoid being counted twice. This is especially relevant for KAN, as both Norwegian authorities and external buyers may seek to count the same removals.

Arguments Against Mandatory Corresponding Adjustments:

- In the Voluntary Market, corporate "offset" claims are typically outside the formal national GHG inventory, meaning the risk of double claiming is primarily reputational, not regulatory.

- Companies' removals and credit purchases are reported for transparency, but not for official compliance, so overlapping claims do not directly influence government targets.

Arguments in Favor:

- Requiring a corresponding adjustment ensures that only one party (the country or the buyer) claims the climate benefit, increasing transparency and credibility.

- It prevents governments from taking credit for the climate ambition of private actors, while encouraging higher ambition and robust "net zero" claims.

Practical example

In the Ørsted-Microsoft BECCS deal, Denmark wanted to count removals for its NDC, Microsoft for its own goals. Gold Standard required a Corresponding Adjustment, Verra did not – showing how standards differ and why these matters for future Norwegian projects.

Double Issuance

Puro employs a proprietary registry, unique project identifiers, and third-party audits. Public disclosure and cross-checks with other registries are routine. Isometric prohibits activities registered elsewhere and requires non-overlapping boundaries and no parallel registration. Verra registers project and requires disclosure of other registry participation. Cross-registry credit cancellation is required if an overlap is found. Gold Standard permits dual certification (registration under both Gold Standard and another standard) only with strict tracking, cross-registry checks, and evidence of cancellation in cases of overlap. Drax/Stockholm Exergi does not specify how they cope with double issuance.

To date, there are to COWI's knowledge no publicly documented, large-scale double issuance events involving major players like Puro, Verra, Gold Standard, or Isometric.

Double Use

All four major standards – Puro, Isometric, Verra, Gold Standard – enforce credit retirement. They operate a central registry that serves as the official ledger for tracking the issuance, transfer, and retirement of carbon credits. Once a credit is retired it is permanently removed from circulation. This action is publicly recorded in the registry, and the credit cannot be transferred, re-sold, or claimed for any other purpose. Gold Standard adds binding, legal agreements to reinforce this.

The effectiveness of these credit retirement processes is highly dependent on the security, transparency, and interoperability of registries. Weaknesses such as insufficient audit trails and poor public access, or lack of coordination between registries can create vulnerabilities – allowing credits to be fraudulently retired and reused or making it easier for mistakes to go undetected. All the registries operated by the leading schemes are transparent and traceable in real time.

Key takeaways for KAN:

- For KAN members, this means that once a carbon removal certificate is sold to a corporate buyer to support their net zero or climate neutrality claims, that specific certificate cannot be claimed again, in any context. From the moment of issuance, the right to use the removal for any emissions reporting, voluntary targets, or regulatory compliance is fully transferred to the buyer. In practice, this requires KAN members to relinquish all rights to count the same removal toward their own climate targets or communicate it in public sustainability disclosures.

Double claiming with national compliance schemes
Standards vary in handling double claiming with national inventories, which impacts KAN's market access. Puro prohibits credits for removals included in a country's GHG inventory and requires proof of "corresponding adjustment" for international transfers. Isometric prevents double crediting technically but is less explicit on alignment with Article 6 and national inventory rules. Verra does not require corresponding adjustments by default, so credits may be double counted in both Norway's inventory and sold internationally unless extra steps are taken. Gold Standard is the strictest: it mandates host country approval and formal adjustments to prevent any double claiming, which ensures the highest integrity but adds procedural requirements.

Key takeaway for KAN:

- The choice of certification scheme determines if KAN's removals can be sold internationally or counted in Norway's climate reporting. To sell credits abroad – especially under strict standards – KAN must coordinate with Norwegian authorities for authorization and corresponding adjustments and recognize that removals claimed by Norway's NDC cannot be double-sold as international credits. The Norwegian government, in line with its commitment to the Paris Agreement's transparency and accounting standards supports the use of corresponding adjustments for any Internationally Transferred Mitigation Outcomes (ITMOs) that count toward another country's or entity's climate goals [49]. Therefore, while the Norwegian government is likely to require or at least encourage clear arrangements and documentation for corresponding adjustments, it is important to note that this approach has not yet been tested in practice. By contrast, in Denmark, the government chose not to require a corresponding adjustment in the case of Ørsted, illustrating that national approaches can differ.

Double claiming with incentivization schemes
Puro requires full disclosure of participation in other incentive schemes and third-party auditing to prevent double counting. Isometric prohibits overlapping claims but leaves some risk management to developers. It is not unlikely that international buyers will expect robust evidence from suppliers that there is no double claiming and may request documentation beyond what the standard requires, especially given the current variability in national implementation.

Verra requires proof that removals have not been credited elsewhere before issuing credits. Gold Standard is strictest – credits cannot be claimed in more than one scheme, with rigorous audits and risk of disqualification for violations.

Key takeaways for KAN:

- KAN should track all current and planned incentive programs to avoid claiming credits for the same activity twice. Failing to do so can result in rejected credits and damage to KAN's reputation. Careful registry selection and thorough documentation are essential for maintaining credibility and market access.

Table 10 below summarizes the findings on double counting:

Table 10: Double Counting Safeguards Across Certification Schemes.

	Double Issuance Prevention	Double Use Prevention	Double Claiming with National Compliance Schemes	Double Claiming with Incentivization Schemes
Puro	Yes	Yes	Yes, requires corresponding adjustments (CA)	Yes
Verra	Yes	Yes	Yes, but CA not required	Yes
Isometric	Yes	Yes	Yes, no clear stance on CA	Yes
Gold Standard	Yes (dual certification with strict rules)	Yes	Yes, requires CA	Yes
Drax/Stockholm Exergi	Not specified	Not specified	Not specified	Not specified

Permanence and reversal
Permanence refers to how long removed CO_2 stays out of the atmosphere. True permanence requires a very low risk of reversal (re-release), which can happen through leaks, poor monitoring, or other factors. Geological storage is considered highly durable if properly managed, unlike non-geological options like forestry, which are more vulnerable to reversal. Ensuring long-term CO_2 storage is critical for real climate benefit and meeting climate goals.

The certification schemes differ significantly in how they manage the risk of reversal, particularly regarding:

- Buffer pools and insurance mechanisms
- Risk Estimation & Mitigation Requirements
- Liability requirements

<u>Buffer pools and permanence</u>
Buffer pools are insurance reserves: a portion of credits set aside to cover any reversal losses. Verra, Gold Standard, and Isometric use risk-based buffer pools (2-20% depending on project risk), but Puro and Drax/Stockholm Exergi do not require buffers for geological storage, viewing it as highly secure if best practices are followed.

Key takeaway for KAN:

- Choosing a standard with buffer pools reduces the number of sellable credits but may be preferred by some buyers for added reassurance (especially multinational firms or ESG-investors with strong due diligence).
- KAN should consider voluntarily setting aside a modest buffer of credits for reversal risk, even if the chosen registry does not require it, especially for sales to multinationals or ESG-sensitive buyers. Adopting this approach would not only safeguard KAN's reputation but could also serve as a valuable market differentiator.

<u>Risk estimation and mitigation</u>
Verra and Gold Standard require detailed, project-specific reversal risk assessments and mitigation plans, adding complexity but boosting credibility. Puro, Isometric, and Drax/Stockholm Exergi assume geological storage is permanent if strict eligibility and monitoring is met.

<u>Liability for reversals</u>
Under Verra and Puro, operators are responsible for reversals until liability formally passes to the state after closure. Isometric and Gold Standard end operator responsibility after credits are issued or after a set period, making administration easier but potentially less robust in the eyes of some buyers.

Key takeaway for KAN:

- By choosing a certification registry and standard that enables liability to shift from the operator to the state after a set period, KAN can be confident that its projects will remain compliant, attractive to buyers, and financially sustainable throughout the carbon storage lifecycle.

Table 11 below summarizes the findings on permanence and reversal risk management.

Table 11: Permanence and Reversal Risk Management.

	Buffer pool (%)	Project-specific Risk Assessment	Liability for reversal
Puro	No	No; relies on geological site requirements	After closure liability transferred to the state
Verra	Yes, risk-adjusted	Yes	After closure liability transferred to the state
Isometric	Yes, up to 20% (2% for WtE)	No	After certification / crediting period
Gold Standard	Yes, min. 2,5% risk adjusted	Yes	After certification / crediting period
Drax/Stockholm Exergi	No	No; site eligibility only	After liability transferred to the state

4.4 Other emerging platforms

As the global market for carbon removals rapidly diversifies, a new wave of innovative certification standards and registry platforms is emerging alongside the established players. Among these, Absolute Climate, Riverse and C-Capsule are examples known for their scientific rigor, innovative use of digital monitoring, and strategic alignment with European regulatory developments.

For KAN, these standards represent not only technically advanced options but also potential early-mover advantages in the European voluntary and compliance markets. This section will therefore describe their core characteristics and assess their overall relevance and accessibility for KAN's ambitions.

A more detailed analysis of these emerging standards, including in-depth comparison of methodology requirements, lies outside the scope of this current study. However, such investigations could be valuable as a next step should KAN wish to explore concrete pathways for certification under these standards.

4.4.1 Selection of emerging platforms

Absolute Climate
Absolute Climate is a US-based new, high-integrity carbon removal standard set up to address conflicts of interest and quality gaps in the voluntary market. Uniquely, Absolute Climate develops scientific standards while the independent registry partner, Evident, handles credit issuance and tracking – separating rule-setting from registry operations. Its universal, science-based approach aims to apply consistent criteria and robust MRV across all removal types, aiming for cross-sector comparability and transparency.

Absolute Climate has not yet developed or published any removal specific protocols yet.

Rainbow (formerly Riverse)
Rainbow is a French-based, ICROA-approved standard and digital registry focused on certifying transparent, high-quality carbon removal projects, especially for emerging and industrial solutions. Its digital-first MRV platform streamlines audits and makes credit tracking tamper-proof via blockchain. Rainbow uses science-driven, flexible protocols and works closely with verifiers and

policymakers, aiming for alignment with the EU's Carbon Removal Certification Framework. While not yet offering a mature WtE CCS methodology, Rainbow's innovative, collaborative approach and lower entry barriers make it an appealing certification partner for Norwegian waste incinerators exploring CCS.

Rainbow has developed a biomass carbon removal and storage (BiCRS) methodology, that focuses on BiCRS technologies. These are primarily gasification and pyrolysis, but also syngas, bio-oil, and biochar as co-products, using biomass and organic waste as feedstock.

C-Capsule
C-Capsule is a UK-based digital platform using continuous, science-based MRV for efficient and transparent carbon removal credit certification. Their fully digital system enables real-time data upload and instant credit issuance, with all credits permanently recorded in a public registry for easy buyer verification.

For KAN, C-Capsule's dMRV platform could significantly streamline certification for engineered removals. The platform's openness to new removal pathways and its strong emphasis on data integrity and durability make it a relevant and innovative option worth considering, especially as expectations for digital MRV continue to rise in the carbon market.

C-Capsule distinguishes itself from many other carbon removal registries by taking a methodology-agnostic approach: it does not rely solely on proprietary methodologies for certifying carbon removal activities. Instead, C-Capsule operates as an independent certification platform, allowing external third-party methodologies – developed by recognized scientific experts, standard-setters, or industry alliances – to become eligible for certification on its registry. To ensure consistency and rigor, C-Capsule has established clear and transparent guidelines outlining the requirements and evaluation process that these third-party methodologies must meet before being approved for use within its system.

The verification and tracking of certified carbon removal units (CRUs) is further strengthened through a partnership with Evident, a global leader in registry services for environmental markets. Evident's registry technology supports full chain-of-custody transparency for all issued CDR certificates.

4.4.2 Comparison of emerging platforms

Rainbow appears to be the most advanced among the three emerging platforms considered. Notably, Rainbow has achieved approvals from internationally recognized standard-setting bodies such as the ICVCM, ICROA, and is eligible under CORSIA. Securing such endorsements demonstrates that Rainbow is meeting evolving requirements for integrity, transparency, and alignment with the latest climate market best practices. These credentials are indicative of market readiness and provide strong reassurance to both project developers and buyers regarding the credibility of credits issued on the platform.

Both Rainbow and C-Capsule have clear and detailed additionality requirements such as investment or barrier analysis [50]. Both also have buffer pool requirements. However, they differ on double counting, where Rainbow actively addresses the issue with double claiming with national compliance schemes [51]. They require host country authorization and a corresponding adjustment to ensure the emission reduction or removal is not claimed by both the host nation and the buyer.

In contrast, Absolute Climate is a newer entrant to the market, characterized by ambitious and innovative aspirations. However, as of now, they have not yet developed concrete methodologies or protocols for project certification, and their operational track record is still to be established. Specifically, Absolute Climate aims to tackle the longstanding conflict of interest inherent in the supplier-pays model, where project developers fund validation and verification, potentially influencing outcomes. If Absolute Climate is successful in establishing an alternative system that demonstrably enhances impartiality and integrity, it could set a new benchmark for the sector.

Key take aways for KAN:

- Rainbow stands out as a high-potential partner, and it would be worthwhile for KAN to engage in dialogue with them, particularly if the goal is to future-proof projects and maximize access to buyers with stringent due diligence requirements.
- Despite this early stage, it remains valuable for KAN to closely monitor Absolute Climate's progress – especially due to their efforts to address structural challenges in the voluntary carbon market. Therefore, keeping abreast of their developments would be important for KAN, both to anticipate future market shifts and to identify potential collaboration opportunities.

4.5 Recommendation for KAN

Based on an assessment of credibility & integrity, market recognition and access, cost model and a set of criteria under the category methodological robustness, Isometric, Verra and Puro emerge as strong certification options for KAN's WtE CCS projects. KAN should start prioritizing engagement with Verra, Isometric and Puro to get an even better picture of their strengths and weaknesses.

As further described in section 8.3, COWI recommends maintaining flexibility regarding the choice of standards at this stage. Instead, the immediate priority should be on preparing the technical installations and developing organizational capacity to meet anticipated customer requirements. This approach allows KAN to adapt as the market and relevant standards evolve, ensuring readiness to align with whichever certification scheme/standard ultimately best support project and buyer needs.

Table 12 below presents a SWOT analysis of the three standards, that could be used as preparation for a more intensive dialog and engagement with standards and buyers.

Table 12: SWOT analysis.

	Isometric	Verra	Puro
Strengths	Specialized in CDR Buyer-pays model reduces conflict of interests Endorsed by ICVCM, ICROA and CORSIA	Global credibility Foothold in the Nordic region (Ørsted project) Endorsed by ICVCM, ICROA and CORSIA	Specialized, strong presence and buyer recognition, especially in the Nordics Widely adopted by top buyers, especially Microsoft Conservative on quantification
Weaknesses	No suppliers/projects yet in Nordic region Lower issuance volume and market liquidity No clear stance on Corresponding Adjustments	Supplier-pays model increases conflict of interests	Not yet fully endorsed by ICVCM or CORSIA Ex ante crediting may be regarded as less robust by some buyers Less detailed in financial additionally assessment
Opportunities	Early-mover advantage for KAN in Nordics Demonstrated leadership in methodological development for WtE	Flexibility through its recent release of new modules and tools tailored for CCS projects and CO_2 hubs.	Ongoing endorsements will further boost credibility Expanding Nordic and European policy alignment could enhance relevance for WtE at CCS Scope to pilot innovative methodologies tailored to WtE
Threats	Potential challenges in buyer acceptance in Nordics	Lack of WtE adaptability?	Market acceptance risk if other standard' endorsements progress faster or become regulatory requirements Uncertainty around treatment of corresponding adjustments and national inventory claims

Verra's main strengths are its global credibility, extensive project experience, and endorsement by major standard-setters (ICVCM, ICROA, CORSIA). It benefits from a strong foothold in the Nordics and ongoing methodological updates, especially for CCS projects. Its broad market acceptance and robust buyer base also support liquidity and future proof. However, Verra faces weaknesses including possible conflicts of interest due to its supplier-pays model, which can raise integrity questions due to potential increases in conflicts of interest risks (see section 4.2.4). Additionally, Verra is perceived as more conservative and administratively complex, which could deter some developers.

Isometric's strengths lie in its specialization in CDR, strict buyer-pays model – a which reduces conflicts of interest – and demonstrated leadership in methodological development for WtE, especially in the Nordics. Isometric's approach is endorsed by ICVCM, ICROA, and CORSIA, and emphasizes high integrity. It currently faces weaknesses due to a lack of projects or suppliers in the Nordic region, and lower market liquidity and project volumes compared to Verra. However, Isometric's early mover position on WtE methodologies presents opportunities, while potential challenges remain related to buyer acceptance and scaling in the Nordics.

Puro's strength is its strong presence in the Nordics and adoption by leading buyers such as Microsoft. Furthermore, a strength is their robust quantification LCA-based methods, strict double counting safeguards, and moderate conflict-of-interest risk, especially after recent reforms to its supplier-pays model. Puro holds ICROA endorsement, with ICVCM and CORSIA assessments underway, which will further enhance its credibility and market access. However, its lower credit issuance volume compared to Verra may limit liquidity, and its acceptance of ex ante credits, along with a less rigorous approach to financial additionality, could pose challenges in some markets. For KAN, Puro offers a credible and regionally relevant option, provided it continues to align with evolving standards and buyer expectations.

Strategic recommendation: A dual or multi-certification strategy
Given the diversity within KAN and the evolving carbon removal certification landscape, it is recommended that KAN as a collective pursues a dual or even a multi-certification strategy – actively engaging with both Verra, Isometric and Puro (and potentially other high-integrity registries where relevant).

From a seller's perspective, early engagement and dialogue with multiple registries is practical; final registry selection can remain flexible until the market/contract crystallizes (as learned from Hafslund Celsio and Stockholm Exergi).

It may also be strategically sound to engage and potentially select more than one registry, since the partners in KAN have very different project designs, risk appetites and potentially also different market ambitions. This will hedge against future regulatory or market changes: If standards revise their rules, lose market support or run into regulatory or policy issues, KAN would not be exposed at all sites. It can also open doors to a broader pool of credit buyers, which is important, since buyers such as Microsoft have preferences for a few specific registries (as learned from Hafslund Celsio). Multi-certification also allows KAN to compare registry costs, administrative burden, and credit prices, developing in-house expertise and strengthening negotiating power.

However, the main drawback can be increased complexity and cost. Certification under carbon standards typically involves several costs, including one-time registration and application fees, potential methodology approval fees if new approaches are used, and substantial expenses for third-party validation and verification – the largest cost component. Additional costs may arise from annual or per-credit issuance fees, ongoing internal efforts for monitoring and reporting, as well as registry fees for the issuance or retirement of credits.

On top of these costs, comes costs of internal labour, training, MRV system set-up, etc.

Multi certification can bring some extra costs and challenges. First, KAN will probably have to pay certain fees more than once, such as those for experts who check the project and the costs for getting officially registered. Additionally, handling several certifications increases the internal workload, since staff must complete more paperwork, follow different sets of rules, and possibly conduct extra training to stay up to date.

The benefits of multi-certification can potentially outweigh the costs if KAN's projects are large enough, as the additional expenses for certifying with multiple registries are likely to be offset by the opportunity to sell credits at higher prices or to a wider range of buyers. Additionally, lock-in to just one registry can be risky, since the registry market and methodologies are changing rapidly. Avoiding putting all eggs in one basket gives a better protection if the situation changes. Finally, if the various partners involved in KAN have different goals, risk tolerance, or ambitions, engaging with only one registry might not work for everyone. Having more than one registry allows for greater flexibility and can meet the different needs of all partners involved.

What multiple registries mean for buyers

For organizations that purchase carbon removal credits, sourcing from multiple registries brings some important challenges and considerations. For example, when purchasing carbon credits from multiple registries, buyers is likely to face increased administrative workloads. Each registry operates with its own contracts, rules, and reporting systems, requiring buyers to manage a variety of purchase agreements and to track the retirement or use of credits across different platforms. Furthermore, buyers must continually verify the standards and methodologies used by each registry, stay updated on changes in procedures, and ensure that their activities remain aligned with overarching “meta-standards” such as the ICVCM's Core Carbon Principles.

5 Monitoring, Reporting and Verification (MRV)

5.1 Introduction and scope

The primary objective of this part is to provide a comparative analysis of leading CDR standards in the context of WtE plants that utilize waste feedstock. The analysis aims to clarify the eligibility, operational requirements, monitoring and verification standards, data and digital infrastructure expectations, alignment with relevant regulatory frameworks, and documentation needs for WtE projects seeking to align with internationally recognized CDR standards.

It is important to address that CDR certifications are under constant review and iteration, meaning that the requirements, procedures, and standards alignment could be subject of changes, which concretely can affect the energy sector including WtE integrated with CCS.

Specifically, the scope of work encompasses:

- Evaluating the eligibility of WtE plants under each selected methodology, including identification of any explicit inclusions or exclusions and the rationale behind them.
- Mapping the technical and operational modifications, plant controls, and pre-requisites needed for WtE facilities to achieve compliance under each CDR standard.
- Analysing and comparing the Monitoring, Reporting, and Verification (MRV) protocols associated with each methodology, with special attention to biogenic carbon accounting and emissions measurement for facilities with mixed (biogenic and fossil) waste streams.
- Summarizing or proposing standardized data collection, digital traceability, and reporting protocols suitable to WtE applications under each methodology, including the requirements for data management and auditability.
- Detailing the alignment of each methodology with applicable international and regional standards and regulations, while identifying any gaps or overlaps between requirements and legal frameworks relevant to WtE-based CDR activities.
- Compiling the types of documentation and supporting evidence required for compliance and certification under each methodology and developing a draft checklist or reporting template designed to assist WtE plant operators in achieving and maintaining standard compliance.

5.1.1 Summary and overview

Part 4 provides a detailed description of the various selected standards, focusing on the key criteria used to compare these standards – including eligibility requirements for WtE projects and the types of waste feedstocks permitted.

This section examines and contrasts the main CDR methodologies and registry schemes currently recommended for WtE facilities utilizing MSW as feedstock. When integrated with CCS technologies, WtE plants can offer a significant pathway for achieving negative emissions – contingent on rigorous accounting and secure sequestration of the biogenic fraction of their emissions.

A critical, side-by-side analysis is provided for the major schemes assessed – **Puro, Verra/CCS+, Isometric, Gold Standard, and Drax/Stockholm Exergi**. Each is evaluated in terms of WtE project eligibility regarding waste feedstock sources (specifically, biogenic and non-biogenic fractions), technical and operational compliance requirements, MRV protocols, data and registration needs, alignment with relevant regulations, and documentation necessary for certification. Special emphasis is placed on how each registry treats or restricts WtE projects processing mixed (biogenic and fossil-derived) waste streams.

This review is intended to support WtE project stakeholders in making informed decisions on CDR certification and compliance. It clarifies the operational, evidentiary, and reporting expectations set by each standard, and highlights key implementation considerations and common pitfalls.

The following table includes a summary of the major topic covered in this chapter regarding MRV

Table 13: Scheme-by-Scheme Comparative Matrix

CDR Scheme	Mixed waste feedstock eligibly*	Exclusion/ Inclusion Rationale	Key Tech/Operational Requirements	MRV – Emissions	Data management /Digital Traceability	Regulatory/ Standards alignment	Key documentation/ evidence
Puro	Conditional	Focus on clearly attributable, pure biogenic CDR; challenges in mixed-source quantification & permanence	Robust waste analysis, radiocarbon (^{14}C) analysis; continuous emissions monitoring, secure traceability; tech-neutral if streams are traceable; Feedstock sourcing criteria	Direct measurement, radiocarbon, continuous monitoring, periodic sampling, annual reporting; full audit.	Full chain-of-custody; meters/sensor-to-database; robust; full audit trail	EN 15440, ISO 13833/ASTM D6866, ISO 22095, ISO 14064/44, ISO 27914, EU CCS Directive	Project & waste feedstock/test (incl. ^{14}C) reports; chain-of-custody; biomass sourcing, CEMS data logs, CO_2 transport/storage; MRV plan; audit reports. Annual third-party verification
Verra	Included	Accepts WtE/BECCS if biogenic CO_2 separated/measured; strict exclusion of fossil fraction	Robust waste analysis and CO_2 composition analysis; continuous emissions monitoring; tech neutral.	Continuous monitoring, direct quantification, periodic/annual reporting; fill audit.	Secure chain plant-to-storage; Integrated digital or analog data; full audit trail	CEN/TC 292, EN 15440, ISO 13833, ISO 22095 (pilot), ISO 14064/44, EU CCS Directive, ISO 27914	Waste composition analysis; CEMS data logs and plant performance; MRV plan; storage verification. Annual third-party verification
Isometric	Included	Explicitly covers WtE as a carbon removal path, outlines requirements for UK incineration sector. Inclusion relies on quantification of biogenic fraction, permanent storage, exclusion of fossil, and additionality	Waste stream characterization, radiocarbon (^{14}C) analysis; continuous emissions monitoring, secure traceability; tech-neutral; Feedstock sourcing criteria	MRV framework not fully established. Likely, it will be alignment with EU CRCF and EU CCS directive	Chain-of-custody model for activity data to be shared; secure databases; complete audit trail	EN 15440, 14C/ASTM D6866, ISO 22095, ISO 14064/44, ISO 27914, UK/EU reg.	Detailed waste feedstock/test (^{14}C) reports; capture plant logbooks MRV-aligned plan; biomass sourcing. Annual third-party verification, focused on waste/CO_2 chain.
Gold Standard	Excluded (for now)	Explicitly excludes mixed municipal solid waste and incineration due to uncertainty in additionality, leakage,	N/A for WtE MSW incineration; separate BECCS supported with stringent feedstock traceability.	N/A for WtE + CCS	N/A for WtE + CCS	N/A for WtE + CCS	N/A; would require dedicated methodology for WtE MSW incineration.

CDR Scheme	Mixed waste feedstock eligibly*	Exclusion/ Inclusion Rationale	Key Tech/Operational Requirements	MRV – Emissions	Data management /Digital Traceability	Regulatory/ Standards alignment	Key documentation/ evidence
		and permanence. Focuses on BECCS from segregated biogenic sources.					
Drax/ Stockholm Exergi	Conditional	Custom-developed, sector-specific methodology for BECCS; Specific WtE methodology under development; Proven biogenic fraction; scheme does not issue credits	Waste stream characterization; CO_2 compositional sampling continuous emissions monitoring, secure traceability; tech-neutral, but departs from thermal combustion technologies;	Continuous monitoring; direct quantification/mass-balance; periodic/annual reporting, full audit	Secure chain-of-custody, registry integration; audit trails.	EN 15440, ISO 13833, ISO 22095 (pilot), ISO 14064/44, ISO 27914, EU CCS Directive	Waste feedstock segregation or mass balance reports; MRV plan, waste/CO_2 logs, storage certification. Annual or quarterly third-party verification,

*Mixed waste feedstock eligibility. Conditional: not natively supported only biogenic waste streams shared is accreditable under certain composition evidence, in where the ineligible fraction is properly accounted. Included: explicitly covered, only biogenic waste streams shared is accreditable. Excluded: waste streams are not currently eligible.

5.2 Technical and Operational Mapping

This subsection examines the technical and operational steps required for WtE plants to comply with each of the main CDR schemes under consideration. It highlights the modifications and controls needed to align plant operations with the expectations of various registries, including requirements for carbon capture systems, verification of the biogenic fraction, emission control, and supporting infrastructure.

A critical challenge for WtE plants processing mixed biogenic and fossil waste streams is the accurate identification and quantification of the biogenic fraction of combusted waste – and, consequently, the proportion of CO_2 eligible for CDR crediting. Meeting this challenge necessitates the implementation of dedicated protocols for waste analysis, precise chain-of-custody systems, and robust monitoring procedures covering everything from feedstock receipt to CO_2 capture and storage. In addition, each CDR scheme sets specific requirements for plant measurement and controls, such as continuous emissions monitoring, waste composition analysis, and rigorous data traceability.

Typically, the technical scopes defined by these standards are technology-neutral and do not explicitly exclude any particular method. The capture module may vary depending on the industrial process in question, encompassing:

- Capture from energy combustion (e.g., post-flue gases in power and heat generation)
- Capture from energy conversion (e.g., anaerobic digestion, gasification, or pyrolysis)
- Capture from bioproduction processes (e.g., fermentation of biomass to produce various products).

Some standards, such as Gold Standard, even allow for the inclusion of other processes on a case-by-case basis. As a result, the technical requirements for WtE do not segregate or exclude specific WtE technologies – including incineration, gasification, pyrolysis, and anaerobic digestion – as long as robust feedstock traceability or characterization is maintained.

Plant controls for waste and resource management applied as best practices to CDR schemes:

CO_2 Capture System: Deployment of suitable capture technologies for flue gas streams (e.g., amine scrubbers, oxy-fuel, or other post-combustion technologies), or for non-flue gas streams (e.g., alkaline scrubbing with regeneration, or other pre-combustion technologies); integration must account for the full mixed fuel composition and deliver accurate measurements of CO_2 separated and intended for permanent storage.

Waste Sorting/Characterization: Systematic analysis of incoming waste feedstock, including compositional (proximate and ultimate) analysis and, where practical, automated measurement technologies such as Near-Infrared (NIR) sorting, which are based on established waste management and material characterization practices commonly applied in the WtE and broader solid recovered fuel (SRF) sectors. This ensures accurate quantification of the feedstock sourcing, the (non) hazardous profile of the waste, and the biomass share of the feedstock used for energy production or feedstock processing. While compliance with a specific waste sampling standard is not mandatory, recognition of European standards (e.g., CEN/TC 292 [52] or CEN/TC 343 [53]) can provide recognized benchmarks for measurement approaches applied in waste and resource management practices.

Biogenic Fraction Attribution: There is certain methodological flexibility, as the CDR schemes do not mandate a specific method for determining the biogenic fraction; a range of approaches is generally accepted, provided the fraction is robustly documented and verified. Accepted sampling methods include:

- **Composition analysis:** Determining the mass fraction of biogenic CO_2 based on mole fraction analysis by sampling; techniques may involve chromatography or gas chromatography coupled with IR spectroscopy, following protocols suggested in schemes such as such as Verra[7] and Gold Standard[8].

- **Radiocarbon (^{14}C) analysis:** Application of ISO 13833 sampling [54] or ASTM D6866 standard test method [55] (e.g., as referenced by Puro) to distinguish biogenic from fossil-derived carbon.
- **Alternative Approaches:** Selective chemical profiling, validated mass balance methods, chain-of-custody may also be utilized to accurately quantify biogenic content.

Emissions Monitoring Infrastructure: Continuous monitoring by the Installation and certification of Continuous Emissions Monitoring Systems (CEMS) or equivalent automated monitoring devices systems capable of delivering robust, auditable data on the quantity and composition of captured CO_2.

These operational controls and technical prerequisites ensure that WtE plants can create a transparent, auditable chain of carbon streams from waste receipt through combustion, CO_2 capture, and storage, aligning with the eligibility and MRV expectations of the CDR schemes reviewed.

Table 14: Key technical and operational requirements by Scheme.

Scheme	Biogenic Fraction Segregation	Tech & CC Integration	Controls/ Mitigations	Prerequisites (Carbon Capture/Verification)
Puro	Robust ^{14}C analysis sampling or testing	Tech-neutral, but agnostic to mixed feedstock if biogenic fraction is mistrustful	Mitigate fossil-influenced emissions, no double-counting	CEMS or alike, isotopic or chemical profiling waste provenance verifications, prepared to integrate for logging
Verra	Physical measurement or waste composition analysis	Tech-neutral. All WtE processes eligible. Biogenic segregation accordingly implemented	Risk assessments, no crediting fossil-CO_2	CEMS or alike, isotopic or chemical profiling waste provenance verifications, prepared to integrate for logging
Isometric	Robust ^{14}C analysis sampling or testing	Tech-neutral. All WtE processes eligible.	Emphasizes feedstock variability management and operational robustness	CO_2 capture analytics data, frequent stream sampling
Gold Standard	N/A for WtE incineration	N/A for WtE incineration	N/A for WtE incineration	N/A for WtE incineration
Drax/ Stockholm Exergi	Compositional sampling	Tech-neutral, but departs from thermal combustion tech. WtE included in case-by-case	Risk assessments, no crediting fossil-CO_2	CO_2 capture analytics, frequent stream sampling

[7] Use the lower value of two consecutive composition analyses to calculate continuous (i.e., at least every 15 minutes) values between the two composition measurements. Weekly aggregation for regular gas chromatography, and monthly aggregation for gas chromatography IR spectroscopy
[8] Continuous metering with monthly aggregation, with a minimum of one measurement every 15 minutes. Absolute frequency of metering shall be highest level possible,

5.3 MRV Assessment

Robust and improved MRV procedures are central to the credibility and market acceptance of CDR from WtE plants. Mixed waste feedstocks introduce complexity in quantifying the portion of CO_2 emissions derived from biogenic sources, and each CDR scheme has responded with stringent MRV protocols tailored to these unique challenges.

5.3.1 Biogenic Carbon Accounting

All eligible CDR schemes require accurate accounting of the biogenic fraction within both the waste feedstock and resulting CO_2 emissions. This typically involves two key elements:

- **Direct Analytical Measurement:** Most schemes (notably Puro Verra) require or strongly prefer scientific measurement, such as the methods presented in section 5.2 for biogenic fraction attribution to distinguish biogenic from fossil-derived carbon in both fuel and captured CO_2 streams.
- **Waste Composition Analysis:** Periodic laboratory testing and compositional studies, supplemented by automated monitoring or default estimation factors when justified, are required to quantify the proportion of biogenic feedstock combusted.
- **Biomass & sustainability:** There is an important component to the sustainability profile that the biomass-share feedstock carries, although the rules are less strict for waste feedstock due to its mixed origin. For which documentation or certification can be required, such as Isometric's *Biomass Feedstock Accounting* [56], Puro's *Biomass Sourcing Criteria* [57], or Drax/ Stockholm Exergi's *Methodology: Appendix C* [48], or Verra's *VMD0059 Appendix A1 Biomass from Waste* [58].

5.3.2 Monitoring plan

As part of the MRV systems required for CDR schemes to stablish a monitoring plan and GHG information system that includes criteria and parameters for obtaining, recording, compiling and controlling. The monitoring procedures are summarized in the following table:

Table 15: Information to be compiled in a monitoring plan for relevant parameters involved in MRV validation.

Parameter	Description
Parameter ID	A unique identifier of the parameter or data point
Data/Parameter	The name of the data point or parameter (type of data)
Data unit	The unit of the data point or parameter
Description	A brief text describing what the parameter is about, and how it is used in calculations
Source of data	A brief text describing where the data is sourced from (origin)
Measurement procedures and conservativeness	A brief text describing how the data is obtained, via what measurements, and why the value selected is conservative in light of possible error or uncertainty
Monitoring methodologies	Estimation, modelling, measurement, sampling and calculation
Measurement error	An estimation of the error associated with the measurement, and how it is determined. (For Puro scheme the calibration error of any measurement device shall not exceed 5%)
Monitoring frequency	The frequency of monitoring of the parameter or data point
QA/QC procedures	Quality assurance and quality control procedures in place. This may include measurement instrument calibration protocols, documentation and certificates
Additional information	Any relevant information that is specific to WtE plant settings

As part of the monitoring plan is it relevant to address the monitoring procedures that are eventually reported and verified.

5.3.2.1 Emissions Measurement and Reporting Frequency

Continuous, high-frequency measurement and reporting are fundamental, with the following requirements observed across the assessed CDR schemes:

- **Continuous monitoring:** CDR schemes such as Puro, Verra/CCS+, and Gold Standard require a continuous monitoring frequency defined as at least once every 15 minutes. This can primarily be achieved by implementing CEMS technologies, or similar commercially available solutions, which are designed to measure the concentration of pollutants[9] and other parameters in the gas stream of a stationary emission source. This kind of technology offers automated, traceable records of pollutants including CO_2 composition, volume, and quality. Currently there is also commercially available Predictive Emissions Monitoring Systems (PEMS) solution, that do not use hardware-based sensors to measure emissions but instead use unique algorithms to determine the emissions signature of an engine, based on the input parameters.
- **Periodic Sampling:** As part of the monitoring procedures periodic sampling and statistical evaluation of emissions, as one of the methods applied for feedstock characterization, should be accordingly applied.
- **Reporting Frequency:** Minimum reporting intervals are typically annual but may be quarterly for biogenic content verification and process performance data submission (see Table 16).
- **Monitoring CO_2 storage**: CDR schemes require continuously monitoring of the mass flow rate of CO_2 entering the storage reservoir through direct measurement of the flow to extract the mass fraction or volume fraction of the CO_2 injected. Mass flow rates must be determined by commercially available devices that measure the mass flow rate of a fluid flowing through a measurement channel (e.g., Coriolis meters, thermal meters, impeller meters, twin turbine meters). Puro suggests monitoring should be implemented quarterly. Similarly, post-injection monitoring data is required for demonstrating permanence.

5.3.2.2 Verification and Audit

For all the reviewed CDR schemes there is an overall harmonized demand rigorous, independent third-party verification:

- **Third-Party Auditing frequency:** Annual or multi-year cycles are standard, depending on the scheme (see Table 16). Auditors validate plant data – including waste composition, CO_2 capture, transport, and storage volumes – and assess compliance with protocol documentation.
- **Corrective Action and Transparency:** Any discrepancies identified during verification must be addressed via corrective action processes, ensuring ongoing accuracy and fostering trust among carbon credit buyers and regulators.

Table 16: Comparative scheme overview of MRV systems.

Scheme	Biogenic Carbon Approach	CEMS Required	CO_2 storage monitoring	Reporting/Verification Cycle	Third-Party Audit
Puro	^{14}C analysis or equivalent	Yes	Yes, quarterly	Annual	Yes
Verra	Direct (volumetric flow) or	Yes	Yes, frequency	Annual	Yes

[9] Pollutants from waste feedstock incineration, such as: Carbon dioxide (CO_2), hydrogen sulphide (H2S), carbon monoxide (CO), nitrogen oxides (NO_X), sulphur oxides (SOx), methane (CH_4), heavy metals, and particulate matter (PM).

Scheme	Biogenic Carbon Approach	CEMS Required	CO_2 storage monitoring	Reporting/Verification Cycle	Third-Party Audit
	scientific method sampling		non specified		
Isometric	^{14}C analysis or equivalent	Not directly, but requires frequent monitoring for eligible projects	Yes, frequency non specified	Annual	Yes
Gold Standard	N/A for WtE incineration	N/A for WtE incineration	N/A for WtE incineration	N/A for WtE incineration	N/A for WtE incineration
Drax/ Stockholm Exergi	Physical segregation or mass balance approach	Not directly, but requires frequent monitoring for eligible projects	Yes, frequency non specified	Quarterly/annually (reporting) plus annual verification	Yes

5.4 Data Protocols and Digital Infrastructure

Accurate data collection, management, and digital auditing are critical enablers of credible CDR. Registries and scheme administrators increasingly require transparent, tamper-proof documentation throughout the carbon removal chain, from waste reception through combustion, CO_2 capture, intermediate storage, transport, storage, and final reporting. The following data protocols and systems are very much incorporated into all CDR schemes.

5.4.1 Essential Data Protocol Components

Chain-of-Custody Tracking
The eligible CDR schemes require a clearly documented digital chain-of-custody linking the biogenic fraction of incoming waste to the verified quantity of CO_2 captured and ultimately stored. This traceability is especially challenging but essential in settings with heterogeneous waste feedstocks shares.

Automated and Semi-Automated Data Logging
It can be interpreted from the assessed CDR standards that there is required the integration of operational sensors (e.g., CEMS, mass flow meters, and waste sampling techniques) directly with central, secure databases. This structure support reporting and minimizes manual errors and facilitates automated oversight.

Robust Data Security and Auditability
CDR Registries expect strong data integrity protocols, including digital signatures, version control, secure backups, and regular data quality assurance checks. The verification of monitoring data and monitoring procedures are to be verified by a recognized third-party auditor.

Transparent and Standardized Reporting Formats
Data must be formatted and reported using standardized templates and protocols specific to each registry. This ensures consistency and comparability across projects and facilitates seamless audits

5.4.2 Digital Infrastructure Requirements

Centralized Digital Monitoring Platforms
Integration of plant-level data management with registry platforms (e.g. via cloud or on-premises solutions) is expected as best-practice, in order to move away from analog registration and mitigate errors. These platforms must support real-time monitoring, data storage, historical trace-back, and access controls for third-party auditors.

Interoperability With MRV Systems
Seamless, secure data transmission between plant MRV infrastructure (such as CEMS, laboratory information management systems, and waste composition analysis tools/approaches) and registry databases is now considered the best-practice.

Data Redundancy and Access Controls
CDR Schemes often stipulate retention periods (e.g., 5–10 years) and requirements for both redundant backups and role-based access controls to safeguard sensitive project information.

5.5 Mapping of standards and regulations

Alignment with internationally recognized standards and regional regulations is essential for establishing the environmental integrity, interoperability, and market acceptance of CDR projects. Adhering to these standards ensures that methodologies for quantification, reporting, verification, and chain-of-custody are robust and transparent, while also reducing regulatory and reputational risks.

5.5.1 Relevant standards and regulatory references

Key standards and regulations pertinent to WtE-based CDR projects include the following areas:

Waste characterization best practice alignment

- **CEN/TC 292** [52]: Characterization of Waste. Develops standards for waste characterization, including sampling, pre-treatment, and leaching properties; or
- **CEN/TC 343** [53]**:** standard for production, specification, and classification of SRF, which is fuel derived from non-hazardous waste, primarily for energy recovery purposes

Biogenic fraction characterization compliance

- **EN 15440** [59]**:** Standard for determining the biomass (biogenic) content in SRF. Particularly important for WtE facilities utilizing mixed waste streams and pivotal to CDR crediting.
- **ISO 13833:2013** [54]: Stationary source emissions – Determination of the ratio of biomass (biogenic) and fossil derived carbon dioxide – Radiocarbon (^{14}C) sampling and determination; or
- **IAEA/ASTM D6866** [55]**:** Standard practice for radiocarbon (^{14}C) testing to distinguish biogenic from fossil carbon – a crucial step in biogenic fraction verification.
- **ISO 22095:2020 – Chain of custody** [60]**:** Establishes general principles and standardized terminology and models for chain-of-custody, underpinning secure, transparent, and auditable carbon/material (biogenic) flows tracing.

WtE & CCS project emissions compliance

- **ISO 14064** [61]**:** Part 2 – Standard that provides principles, requirements, and guidance for quantifying, monitoring, and reporting GHG emission reductions or removal at the project level (see also part 3, 3.6.5); or
- **ISO 14040/44 – Life Cycle Assessment (LCA)** [62]**:** Principles, framework, and requirements for LCA – essential for substantiating both direct and indirect (upstream/downstream) impacts, net climate benefit and guarding against burden shifting across the CDR project life cycle; and

- **EN 15978:2012** [63] & **ISO 21930:2017** [64] – *Sustainability of construction works – Assessment of environmental performance of building*: Methods for calculation of the environmental performance for building products; relevant when WtE facilities pursue integrated sustainability CRD certification (capital goods or embodied emissions) and for broader life cycle thinking in the built environment.

CCS value chain (CC, transport, storage) compliance

- **ISO 27914:2017 – CCS** [65]**:** General requirements for carbon dioxide capture, transportation, and geological storage, harmonizing technical, safety, and environmental controls for CCS underpinning negative emission durability.
- **EU CCS Directive 2009/31/EC** [66]**:** The backbone of CO_2 geological storage policy in Europe, with practical, harmonized guidance for permitting, monitoring, risk assessment, site closure, and liability. Compliance is mandatory within the EU and often referenced or required by European CDR registries.

Table 17: Overview of CDR schemes alignment and regulatory gaps & overlaps.

Scheme / Standard	EN 15440	IAEA/ ASTM D6866	ISO 22095	ISO 14064	ISO 14040/44	EN 15978 / ISO 21930	ISO 27914	EU CCS Dir. & Guidance	Gaps/Overlaps & Notes
Puro	Yes	Yes	Yes	Yes	Reference	Yes	Referenced	Yes, if in EU	Chain-of-custody, LCA integration evolve; jurisdictional alignment varies but focus on EU; Embodied emissions (emissions from capital goods) are mandatory
Verra	Yes	Yes	Partial	Yes	Reference	No	Referenced	Yes, if in EU	LCA integration developing; relies on host regulation for EU storage.
Isometric	Yes	Yes	Developing	Yes	Reference	Reference/ Contextual	Referenced	Partial, emphasizes UK and seeks alignment in EU frameworks	Integration of core standards with evolving digital traceability and LCA; promotes best practice alignment with ISO and UK-EU CCS requirements; actively developing MRV and chain-of-custody models to enhance biogenic carbon tracking and reporting transparency.
Gold Standard	Yes	N/A	Yes	Yes	Reference	Reference/ Optional	N/A	N/A	Excludes WtE for CDR, but follows international standards not specific to EU
Drax/ Stockholm Exergi	Yes	Yes	Partial	Yes	Reference	Reference/ Application	Yes	Yes, if in EU	Harmonization with ISO/EU standards; LCA and 22095 under deployment.

"Yes" = formally integrated requirement or standard basis.
"Partial/Reference" = referenced or under pilot/voluntary.
"N/A" = not applicable to mixed MSW incineration for CDR due to methodology exclusion.

5.5.2 Review and Observations

As summarized in Table 17, not all the listed standards apply universally to the CDR schemes, as the compliance requirements my vary across regions (EU or international) and scope of rugosity, for instance Verra excluded accounting for embodied emissions (see also part 4, 4.3.1). Further it is worth nothing that there might appear redundancies when implementing certain standard within the same areas.

Waste characterization

- **CEN/TC 292** and **CEN/TC 343**: suggested as best practice in waste and resource management.

Biogenic fraction characterization

- **EN 15440**: All major schemes that support WtE projects align with these core standards for biogenic content determination.
- **ISO 13833** and **IAEA/ASTM D6866**: ^{14}C (radiocarbon) testing is an accepted or required practice for biogenic fraction determination in Puro and Isometric. Puro recommends radiocarbon dating but may accept alternate methods with sufficient statistical confidence.
- **ISO 22095**: Chain-of-custody requirements are increasingly emphasized, particularly for ensuring the traceability of biogenic carbon from waste collection to storage. Puro and Gold standard provide the most explicit references, aligning terminology and models as outlined in ISO 22095. Verra and Drax/Stockholm Exergi are advancing pilots or evolving guidance in this area.

WtE & CCS project emissions

- **ISO 14064**: All major schemes that support WtE projects align with these core standards for GHG emissions and removal quantification.
- **ISO 14040/44:** Principles and detailed LCA requirements are increasingly referenced, especially in the EU, to demonstrate overall net climate benefit and full life cycle transparency. Adoption in Puro, Verra and Drax/Stockholm Exergi is in progress for enhanced environmental legitimacy.
- **EN 15978:2012 & ISO 21930:2017:** These are particularly relevant for WtE sites integrating new-build CCS infrastructure-construction; mainstream as background but not universally mandatory.

CCS value chain compliance (Carbon capture, transport, storage)

- **ISO 27914:2017:** Reference document in most credible schemes for CCS – detailing technical, safety, and monitoring requirements for the full CCS value chain and geologic permanence.
- **EU CCS Directive**: Full legal and regulatory compliance is non-negotiable for eligible European projects, strongly referenced in all EU-based methodologies (such as Puro., CCS+ and Drax/Stockholm Exergi).

Gaps and Overlaps

- Projects operating under multiple schemes or across jurisdictions must navigate overlaps – particularly around MRV, chain-of-custody, and LCA documentation – to avoid duplicated or conflicting processes.

- Some schemes (especially those not rooted in the EU or in commercial pilot phases) are still evolving their integration of ISO 22095 and ISO 14044 in day-to-day chain-of-custody and LCA practices. However, overlaps exist where chain-of-custody or LCA requirements repeat those of other standards (ISO 14064) or require supplementary documentation for biogenic fraction verification. Full digital chain-of-custody and operational LCA implementation are developing quickly, but practical harmonization of documentation, digital record-keeping, and reporting is ongoing.

- There is some functional overlap between registry requirements and EU regulatory documentation, especially in MRV and chain-of-custody logging, requiring clear internal procedures by project operators to avoid duplication or inconsistency.

5.6 Documentation & compliance

Proper documentation and structured certification templates form the backbone of compliance within CDR registry schemes. These records ensure traceability, facilitate verification, and provide robust evidence demonstrating operational conformity with scheme-specific, technical, and regulatory requirements.

Key Documentation Categories

1. **Project Registration and Baseline Documentation**
   - Description of the WtE facility, including location, capacity, and operational history.
   - Detailed characterization of feedstock composition, emphasizing biogenic fractions.
   - Baseline GHG emissions inventory without carbon capture.
   - Description of planned or installed carbon capture technology and storage arrangements.
2. **Feedstock and Biogenic Fraction Verification**
   - Laboratory reports from proximate and ultimate analysis of feedstock.
   - Radiocarbon (^{14}C) testing results or alternative biogenic content validation methodologies.
   - Chain-of-custody records traceable from waste suppliers to incineration.
3. **Carbon Capture and Emissions Monitoring**
   - CEMS or alike logs and calibration certificates.
   - Cumulative CO_2 capture volume and purity reports.
   - Records of operational downtime or anomalies affecting capture performance.
4. **CO_2 Transport and Storage Documentation**
   - Contracts and permits for CO_2 transport.
   - Storage site certificates, monitoring plans, and injection records.
   - Post-injection monitoring data demonstrating permanence.
5. **MRV Records**
   - Scheduled MRV reports, including methodology calculations and uncertainty estimates.
   - Third-party verification statements and audit reports. Submission for verification and auditing is to be prepared for the addressed monitoring parameters in monitoring plan form section 5.3.2.
   - Records of corrective actions and compliance measures taken post-verification.
6. **Digital Traceability and Data Management Logs**
   - Chain-of-custody tracking from waste feedstock inflow to final CO_2 storage.
   - Data platform summaries demonstrating secure data flows, backups, and audit trails.
   - Digital authentication signatures documenting report veracity.

Table 18: Sample draft checklist for WtE CDR compliance and certification.

Section	**Item Description**	**Source / Responsible Party**	**Streamlined check or Full check**	**Status** (✓ / ✗)	**Date** (dd/mm/yyyy)
Project Setup and Baseline	Facility details and baseline GHG inventory	*Project Developer / Environmental Consultant*			
	Registered CCS technology description	*Engineering Team / CCS Supplier*			
Feedstock Characterization	Waste composition reports (periodic)	*Waste Management / Laboratory (internal or external)*			
	^{14}C isotopic/ radiocarbon analysis or equivalent biogenic validation	*Laboratory (internal or external)*			
	Chain-of-custody documentation from suppliers to plant	*Procurement / Quality Control*			
Capture and Emissions Monitoring	CEMS installation and calibration logs	*Operations / Monitoring Team*			
	CO_2 capture volume and purity logs	*Plant Operations*			
	Incident and downtime logs	*Operations / Maintenance*			
CO_2 Transport and Storage	Transport contracts and permits	*Legal / Compliance*			
	Storage site permits and injection records	*Storage Site Operator*			
	Long-term monitoring reports	*Storage Site Operator / MRV*			
MRV and Verification	MRV plan and reporting schedules	*MRV Coordinator*			
	Verification audit reports	*Independent Verifier Body/Auditor*			
	Corrective action and compliance tracking	*Project Management*			
Digital Data and Traceability	Digital chain-of-custody system logs	*IT / Data Management Team*			
	Backup and cybersecurity evidence	*IT Security*			
	Digital signatures and report submission proofs	*Project Coordinator / Registrar*			

6 Price and market

6.1 Introduction

This section presents an analysis of CDR market trends, price outlooks, and market potential for Norwegian WtE operators. By mapping historic and forecasted price developments for various CDR methods, as well as regulatory drivers and buyer trends, the section offers a fact-based foundation for strategic decision-making and market participation.

This section is organized into several chapters, each providing a focus on core aspects of the CDR market and its relevance for Norwegian WtE operators. This chapter sets the context for the analysis. Section 6.2 examines the evolution of CDR credit prices, providing an overview of historical trends and recent market developments. This chapter also includes scenario-based price forecasts and a detailed discussion of regulatory price mechanisms, with a special focus on how carbon pricing in Norway influences the business case for CDR from WtE plants.

Section 6.3 presents a detailed overview of current market demand, identifying leading buyers and sellers, transaction volumes, and the CDR methods in play. It explores both the current landscape and anticipates how demand will evolve post-2030, considering key drivers such as corporate climate commitments, emerging regulation, and projected credit demand across sectors.

Finally, section 6.4 benchmarks Norway's potential for BECCS relative to other countries. This includes an assessment of technical potential, project maturity, storage infrastructure, and the regulatory environment supporting future CDR market development.

6.1.1 Summary and key findings

This section explains how CDR credit prices have developed, where they stand now, and what they might look like in the future – especially for Norwegian WtE operators. It also covers market demand, main buyers and sellers, regulatory impacts, and Norway's position in the global CDR market.

Since 2019, the market for CDR credits has undergone rapid growth and maturation. Traded volumes and the diversity of supply have increased each year, accompanied by notable advances in price transparency and the development of new project pipelines. Despite these improvements, the market remains fragmented, with significant differences in pricing within and across CDR methods.

CDR credit prices have also been characterized by considerable volatility. Initially, credits traded at high premiums due to scarcity and a lack of technological maturity, with prices at times exceeding USD 400 per tonne CO_2. As supply has expanded and market dynamics have matured, prices have moderated. Technologies such as Biochar Carbon Removal (BCR) have emerged as the lowest-cost CDR solutions, whereas more technologically complex approaches like DACCS continue to command higher price points.

Policy and regulatory frameworks, particularly the Norwegian CO_2 tax – which is set to rise to approximately USD 235 per tonne by 2030 – play a defining role in shaping the business case for CCS and CDR credits from WtE operators. An analysis shows that unless technology costs are significantly reduced, the break-even price for biogenic CDR credits is likely to remain significantly above the level of the CO_2 tax.

Examining market demand reveals that the current voluntary market is dominated by leading technology and finance companies, with firms such as Microsoft responsible for most CDR purchases to date. Early buyers have focused on securing credits for near-term climate targets, but it is anticipated that demand will broaden substantially after 2030. This expansion is expected to bring in new buyers from hard-to-abate sectors – including aviation, shipping, heavy industry – and a growing number of institutional investors. Within this context, Nordic suppliers, and Norwegian projects in particular, are regarded as high-quality, reliable providers of durable removals.

When benchmarking Norwegian BECCS potential, while the theoretical capacity is modest (2–3 $MtCO_2$ per year), Norway distinguishes itself through advanced project maturity, robust regulatory frameworks, and well-developed storage infrastructure. The global CCS Readiness Index ranks Norway third, underscoring its strategic position as both a domestic and international leader in CDR deployment and CO_2 storage.

Table 19: Key findings, price and market.

	Conclusions	Takeaways for KAN
Current demand and demand outlook	Pre-2030: Rapid growth in traded volumes, price transparency improving, but market still fragmented, price spectrum: Biochar (low) → DACCS (high). Dominated by early movers (Microsoft major buyer) who focuses on near-term climate targets Post-2030: Buyers broaden to aviation, shipping, industry, investors driven by net-zero deadlines	KAN must develop strong MRV systems and engage in pilots to build first-mover reputation and attract investors and buyers.
Regulatory drives	CCS costs optimistically 253/t to more likely 334/t USD by 2030 CO_2 tax rising to ~USD 235/t by 2030 CDR price/tax break-even is unlikely unless LCoCCS scenario is optimistic	Break-even with CO_2 tax unlikely in the coming decades unless CCS costs are reduced significantly and projects receive public funding.
Norway's strategic position	BECCS: 2–3 $MtCO_2$/year potential Mature projects & storage infrastructure #3 in Global CCS Readiness Index	KAN can leverage Norway's strong CCS readiness and collaborate with Nordic partners for market advantage; maintain innovation and engage with policymakers and investors to ensure long-term competitiveness.

6.2 CDR pricing

This chapter reviews the evolution of CDR credit prices, highlights recent developments, and provides insights on what this means for WtE operators in Norway. By understanding these trends, KAN members can better assess the potential, risks, and opportunities in developing and participating in the growing CDR market.

6.2.1 Historical CDR price development

Biogenic CDR credits are a relatively new component of the global carbon market, particularly compared to traditional avoidance or forestry credits. Traditional credits typically reward the prevention of new emissions (i.e., "avoided emissions"), such as by conserving forests or displacing fossil fuels, but do not actually remove CO_2 that is already in the atmosphere. By contrast, biogenic CDR methods actively draw down atmospheric carbon and permanently sequester it, addressing not only ongoing emissions but also the legacy emissions that have accumulated over time.

Two CDR technologies are biochar and BECCS, which are notably different in terms of permanence. While BECCS is generally seen as delivering the most permanent form of storage – since captured CO_2 is injected into geological formations and effectively locked away for centuries or longer – biochar stores carbon in a solid, stable form in soil, but with some ongoing uncertainty over just how permanent or "risk-free" this storage is across long time horizons.

Durable CDR credits only began seeing significant transactions around 2019, making this a very young segment of the carbon market. Initial activity was limited mostly to experimental pilots and a handful of buyers, often "innovators" or philanthropically motivated organizations (such as Frontier or the Milkywire Climate Transformation Fund), willing to pay high prices to jumpstart the sector.

Most biogenic CDR credits delivered to date have come from biochar projects, reflecting the comparative technological readiness, lower cost, and co-benefits (e.g., soil improvement), while the market for BECCS credits has been slower to develop: large-scale BECCS projects require substantial upfront investment and secure offtake, and have thus been primarily pursued in locations with strong policy support (e.g., Sweden's and Denmark's BECCS state support mechanisms).

However, over the last decade, reports from the IPCC and other scientific bodies have made it clear that large-scale carbon removal is necessary to meet net-zero and Paris Agreement targets, especially for compensating residual emissions from hard-to-abate sectors. This recognition has driven both policy (inclusion in climate strategies) and corporate action (integrating CDR into net-zero plans and compliance with the Science Based Target initiative (SBTi).

Early deals were negotiated privately, with limited price discovery. The entry of price organizations (like OPIS and CDR.fyi) and transparency initiatives has only recently begun to illuminate "real" market pricing, making it easier for new participants to enter and plan projects. With few projects and buyers, prices started high, reflecting R&D risk, lack of scale, high MRV costs, and uncertainty about durability and long-term value. Now we are beginning to see an emphasis on price transparency, standardized crediting, and credible durability, prompting greater differentiation between CDR methods.

Additionality a critical factor in shaping prices
Considering what drives prices, additionality is a critical factor for buyers. Large corporate buyers, particularly early movers such as Microsoft, are placing a premium on credits that demonstrate robust additionality and clear climate impact. They want to be confident that their purchases are supporting projects that genuinely deliver new removals, rather than those that might have happened anyway. This focus has elevated the due diligence bar for sellers and has a direct impact on price formation in today's market.

So far, the market is not shaped by classic supply-and-demand mechanics where increasing project volume naturally lowers prices. Instead, the prices set for most biogenic CDR transactions reflect the real needs of suppliers to reach FID. In other words, the price is often anchored to what is required for a project to move from planning to construction and operation, accounting for capital and operational costs, investor risk, and expected returns. Many high-profile deals such as the Hafslund Celsio-Microsoft deal have been negotiated on a project-by-project basis, rather than through a transparent marketplace and there is significant variation in prices between technologies, regions, and specific deals.

Currently, buyers are less concerned with simply securing the lowest-cost credits and more focused on the environmental quality, additionality, and integrity of the projects they support. These buyers are using their purchasing power to catalyse the market and drive technological innovation, expecting robust MRV as well as clear proof of permanence and additionality. As a result, we see significant price dispersion: for example, biochar credits consistently trade below BECCS due to differences in perceived permanence and project economics, while pilot BECCS projects can command a premium needed to overcome their high upfront costs.

Overall, the voluntary carbon removal market for biogenic CDR is currently characterized by bespoke contracts, price discovery based on project viability rather than market equilibrium, and a strong emphasis on project quality. As regulatory frameworks mature and CDR becomes integrated into compliance markets, pricing mechanisms may shift, but for now the drivers remain fundamentally rooted in the financial realities of project development and buyer expectations for additionality and permanence.

Historically, there has also been an absence of strong policy drivers. Unlike renewable energy markets (where FITs, auctions, mandates drove early growth), CDR markets initially lacked robust government incentives. Recently, national policies (e.g., Sweden's BECCS auctions, US 45Q tax credit) and the development of carbon markets with CDR provisions are beginning to provide the certainty and scaling capital needed for larger projects.

A recent report conducted by the newly established Nordic Carbon Removal Association (NCDRA) in collaboration with Implement [25] argues that there is room for significant optimism for the expansion of BECCS credits as more WtE and heavy industry facilities in the Nordics, move towards commercial-scale carbon capture. The report describes how Nordic projects are the largest providers of permanent CDR certificates – as of May 2025, 39% of the top 25 CDR sellers by volume were Nordic actors [25].

Over the past 5 years, the market for biogenic CO_2 credits has grown significantly. From just a few thousand tons sold in early years, cumulative volumes are projected to reach 32 million tons by July 2025 according to CDR.fyi [43]. Figure 2 below illustrates how the sales volume has increased over time and the changes in the associated CO_2-price. The first deals in 2019 started at USD 150 /t CO_2, which more than doubled one year later. The average price peaked at around USD 440 /t CO_2 mid-2022 and has since fallen below USD 300 /t CO_2.

The figure makes clear that prices until now have been characterized by high volatility and an inverse correlation with volume: the price per ton has decreased, as sales volume of credits increase (and vice versa). This is typically to be expected of new, innovative markets, which often start with low volumes and premium pricing, then shifting to higher volumes and greater accessibility as the market matures and suppliers learn to lower costs.

Buyers now have access to a growing pool of biogenic credits at more competitive prices, supporting broader carbon management ambitions, while suppliers face increasing competition and must find efficiencies or differentiation to maintain margins as prices fall.

Waste incineration plants such as KAN members can leverage this trend: While average prices have fallen, the growing traded volume indicates healthy and expanding demand if costs can be controlled.

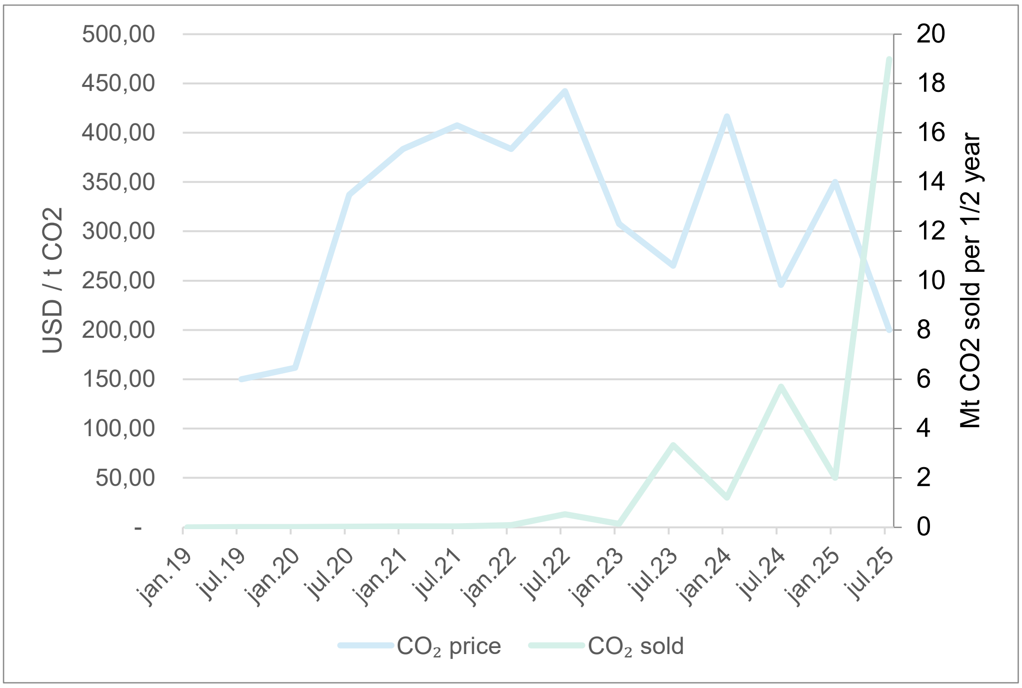

Figure 2: CO_2-price over time based on [2].

Table 20 presents the comparison of CDR prices depending on the CDR method from sales until now in. The price does have some correlation with the cost and technological maturity of the method. For example, Direct Ocean Removal (DOR) has the highest prices in the voluntary market so far reflecting several factors, including its relatively novel and complex technology, higher operational costs, and the perceived durability and additional environmental co-benefits of ocean-based carbon sequestration.

In contrast, methods such as biochar production and biomass storage have traded at significantly lower prices. These methods typically benefit from more established processes, lower energy requirements, and comparatively easier scalability. Their lower costs translate into more affordable CDR credits, which can be attractive for buyers looking for cost-effective removal options.

Table 20: Observed prices paid for CO_2 for different carbon removal methods (average across 2019-2025) [43].

Method	USD / tonne
Direct Ocean Removal	1,300
DACCS	490
Alkalinity Enhancement	460
Biomass Geological Sequestration	420
Enhanced Weathering	360
Mineralization	340
MBCCS	250
BECCS	200
Biochar Carbon Removal	150
Biomass Direct Storage	61

However, it is not always the case, that price and cost correlates. Some of the recently observed CDR credit agreements reveals other patterns. For example, there have been agreements where the price on DACCS is significantly lower than the price for BECCS project such as the Google-Holocene deal in 2024, where credits were traded to ~ 100 USD/t CO_2. A possible explanation for this is that the Google-Holocene deal is based on the buyer' anticipated future cost reductions from economies of scale, improved processes, learnings, etc. Offering a low price to a reputable buyer like Google enhances Holocene's profile, helping them attract further investment and help defining technical, MRV and policy standards because the project serve as a benchmark. Furthermore, it can have a catalytic effect in the sense that early, committed customers such as Google can crowd-in additional investors or grant funders who see commercial momentum. The deal can also be seen as policy and regulatory positioning and help buyers gain a "seat at the table" in regulatory design or pilot credit programs because they're running real projects.

To conclude, the diversity of CDR technologies and project circumstances, combined with immature and fragmented market structures, means there is not yet a single "market price" for carbon removal. This variability poses challenges for both buyers, who must thoroughly assess value and risks, and for suppliers, who must articulate the unique merits and costs of their specific projects to justify their pricing. As the market evolves and more standardized contracts or platforms emerge, pricing could become more transparent and comparable – but for now, it remains highly project-specific.

6.2.2 Market price expectations

The report "Bridging the Gap: Durable CDR Market Pricing Survey" from January 2025 [67] provides an analysis of the rapidly evolving market for durable CDR solutions. Published jointly by CDR.fyi and OPIS, the survey provides rare, in-depth insights into both the supply and demand sides of the durable CDR credit market, covering a range of engineered and nature-based methods such as BECCS, DACCS, biochar, enhanced weathering, mineralization, marine CDR (mCDR), and other biomass solutions.

As the carbon removal sector is still in its infancy – with far fewer credits delivered compared to traditional offset markets – transparent and credible price discovery is especially challenging. The report addresses this gap by gathering and comparing supplier breakeven costs and purchaser willingness-to-pay across multiple CDR technologies for 2025 and 2030.

For Norwegian KAN members considering carbon capture, the report provides valuable insight into the current and expected price landscape for durable CO_2 removal. The findings in the report can help with benchmarking projects and understand how costs and value propositions compare within a growing international CDR market. Additionality the report provides a perspective on anticipated price developments and technological maturity across different CDR solutions. Finally, the report findings can support decision-making and inform market outlook and strategic planning as regulatory and buyer expectations evolve.

For each method (BECCS, DACCS), both suppliers and purchasers were surveyed for prices both for 2025 and 2030 that reflect:

- Too Cheap / Below Cost (not credible, or would lose money)

Cheap / Good Value / Breakeven
Expensive / Reasonable Profit

- Too Expensive / High Profit but Risky

The differences in prices are likely due to differences in costs for the suppliers. Zooming in on the breakeven price, it is clear that biochar is still considered the lowest-priced CDR method, while DACCS remains the highest-priced method – though its prices are projected to fall significantly by 2030. BECCS is a mid-range alternative, with a modest decrease by 2030 expected mostly from storage and scale, not radical capture technological change.

Table 21: Anticipations of breakeven price. Note: The table is based on global project data – mainly North America, the Nordics and UK. The numbers are relevant and reasonably representative as benchmarks but should be interpreted cautiously, considering the particularities of the Norwegian context.

CDR method	2025 Purchaser/buyer	2025 Supplier/seller	2030 Purchaser/buyer	2030 Supplier/seller
BCR	$94	$143	$85	$136
Other biomass	$122	$214	$112	$139
BECCS	$169	$232	$153	$212
Mineralization	$181	$316	$160	$228
Enhanced Weathering	$187	$272	$149	$252
mCDR	$246	$155	$217	$187
DACCS	$458	$670	$272	$341

Significant trends over time include that both sellers and buyers expect lower prices by 2030 for almost all CDR methods, and that the seller-buyer gap narrows for most methods, although buyers generally expect lower breakeven prices than sellers.

This is based on the pricing survey from CDR.fyi/OPIS Pricing Survey Jan 2025 [68] and reflects early-stage market dynamics and the negotiation tension between cost realities and willingness to pay as the CDR market develops.

It is also worth highlighting that the seller's breakeven price for BECCS is lower than what the buyers consider expensive, which shows that there are possibilities of finding prices that can work for both.

Table 22: Different price perceptions for BECCS credits, USD/t in 2025 [67].

	Breakeven supplier /seller	Expensive purchaser /buyer	Reasonable profit supplier	Too expensive purchaser
BECCS	$232	$290	$301	$396

6.2.3 Price forecast scenarios

There is broad agreement, that the prices for CDR credits will follow the costs of CCS to a higher level than to date, with more projects being operational and larger supply and demand creating a more transparent market.

However, there is uncertainty about how many CCS projects will be realised, with several projects being delayed or experiencing sharp cost increases. In the case of a lower number of operational projects and hence lower supply of CDR credits than expected, the price will largely depend on the persistence of the demand side. With expected increases in demand (see section 6.3), there will be increased competition between buyers wanting to reach their climate commitments, which could lead to a CDR price above CCS costs.

Furthermore, an important nuance emerges when considering how carbon standards assess “additionality,” which is a central requirement for generating credits in the voluntary market. Most standards stipulate that for a project to qualify, it must go beyond common practice, as further explained in 4.3.2. If CCS becomes commonplace, then, additionality is threatened. This dynamic will result in one of two outcomes: either the eligibility rules of VCM standards will become a limiting factor for credit supply, or the standards and compliance schemes themselves will be forced to evolve and relax the common practice requirements. The outcome will influence not just market pricing, but the continued role of voluntary markets as a catalyst for climate action and technology scaling.

Agreement of future price decrease, but not on how much
The literature is also showing that the prices are expected to decrease in line with CCS costs, which are predicted to decrease in the future with economies of scale as well as project and technology maturity.

Table 23 shows the predicted prices from two published studies. Due to large fluctuations in the exchange rates, the values are not aligned to be in the same currency. While being quite aligned on the predicted CDR price soon, the study by Implement [25] expects a significant reduction of the price in 2030 across CDR-methods. ClimeFi [69] only expect moderate reductions except for DACCS, which shows the large uncertainty on how the price will develop.

Table 23: CDR price forecast by [25] and [69]. Cost per tonne CO_2.

	Implement	ClimeFi	Implement	ClimeFi
	2025 (EUR/t)	2026 (USD/t)	2030 (EUR/t)	2030 (USD/t)
Biochar	100-200	181	>80	164
BECCS	200-300	356	>180	344
DACCS	500-1,000	1,241	>270	439
DOC	300-1,100		>100	
Mineralization	200	332	>100	268

Large cost reductions expected depending on the CDR-methodology
Fastmarkets have put together cost reduction curves until 2050 based on announcements by CDR suppliers. E.g. Climeworks predict that their production cost from DACCS will fall from USD 1,000 / t CO_2 to USD 250 / t CO_2. BECCS and biochar projects, which are relatively less expensive, will likely have a lower cost decrease as they already have reached a higher technical maturity.

Biochar is still expected to deliver CDRs at the lowest cost in 2050. Depending on the demand and supply volumes, different prices between CDR-methods can still be expected far into the future. Buyers will look for the cheapest method, if the different methods are deemed to be of the same quality and reliability (as presented in 6.2.1). With a larger demand due to regulatory and voluntary incentives, the volumes supplied by the cheapest method will not be sufficient, which is why CDR credits from all methods will be relevant. Hence, the more expensive methods can charge a corresponding price to cover their cost.

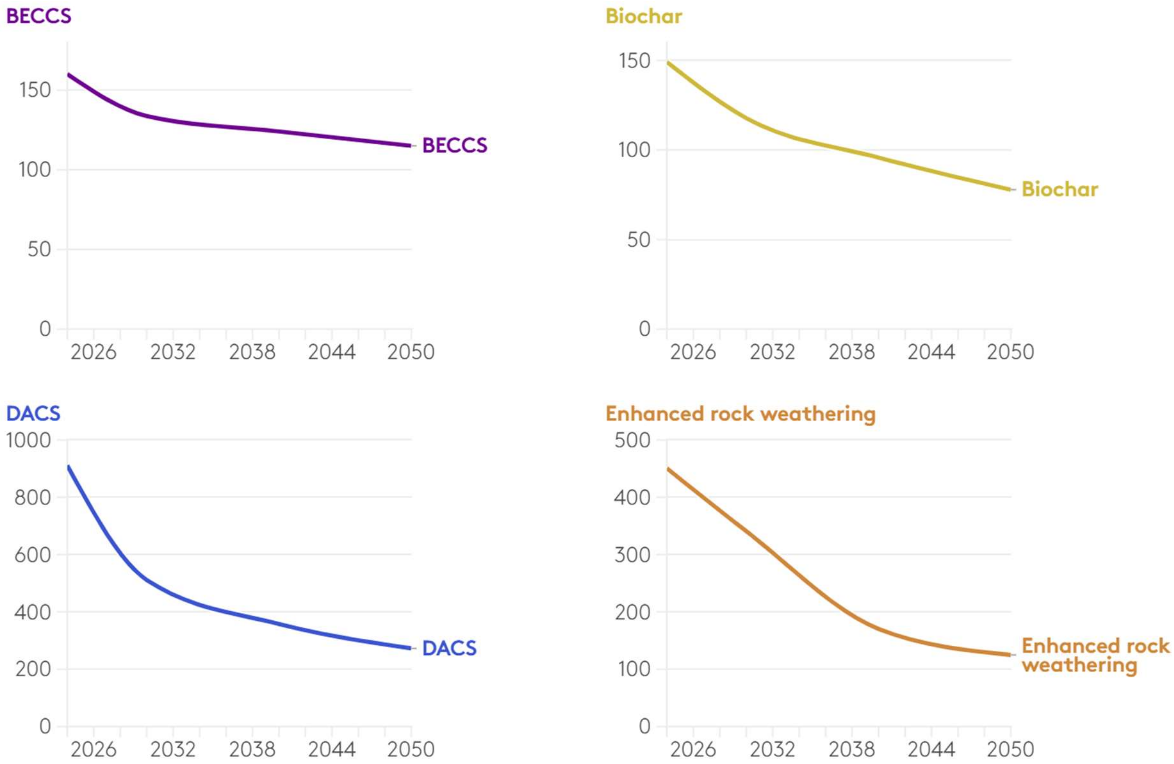

Figure 3: CDR price forecast based on tech-based removal costs (USD/t CO_2) [70].

Regulatory price mechanisms

Within Europe, the EU ETS emission trading system penalizes the emission of fossil CO_2 and is applied on waste incineration plants in a smaller number of countries such as Sweden and Denmark. This gives an incentive to invest into carbon capture solutions, if the costs are lower than the CO_2-quota price. In Norway, the national CO_2 tax on fossil emissions provides a similar incentive. The general CO_2 tax is NOK 1,210 (USD 119) / tonne fossil CO_2 for emitters which are not included in the EU ETS trading scheme. Currently, waste incineration pays 75% of the general tax, which increases to 100% in 2026. The general CO_2-tax will be increased to ca. NOK 2,400 (USD 235) / tonne in 2025-prices by 2030, see Table 24.

Table 24 : Norwegian CO_2 tax per tonne fossil CO_2 from waste incineration. Source: Regeringens klimastatus og plan 2024-2025

	2022	2023	2024	2025	2026	2030
NOK / tonne	192	766	882	908	1,405	>2,400
USD / tonne	19	75	86	89	138	235

6.2.4 Impact of regulatory carbon pricing on CDR credit prices: A case study of Norwegian WtE plants

The price for CDR credits is closely affected by carbon pricing regulations, such as Norway's CO_2 tax, which applies exclusively to fossil CO_2 emissions. Under this system, sources emitting fossil CO_2 have a direct economic incentive to implement CCS if the cost of CCS (including both investment and operating expenses) is lower than paying the CO_2 tax. In such cases, CCS projects can create a positive business case.

However, WtE plants – for example KAN members – emit both fossil- and biogenic CO_2. For these sources, the business case for CCS becomes more complex. Here, a CCS solution will both (i) reduce the CO_2 tax payment for the fossil CO_2 amount and (ii) provide a revenue possibility through the sale of CDR credits based on the biogenic CO_2.

Illustrative Business Case calculation
Through an illustrative calculation example, the influence of the Norwegian CO_2 tax on the CDR price from Norwegian WtE plants is assessed. The assumptions are as follows:

- **50% biogenic CO_2:** Assume a WtE plant with an approximate split of its CO_2-emissions between fossil and biogenic CO_2 of 50% each. This is representative for KAN's members.
- **CCS implementation:** The WtE plan is implementing a CCS solution and has associated costs along the value chain (CAPEX and OPEX of carbon capture, transportation and storage).
- **Tax savings:** 50% of the captured CO_2 (fossil) will provide savings in CO_2 tax payments.
- **Revenue stream from CDR credit sales:** The other 50% of the captured CO_2 (biogenic) can generate revenue through CDR certificates (price to be determined).

Comparing the CCS costs to the savings from the reduced tax payments provides an insight into how high the price for the biogenic CO_2 should be to close the gap in the business case. This price can be seen as the minimum price a supplier would charge to break even[10].

CDR price and CO_2 tax could converge by 2035
KAN [71] has estimated the levelized cost of CCS (LCoCCS) for WtE projects in Norway to be between NOK 2,500 /t CO_2 and NOK 3,300 (2024-level) – corresponding to USD 253/t and USD 334/t respectively, 2025-level). The range illustrates the variation depending on the CO_2 volume and distance to permanent storage. Based on the current status of KAN members' CCS projects, costs in the higher end are more likely to be expected. Future cost developments are highly uncertain, as they depend on the volume of projects and CO_2, technology development, and how many actors from realised projects will share the costs of transportation and storage costs to take advantage of economies of scale. With CCS projects globally being in early stages associated with many risks, some cost reductions can be possible. Hence, an optimistic LCoCCS-scenario is illustrated in the graph below together with the currently more likely seeming scenario depicting no fall in costs over time.

[10] In the unlikely event, that the tax savings already outweigh the total CCS costs, no revenue from CDR sales is needed to break even.

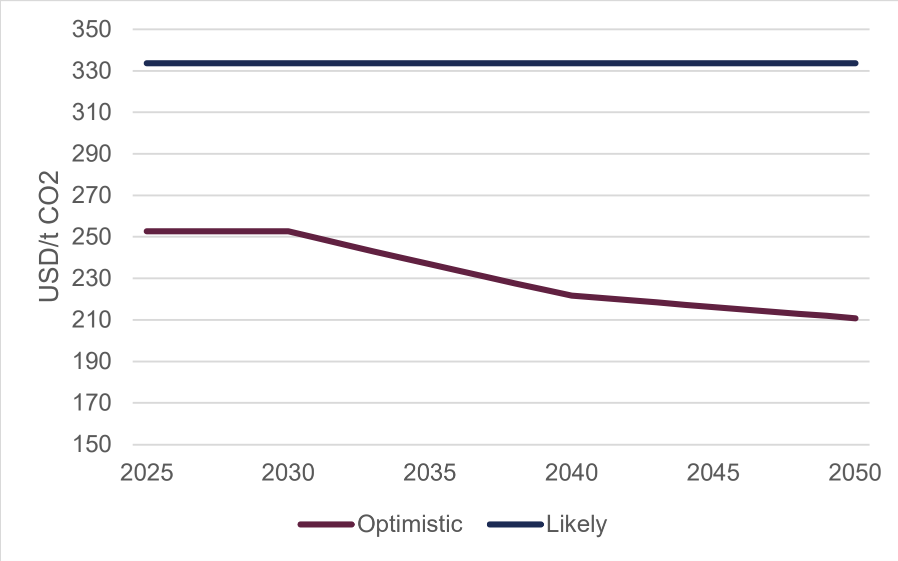

Figure 4: Predicted LCoCCS for a Norwegian CCS project on a WtE plant (2025-prices). Based on KAN [71] and learning curves [72].

Notably, these estimated CCS costs exceed the projected Norwegian CO_2 tax in 2030. This means that even if all captured CO_2 were fossil-based (maximizing tax savings), the CSS project would still not be profitable – the avoided tax is less than the CCS cost. If the CO_2 tax rate were also used as a benchmark for CDR credit pricing, the financial loss would be between NOK 1,000 (USD 98) and NOK 180 (USD 18) per tonne, depending on the CCS cost scenario.

For a WtE plant with a mixed stream of CO_2 (50% biogenic), to close the financial gap, the required CDR credit price would need to be between USD 370 to 530 per tonne CO_2 in 2026, and between USD 270 and 430 per tonne in 2030.

This illustrates, that the CDR price for the optimistic LCoCCS scenario is not too far from the 2030 CO_2 tax level of ca. USD 235 / t CO_2. In the example calculation, the CDR price could reach the CO_2 tax level around 2035, if the LCoCCS is optimistic (see Figure 5). On the other hand, in the more likely scenario, the break-even CDR-price would be significantly higher than the CO_2-tax, approximately USD 200 /t CO_2. This shows that if LCoCCS do not decrease over time, either sufficient demand for CDR-credits with a price in the higher end, or higher political ambition to increase the CO_2-tax, or provide public funding, after 2030 is needed to provide more security for a CCS business case on WtE plants in Norway.

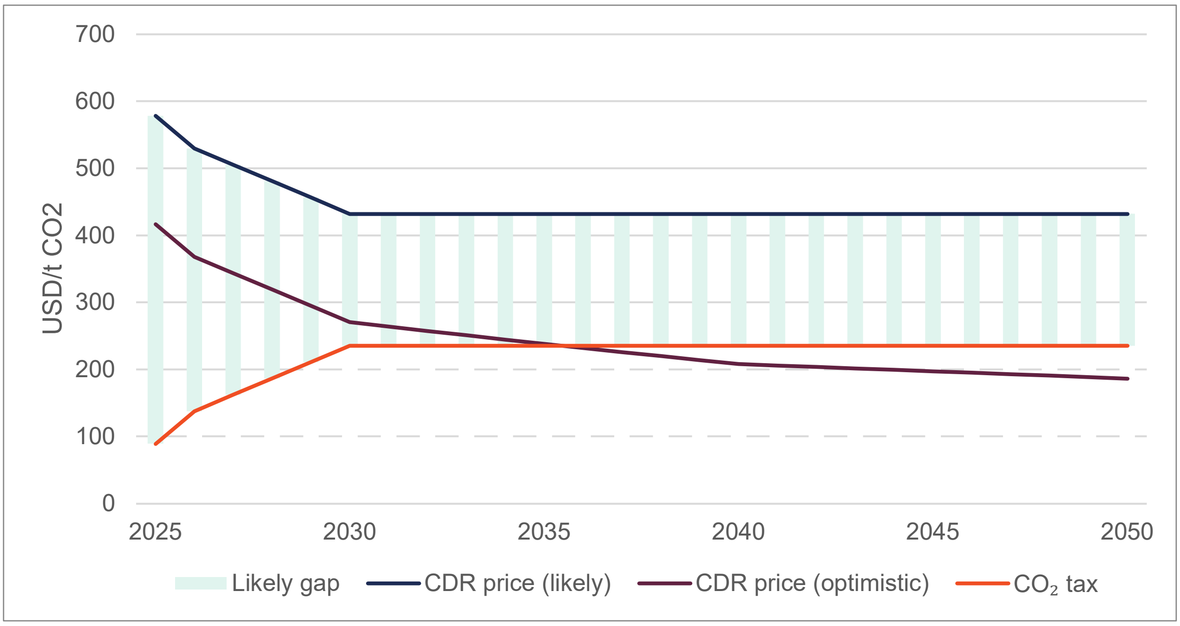

Figure 5: Illustration of the break-even price a supplier should charge per CDR-credit to break even in the business model for an optimistic and a likely level of LCoCCS provided by KAN. Break-even prices are compared to the CO_2 tax. Assumption, that the CO_2 tax level is not changing after 2030, which is likely depending on future political decisions.

6.3 Demand for biogenic CO_2 credits

This chapter presents a detailed overview of the current CDR market landscape using data from CDR.fyi platform[11]. It explores who is buying and selling CDR credits, the scale of their transactions, the technologies in play, and the sectors they represent.

Importantly, demand for CDR credits is projected to increase after 2030. As more companies and national governments adopt long-term climate goals and as regulatory frameworks mature, durable CDR is expected to play a growing role in addressing hard-to-abate emissions. This ongoing demand will be driven by both voluntary commitments and anticipated compliance requirements, making the post-2030 era a critical period for CDR market growth.

On the supply side, the chapter summarizes the current gap between CDR credits sold and actual CO_2 delivered, identifying leading technologies and suppliers, with Nordic countries standing out as reliable, high-quality providers.

These insights offer a snapshot of today's market while framing the developments that are expected to shape CDR demand and supply dynamics in the coming years and after 2030.

6.3.1 Existing buyers and sellers

Data reported by CDR.fyi shows, that there is a varied spectrum of buyers and sellers of CDR-credits from different sectors.

Microsoft as the major buyer of CDRs
On the demand side, around 50 companies worldwide have purchased above 10,000 tonnes individually. The largest buyer is Microsoft with 25.7 million tonnes CO_2 as of July 2025, which corresponds to 80% of all CDR-sales. Microsoft's large market share is illustrated in Figure

[11] The CDR.fyi platform provides insights & analytics on durable CDR orders, projects, and financings across the carbon removal market.

showing the top 10 purchasers of CDR-credits. The nine purchasers below Microsoft have a significantly lower volume of 0.2 to 1.4 million tonnes each.

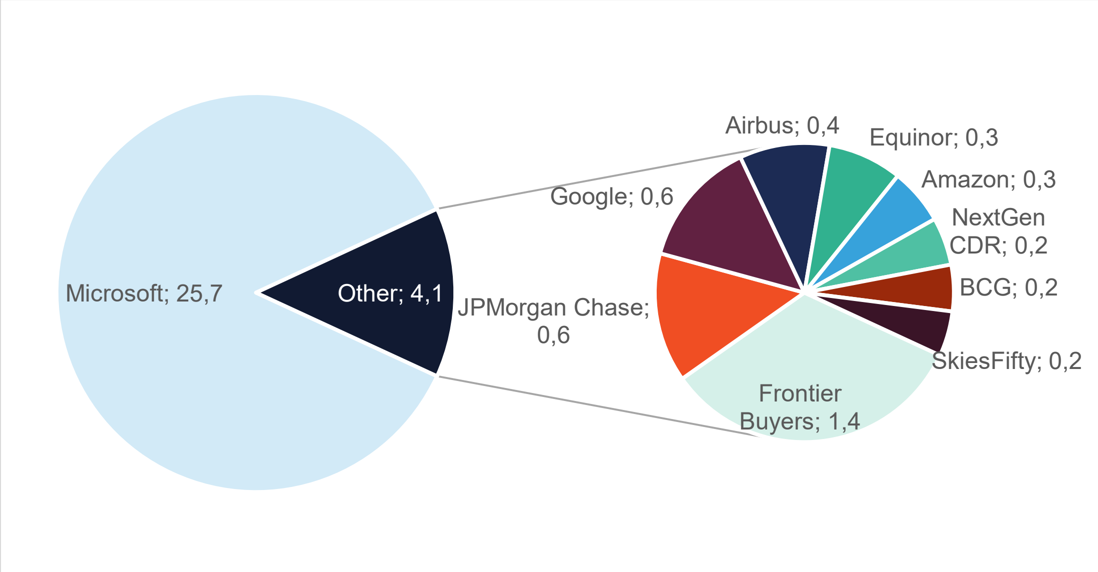

Figure 6: Top 10 buyers of CRD-credits by July 2025 (mill. tonnes CO_2). Source: CDR.fyi.

Climate commitments as driving force for voluntary market demand

Due to the price-level of CDR-credits, buyers are from sectors with high profits and low operational emissions, such as technology, finance and business services [70]. These first movers have a need to purchase CDRs to fulfill their net-zero climate goals. They face pressure from consumers, investors and employees to take climate action and are willing to pay a premium for CDRs, which account for an only small part of their operational expenses.

Importantly, major buyers – including Frontier's coalition members and leading technology companies – have signaled a strong preference for credits to be delivered before 2030. This is motivated by the need to make concrete, near-term progress on climate targets, and to avoid relying on future promises that may not materialize due to technological or regulatory uncertainties. For example, both Frontier and Microsoft have prioritized agreements with suppliers that can guarantee delivery of carbon removal credits in the current decade, underscoring the urgency to scale permanent CDR solutions and accelerate market development today. In part 6, Case studies and best practice., it is described how this "before-2030"-preference was evident in the transactions in the agreeements between Microsoft, Frontier and Hafslund Celsio.

- Microsoft has pledged to become carbon negative by 2030 across its scope 1-3 emissions
- Google wants to achieve net-zero emissions within operations and value chain by 2030
- Apple aims to be net-zero by 2030
- Boston Consulting Group want so remove more carbon than it is emitting from 2030
- A recent review of 6,000 climate commitments by accounting firm PwC [73] highlights a nine-fold increase in the number of emissions reductions targets and net zero targets over the last five years, which indicates that voluntary commitments will spread to more companies and industries in the future.

CDR-credit sales and CO_2 delivered are currently far apart

On the supply side, there is a large gap between the CDR-credits sold and the actual CO_2 delivered, which shows that many projects are not fully realized yet nor operational. According to CDR.fyi, only 2.5% of purchased CO_2 has been delivered. Figure 7 shows the volumes of CO_2 sold and delivered by CDR-methods. The large majority of CDR-credits sold is from BECCS projects, where a small share has been delivered. The second largest amount is sold from BCR-projects, which have been delivered to a much larger extent, showing a higher maturity in BCR-projects. CDR-credits from DACCS have also been sold, however, only a negligible amount has been delivered so far, which shows that these projects have a low maturity and scale to date.

A key reason for the slow delivery of BECCS and DACCS credits is the fundamentally different investment and operational profiles of these methods compared to approaches like biochar. Both BECCS and DACCS projects are highly capital-intensive, involving significant up-front infrastructure investments (e.g., industrial plants, capture equipment, transport pipelines, and storage facilities). In addition, they have substantial operational expenses once up and running (energy requirements, maintenance, storage fees, etc.).

Because of the exceptionally large investment required – and the long lead times needed to permit and build these facilities – it is standard industry practice that BECCS and DACCS projects can only reach Final Investment Decision (FID) if they secure long-term offtake agreements with buyers. These agreements typically commit buyers to purchasing large volumes of carbon removal credits over many years, often for future delivery well beyond the project's initial operational date.

This means that for BECCS and DACCS, a high proportion of credits are "pre-sold", with actual delivery scheduled to occur over the coming years or even decades. Consequently, the current market dynamic is that the vast majority of CDR credits sold from BECCS and DACCS represent future removal. This lag between sales and delivered CO_2 is inherent to the commercial and technical realities of scaling engineered CDR approaches.

In contrast, BCR projects generally require lower up-front capital investments, are less complex to deploy at smaller scales, and can achieve operational readiness and credit delivery much faster, which is why a larger share of biochar credits sold have already been delivered.

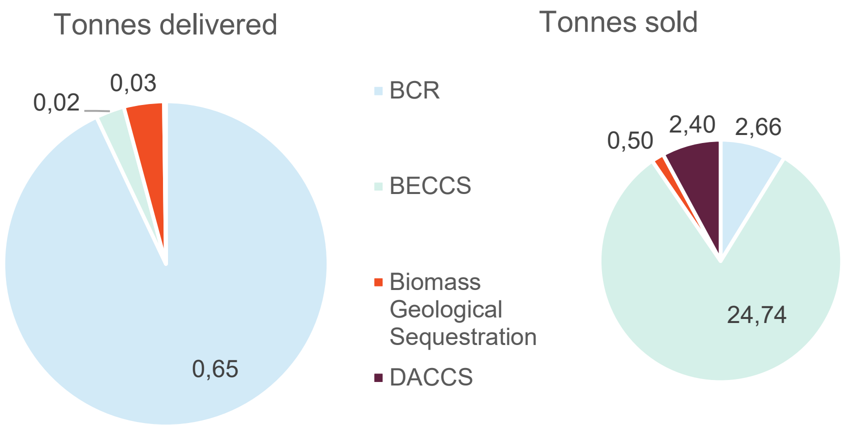

Figure 7: CO_2 sold and delivered by July 2025, divided on CDR-methods (Mt CO_2). Based on [43].

Approx. 45 suppliers have delivered above 1,000 tonnes CO_2 each, together accounting for 0.77 million tonnes. The biochar producer Exomad Green has currently supplied most of the CO_2, see Table 25 with the top 10 suppliers. Nine out of ten use the BCR-method.

Table 25: Top 10 suppliers by the amount of CO_2 delivered by July 2025. Based on [2].

Rank	Company	Mt CO_2	CDR method
1	Exomad Green	0.17	BCR
2	Aperam BioEnergia	0.09	BCR
3	Varaha	0.08	BCR
4	Wakefield Biochar	0.06	BCR
5	Carboneers	0.05	BCR
6	Pacific Biochar	0.04	BCR
7	Freres Biochar	0.03	BCR
8	CarbonCure	0.02	Mineralization

Rank	Company	Mt CO_2	CDR method
9	Planboo	0.02	BCR
10	Running Tide	0.02	BCR

As the only supplier from Table 25, Exomad Green is also in the top 10 suppliers by the amount of CO_2 sold to date, shown in Table 26. The largest suppliers use the BECCS-method, followed by DACCS. As none of those are part of the top 10 suppliers who have delivered CO_2, it shows that BECCS and DACCS can be expected to supply and deliver large amounts of CDR-credits in the future, once the projects are operational and scalable.

Table 26: Top 10 suppliers by the amount of CO_2 sold by July 2025. Based on [2].

Rank	Company	Mt CO_2	CDR method
1	AtmosClear	6.75	BECCS
2	Stockholm Exergi	5.08	BECCS
3	CO280	4.36	BECCS
4	Ørsted	4.00	BECCS
5	Gaia ProjectCo	2.95	BECCS
6	Exomad Green	1.76	BCR
7	1PointFive	1.34	DACCS
8	Hafslund Celsio	1.20	BECCS
9	Climeworks	0.38	DACCS
10	Heirloom	0.34	DACCS

Nordic countries have a large market share
An analysis of the geography of the 25 largest sellers of CDR-credits up until May 2025 shows, that 39 % of the traded CO_2 volume come from Nordic actors. Slightly more than half the volume has been sold by North American actors, leaving only minor market shares for South America, Asia and other European countries. The large market share of the Nordics can be partly explained by strong sustainability standards and reliable regulatory conditions. Industry stakeholders mention that international buyers of CDRs see Nordic countries as providing high quality and less risk [25].

6.3.2 Qualitative reflections on demand post-2030

As previously described, the first mover buyers – including Microsoft, Frontier's AMC coalition, and other tech and finance leaders – are prioritizing credits delivered before 2030 to help meet critical interim climate targets and to demonstrate immediate climate action. But many Norwegian waste incineration plants are expected to become CCS operational only after 2030.

Demand for CDR credits is expected to persist and likely increase, after 2030. This is due to several factors, first and foremost that many companies – and countries – have set 2040, 2045, or 2050 net-zero or carbon negative targets. For example, EU member states, and corporates with SBTi and science-based net-zero trajectories, will need durable removals to compensate for residual emissions that cannot be abated. Secondly, while the largest "first mover" buyers are driving demand for pre-2030 credits, much of the real market mass – especially from less ambitious companies or those in harder-to-abate sectors – will follow later, as removal options become more viable and cost-competitive. Thirdly, there is a strong expectation from market actors that compliance-based demand (e.g., under the EU's CRCF, or inclusion of removals in the EU ETS and other national compliance schemes) will grow after 2030 – potentially dwarfing the voluntary market and driving uptake of large-scale CDR such as CCS equipped WtE.

Multinational emitters facing scope 3[12] pressures
Key sectors likely to emerge as significant buyers of biogenic CDR credits include aviation (such as Lufthansa, Air France KLM, and SAS), maritime shipping (exemplified by Maersk), and energy-intensive manufacturing (including companies like Heidelberg Materials, Aalborg Portland, CEMEX and LIMAK Group). Consumer brands such as Unilever and Nestlé, as well as tech companies with global operations like Microsoft and Google, also fall into this category.

What unites these companies is the challenge of managing hard-to-abate residual emissions[13] that remain after they have implemented substantial reduction measures. Many of these organizations have made public net-zero commitments – often validated by the Science-Based Targets initiative (SBTi) – and are facing increasing pressure from shareholders and customers alike to demonstrate credible climate leadership. As a result, they are actively seeking high-integrity carbon removal solutions to bridge the gap and achieve their ambitious climate objectives.

However, projections by organizations such as VCMI caution that demand uptake depends on the credibility, additionality, and permanence of the offered credits, and on continued regulatory endorsement of removals as legitimate for Scope 3 reporting.

For these buyers, the traceable, permanent, and verifiable removals delivered by suppliers such as KAN will offer a credible way to address their Scope 3 exposure, especially under emerging disclosure and reporting standards in Europe and beyond.

Financial institutions and investors
Institutional investors such as Nordic Investment Bank and the Norwegian Export Credit Guarantee Agency (GIEK) are increasingly active participants in the field of climate finance. Insurance companies, including Swiss Re and Munich Re, are also prominent actors in this space.

The primary motivation for these investors stems from the growing importance of climate-aligned investing. Many manage thematic funds that are directly tied to environmental, social, and governance (ESG) benchmarks, and as a result, they are under increasing pressure to ensure that any net-zero claims made by the companies in which they invest are both credible and verifiable. This has led to heightened scrutiny of portfolio companies' carbon footprints and a stronger demand for high-quality, durable carbon removals, such as those offered by BECCS-equipped WtE facilities.

Additionally, institutional investors and insurers are motivated by the need to hedge climate-related risks within their own portfolios. By investing in, or directly purchasing, high-integrity carbon removal credits, they can support climate mitigation efforts while also addressing potential regulatory and reputational risks associated with climate change. This dual focus on ESG performance and risk management makes these investor groups increasingly relevant and valuable stakeholders for suppliers of robust carbon removal solutions.

Yet, research underscores that the majority of institutional capital is still cautious, seeking clear standards for MRV, legal additionality, and a harmonized regulatory environment before mainstreaming CDR credits into core investment activities.

For KAN, this creates opportunities not only to sell CDR credits directly to investors seeking to offset their operational or portfolio emissions, but also to attract project finance or backing from these influential financial actors, who have a strong interest in credible and verifiable climate solutions.

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[12] Scope 3 emissions are those arising from a company's value chain outside its direct operations (upstream and downstream) and they often make up the largest share of total emissions for multinational companies.

[13] Here we use the traditional approach of hard-to-abate, which focuses on emissions, that remains after all feasible mitigation options (such as energy efficiency, fuel switching, and process optimization) have been exhausted. However, some experts have recently in the article" (How to) avoid the inflationary labelling of emissions as "hard to abate"" in ScienceDirect offered an alternative approach, where hard-to-abate emissions is understood as emissions that can be reduced to zero more efficiently via DACCS or BECCS than by the best available alternative reduction method. This approach makes the definition dynamic – if a CDR method becomes cheaper or more scalable over time, the set of "hard-to-abate" emissions can shift.

Consumer-facing brands as buyers of biogenic CDR credits
Consumer-facing brands, spanning industries such as food and beverage, retail, fashion, and technology, could evolve as future buyers of biogenic CDR credits. In the food and beverage sector, companies like TINE, Orkla, and Carlsberg are setting ambitious climate targets and seeking credible carbon removal solutions to address residual emissions, responding to significant consumer and regulatory expectations in Scandinavia and Northern Europe.

In retail and fashion, brands such as H&M and IKEA are enhancing their sustainability credentials by looking to integrate carbon removals into their climate strategies. In the technology sector, Apple is working towards a net-zero supply chain and beginning to purchase high-quality CDR credits, a trend also seen with Microsoft, a leader in the CDR credit market.

The primary motivations for these companies include protecting and enhancing brand value, as sustainability leadership has become a key differentiator among climate-savvy consumers, particularly in Europe. Brands are also keen to develop compelling corporate responsibility narratives, such as highlighting local or Nordic carbon removal initiatives.

Regulatory developments, like the EU's Green Claims Directive[14] and rising requirements from business customers and retail partners mean companies will seek durable, science-backed carbon removals.

However, brands may also be wary of public backlash if removals are used as a substitute for insufficient direct mitigation – meaning that buyers may favour CDR credits to neutralize only genuinely residual emissions, as called for in the latest SBTi and ISO net-zero frameworks.

KAN's biogenic CDR credits, characterized by strong MRV, Scandinavian oversight, and permanent geological storage, will be well-aligned with these evolving standards. As large consumer-facing brands pilot the use of robust CDR credits to future-proof their market access and enhance their corporate responsibility narratives, KAN can position itself as a preferred supplier, particularly for buyers looking for local or Nordic climate action stories.

Country-level demand for CDR credits
In addition to growing corporate and financial demand, countries are set to become increasingly important buyers of durable CDR credits – especially after 2030 – driven by international climate commitments and the operationalization of Article 6 in the Paris Agreement. The recent pilot agreement between Norway and Switzerland (described in section 3.2.2) exemplifies an emerging trend: governments not only regulating and enabling CDR within their borders, but also formally purchasing and transferring high-integrity removals across borders to achieve nationally determined contributions (NDCs).

Nordic countries like Norway, with a strong CCS pipeline and infrastructure, are positioned as key CDR credit exporters, supplying removals from BECCS and other high-integrity solutions to nations aiming to go beyond their domestic abatement capacity. As the Article 6 mechanism scale, KAN should anticipate increasing engagement not only with corporate buyers but also with governments – both as direct offtakers and as regulators shaping the frameworks under which CDR is generated, certified, and traded. Early engagement in pilot projects and standard-setting dialogues will be essential to build trust and market share in this emerging landscape.

6.3.3 Quantifying the impact: CDR demand projections

This section explores the key drivers behind the expected CDR demand after 2050. The central role of climate policies at both the national and international levels are examined. Next, it is analysed how rising corporate climate commitments and the push to address value-chain emissions are fuelling increased demand for high-integrity removals. Finally, we look at how the ability of various sectors to pay for CDR credits is changing over time, and how this is likely to bring new industries into the market in the years ahead.

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[14] The Green Claims Directive is an EU initiative aimed at ensuring that environmental claims made by companies are clear, accurate, and substantiated, thereby preventing misleading or exaggerated statements around climate claims. However, the EU Commission withdraw the Directive proposal in June because of rising political pressure and an anti-green coalition leaded by the centre-right European People's Party, the largest force in the EU Parliament

6.3.3.1 Policies will decide the future demand of the CDR market

The scale of durable CDR demand will vary regionally, driven by the maturity of existing climate policies, the ambition of proposed policies, and the ability to finance decarbonization, with the largest gaps likely to remain in Asia Pacific. Europe and North America are the most advanced regions in the implementation of climate policies and therefore also present the greatest opportunity to drive demand for durable CDR [74].

Innovation in the supply of CDR that supports both the global scale-up and the significant reduction in costs of numerous CDR technologies will be required to enable the demand for removals. Boston Consulting Group [74] estimate the future CDR demand under three different policy scenarios. Depending on policies and prices, the CDR demand could very low, moderate of high.

- **Low scenario:** Only 0.5 gigatons (Gt CO_2) of durable CDR needed in 2050, reflecting weak policy pressure and low prioritization of durable removals. In this scenario, most emission reductions are achieved via demand reductions and non-permanent offsets; governments do not strongly back permanent removals.
- **Medium scenario:** About 1.0 Gt CO_2 durable CDR demand, associated with moderate policy support, rising attention to the importance of high-integrity removals, and a willingness among governments and businesses to drive additional action.
- **High scenario:** Up to 2.5 Gt CO_2 of durable CDR could be needed if there is aggressive policy pressure, strong prioritization of permanent removals, and widespread adoption of compliance and voluntary mechanisms. Here, CDR supply becomes essential to closing the emissions gap as reduction options are exhausted.

How much carbon removal is ultimately needed in 2050 will depend on the ambition and effectiveness of policy measures, the willingness of businesses and consumers to pay for removals, and the evolution of technology costs. Notably, demand could be five times higher in a world of strong policy and accessible pricing compared to a world with limited action and high costs. The pathway taken will thus have profound implications not only for global CDR deployment, but also for who leads – and who lags – in the emerging carbon removal economy.

6.3.3.2 Growing corporate commitments signal an increase in CDR demand

Dramatic increase in demand expected until 2050
PwC [73] have screened almost 6,900 companies who have responded to the Carbon Disclosure Project (CDP), where over 4,000 have indicated that they have climate commitments. These emission reduction targets span from individual GHG goals to SBTi approved targets and science-based Net-Zero targets and cover mostly Scope 1 and 2 emissions. The number of companies with decarbonization targets is growing every year. PwC also find, that while larger companies are first movers, smaller companies are making commitments since 2024, which results from supplier engagement efforts as larger companies start to address Scope 3 emissions. PwC expect that this effect will increase over time and more suppliers will set up climate targets. Implement [27] have estimated, which effects companies' climate commitments will have on the future CDR demand (Table 27).

Table 27: Estimated future demand for CDR due to climate commitments.

	2030	2040	2050
Mt CO_2	900	1,700	3,500

Other economic sectors will enter the CDR market in the future
Fastmarkets[15] [70] have analysed a prospective pool of 17,000 companies' ability to pay for CDR credits, defining ability to pay by how much profit a company makes per tonne of CO_2 it emits. As shown in Figure , the ability to pay per tonne is significantly lower than the current and expected prices for CDR credits. The highest ability to pay is within the finance, business services and

[15] Fastmarkets is a global cross-commodity price reporting agency.

technology sectors. The ability to pay will increase as profits increase and company emissions decline over time, bringing more buyers into the market.

Fastmarkets [70] also looked at sustainability targets for 2,900 companies, which show an eight-fold increase of emissions covered by net-zero targets by 2030 compared to 2025. They expect the amount to increase further until 2040, with sectors such as industry, manufacturing and automotive becoming larger buyers. This is a shift from the current predominance of finance, business and technology companies.

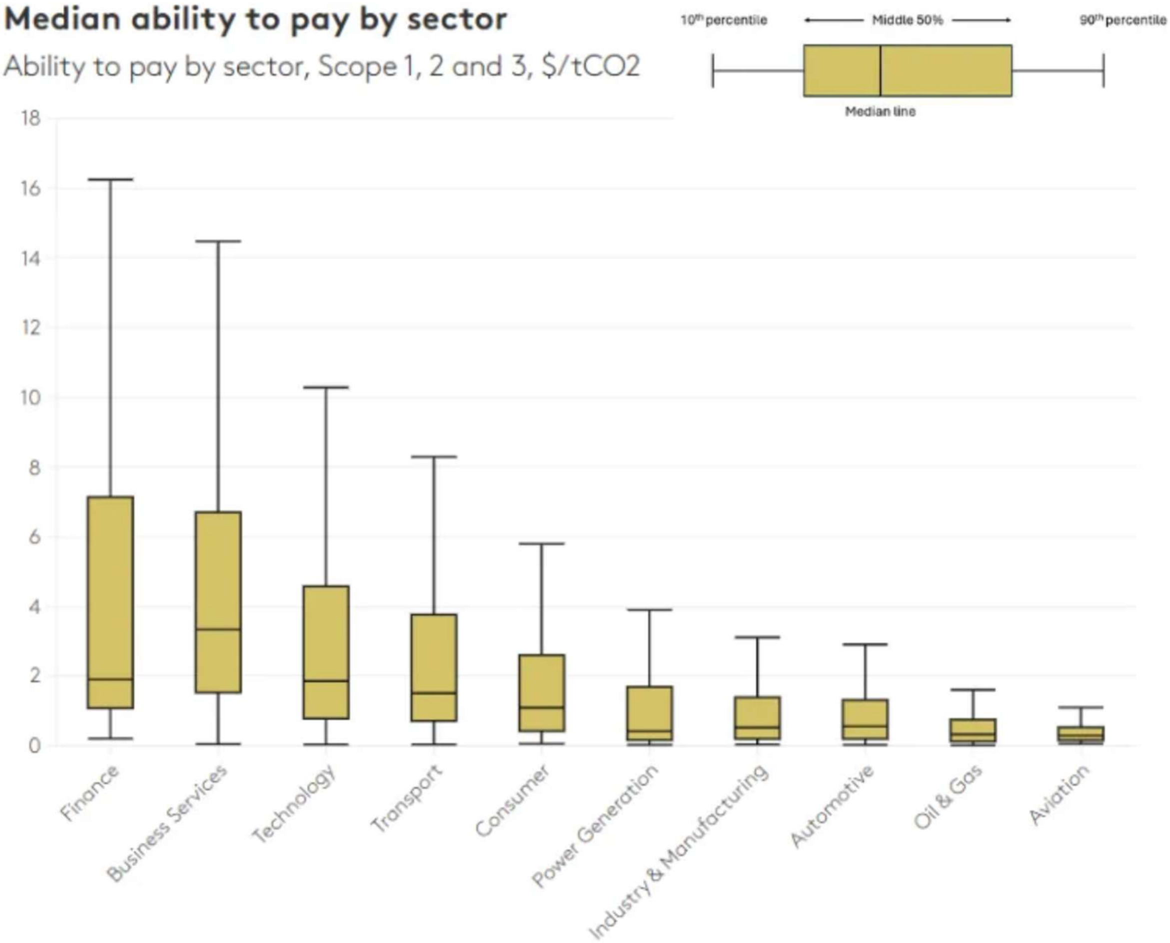

Figure 8: Median ability to pay by sector [70].

6.4 Norwegian market potential

This chapter provides a benchmark of the potential of the Norwegian market for BECCS by comparing it to other relevant countries. For a holistic benchmarking approach, it is essential to include countries representing diverse profiles across dimensions such as CO_2 storage capacity, technology and project maturity and the political and regulatory foundation for the growth of a CDR market.

A broader perspective on which countries are leaders in creating an enabling environment for the commercial deployment of CSS is given by the CCS Readiness Index [75], which is between 0 and 100. The index was created by the Global CCS Institute in 20215 and ranks over 50 countries for their attractiveness for investment and deployment. The index is composed of three categories: 1) endowment of storage resources and state of knowledge about those resources, 2) each country’s policy environment and 3) each country’s legal and regulatory framework of relevance to CCS.

Table 28: Country comparison [1, 13, 14, 12].

Country/region	BECCS potential ($MtCO_2$/year.)	Project maturity	CDR targets and CDR funding	Storage capacity and infrastructure	CCS Readiness Index
Norway	2-3	Highest	No target Norway Reverse Carbon Tax (proposed by Environment Agency)	First-mover with legal and regulatory clarity on offshore CO_2 storage (80 Gt)	67
Finland	15-20	Low	No target No funding	No storage capacity or intention to use own storage	29
Sweden	30-35	Medium	CDR target in 2045 Reversed auction scheme for BECCS	Insignificant storage capacity	41
Denmark	3-6	High	No clear targets Danish CCS fund reverse auction	Significant onshore potential (12-25 Gt)	56
United States	522-1,500	High	No clear targets Section 45Q tax credits in the IRA	Very large storage capacity (3,000 Gt)	72
UK	20-70	Lowest	No clear targets, but high ambitions in 2030, 2035 and 2050 Government investment in CCS clusters	Large storage capacity (80Gt)	66

Comparing countries reveals that Norway, and to a lesser extent Denmark, could play a central role as regional storage providers. In contrast, both Sweden and Finland lack domestic storage capacity despite their high potential for capturing and exporting biomass-CO_2 to other countries.

Both Norway and Denmark have matured frameworks despite smaller potential. The BECCS potential of 2-3 Mt CO_2/year in Norway measured in the amount of CO_2 is the lowest compared the Nordic peers and largest players globally. However, Norway scores the third highest globally in the CCS Readiness Index and is more advanced than its Nordic neighbours. This is due to its comparatively high project maturity – 22 CCS projects in pipelines, with several having reached or surpassed FID phase and 12 carbon storage licenses and 1 storage permit [76] 16 – making Norway an important player on the BECCS market and in a key position to import CO_2 from BECCS capture sites globally.

The US is unique in the sense, that they combine both scale with policy incentives, making CDR most deployment- ready [77]. It is the highest scoring country in the CCS Readiness Index. The US has vast agricultural and forestry sectors producing large volumes of residues suitable for BECCS; an estimated 3,000 GT of well-characterized storage capacity and an existing CO_2 pipeline network (~8,000 km), which can be expanded to connect biomass facilities to storage sites more easily than in many other countries. Additionality, the US has strong policy incentives such as the Section 45Q Tax Credits in the Inflation Reduction Act and states such as California and Louisiana have additional incentives or streamlined permitting procedures for CCS/BECCS. Finally, the technical and operational readiness for CCS/BECCS is very high due to the country's deep roots in its long-standing drilling experience and oil and gas infrastructure.

[16] By April 2025

Another interesting country to look at is the UK, which has the potential to deliver 20–30 MtCO_2 of BECCS removals annually by 2030, rising to as much as 70 Mt if biomass imports are scaled [77]. It was among the first countries to set explicit engineered CDR ambitions in its Net Zero Strategy and are working intensively on integrating CDRs into the UK Emissions Trading Scheme as early as 2028 – making it a potential global rule-setter for CDR markets.

In the UK, deployment is still at an early stage, with Drax's pilot operating and larger-scale projects planned within industrial CCS clusters such as HyNet, East Coast Cluster, Acorn, and Viking. The government has committed over £21 billion in operational support and nearly £10 billion in capital for CCS and BECCS infrastructure, underpinned by an estimated 78 Gt of offshore CO_2 storage capacity in the North Sea.

7 Case studies and best practice

7.1 Introduction

This section reviews three leading CDR projects – from Hafslund Celsio (Norway), Ørsted (Denmark), and Stockholm Exergi (Sweden) – that are at the forefront of large-scale biogenic carbon removal in Northern Europe. By examining their different approaches to financing, certification, and market engagement, we aim to highlight practical lessons and best practices. The findings are especially relevant for scaling carbon removals in Norway's WtE sector and provide insights into how public support, private demand, and credible certification come together to make CDR projects viable.

7.2 Hafslund Celsio's Oslo CCS at Klemetsrud

Hafslund Celsio is Norway's largest WtE and district heating company and is currently building a state-of-the-art carbon capture facility at its Klemetsrud plant in Oslo. Set to begin operations in 2029, the facility will capture approximately 350,000 tonnes of CO_2 each year. About half of this CO_2 is biogenic, originating from sources like unsorted food waste, while the rest comes from fossil materials such as non-recyclable plastics. Only the biogenic portion, verified through radiocarbon analysis, qualifies as carbon dioxide removals; the fossil portion will help cut Oslo's annual emissions by about 20%.

The project is made possible through a public-private partnership involving the Norwegian government, the City of Oslo, and Hafslund Celsio. It forms part of Norway's Longship demonstration project, establishing a full value chain for capturing, transporting, and permanently storing CO_2 in geological formations beneath the North Sea. The project already includes commercial agreements for expanding the value chain to major emission sources across Northern Europe. Hafslund Celsio's ambition is to set a model for the roughly 500 WtE plants operating throughout Europe.

On April 1, 2025, Hafslund Celsio signed an agreement with Frontier for the removal of 100,000 tonnes of CO_2 in 2029 and 2030. Most recently, on June 30, 2025, the company announced a landmark deal with Microsoft for the sale of 1.1 million tonnes of permanent carbon removals over a decade.

The following lessons learned from Hafslund Celsio's experience with developing their CDR project and selling CDR credits are based on an interview in August 2025 with Jannicke Gerner Bjerkås, Director CCS and Carbon Markets, and Mathias Sæten, Business Developer CCS and Carbon Markets.

Firstly, they emphasized the importance of thoroughness, patience, and attention to detail in their dialogue with the buyers, in this case Microsoft and Frontier. The process was highly demand-driven with buyers defining highly specific requirements and implementing detailed due diligence processes. Meeting these expectations entails a significant investment of time and resources from the supplier's side: every requirement and data point must be addressed with high quality and transparency. Both Microsoft and Frontier place strong emphasis on the quality of carbon credits – specifically, the guarantee that CO_2 is physically removed.

The most demanding and complex part of the process was MRV. Here, robust systems and especially credible documentation for both the biogenic and fossil fractions of CO_2 are critical, in order to satisfy due diligence and build trust. This scrutiny extends to the value chain (including storage, and full LCA documentation), reflecting the expectation for transparent, high-integrity credits.

It was highlighted that pricing in this market is challenging; there is no universal market price, as each project has unique cost structures. However, customers pay close attention to the additionality of projects, which often becomes the key driver for price negotiations.

Furthermore, the buyers require registration of credits within recognized certification frameworks. However, due to evolving methodologies and lack of standardization, there is ongoing dialogue with various registries (especially Puro, Verra and Isomeric), and selection had to be approved by the buyer. Microsoft/Frontier's preference is for ICROA-approved registries, but not for any single register, allowing for flexibility as the market matures. Hafslund Celsio aims to simplify operations by using a single register for the entire credit volume, but this is subject to client input.

At present, agreements with Microsoft and Frontier avoid locking in with a specific registry too early, given uncertainty and rapid market development.

Additionally, Hafslund Celsio was asked about organizational learning and challenges. Hafslund Celsio explained how developing the CDR project required rapid organizational capacity-building, growing from virtually no relevant internal experience to dedicated resources focused on partner engagement and process screenings. Initial market outreach, especially internationally through diplomatic missions to the United States to meet with potential customers in the tech sector created was resource intensive but opened up the door to customer dialogue. In contrast, outreach to the domestic market – such as engaging potential investors in Norway – yielded limited results, indicating that Norwegian market actors do not yet appear ready or willing to purchase CDR credits.

Regarding negotiations and contracts, these were complex, and time-consuming, dominated by two main themes: commercial terms (price, duration, quantity) and risk allocation. Risk-sharing proved especially challenging in a first-of-its-kind project, where both sides needed to align on how to divide risks given low volumes and market uncertainty. Legal support was essential, with final agreements using neutral (neither US nor Norwegian) jurisdiction to accommodate both parties.

Hafslund Celsio further described how technical investments – such as installation of biogenic CO_2 monitoring equipment – were made early, in order to meet customer requirements and demonstrate commitment to transparency and credibility. A critical factor for both Microsoft and Frontier was Hafslund Celsio's ability to deliver CDR credits before 2030; early delivery was non-negotiable and central to their interest in these agreements. Securing an offtake agreement that could demonstrate the tangible existence of a market for CDR was likewise essential – not just as proof of market dynamics, but as concrete reassurance that a viable revenue stream could be established. Importantly, Hafslund Celsio had already finalized its agreement with Frontier and was in advanced negotiations with Microsoft at the time of the final investment decision. These agreements were pivotal, as their existence was a precondition for making the investment decision possible. Without this demonstrated income stream and market demand, Hafslund Celsio would have been unable to move forward with its investment.

Equally, outreach to buyers required clear communication of the WtE sector's role, not just in energy supply but as essential waste treatment infrastructure. Both buyers and standards organizations (registers) needed education on the specificities of WtE with CCS, as these were initially poorly understood. Hafslund Celsio described that they have been collaborating with Stockholm Exergi on standards and methodology development for two years, and how this development has been critical for taking a leadership role in defining future requirements specifically for the WtE sector. By being engaged early and proactively in dialogue with registers and EU entities, Hafslund Celsio has improved both external understanding of its operations and its own readiness to comply with evolving standards and registries. The specific characteristics of waste feedstock compared to biomass was emphasized, especially that waste incineration takes place regardless, as it is primarily a societal service for managing residual waste – a quite different from purposefully growing and processing biomass for energy production. Because waste incineration addresses an essential public function, it is subject to somewhat lower documentation requirements compared to dedicated biomass projects. However, there are still important criteria that must be met: all waste must be properly sorted to ensure that only residual, non-recyclable material is incinerated; the feedstock must truly constitute residual waste rather than recyclables or materials diverted from higher value uses. Additionally, there must be clear documentation regarding customer profiles and the geographical origin of the waste. Satisfying these criteria is critical for demonstrating compliance, transparency, and the environmental integrity of WtE-based carbon removal projects

Finally, COWI wanted to hear how Hafslund Celsio see the CDR market developing. It became clear that they expect compliance markets will grow and that CDR prices will rise. According to Hafslund Celsio, for the voluntary carbon market to function and incentive genuine emission reductions, CDR prices must remain above the ETS allowance prices. Otherwise, companies would lack financial motivation to cut their own emissions in favour of simply buying removal credits. Hafslund Celsio mentioned how recent policy developments – such as the UK merging CO_2 removal with established ETS markets – could accelerate convergence of CDR credit prices. However, Hafslund Celsio views rapid price convergence with scepticism, fearing it could dampen climate ambition in the short term.

7.2.1 Summary and lessons learned

This section summarizes the key project experiences of Hafslund Celsio's CDR project:

Criteria	Hafslund Celsio, Klemetsrud
Start of operations	2029
Scale (annual CO_2 capture)	350,000 tonnes (approx. 50% biogenic, 50% fossil; from mixed waste)
Feedstock	Mixed municipal solid waste
Storage location	(Longship/Northern Lights infrastructure)
Revenue Model	Government support, sales of CDR credits
Certification & Standards	Ongoing dialogue with several registries (esp. Puro, Verra, Isometric); buyer (Microsoft, Frontier) approval required for registry choice; focus on ICROA-approved credibility; flexible/market-led
Major Corporate Buyers	Frontier (100,000 tCO_2, 2029–30); Microsoft (1.1 $MtCO_2$ over 10 years)
Risk Management	Risk allocation a major negotiation challenge; contractual complexity due to first-of-its-kind project; legal support was essential; final contracts used neutral legal jurisdiction
Key Negotiation Lessons	Buyers placed strong demands on MRV, transparency, documentation (especially biogenic/fossil split), robustness of value chain and LCA; agreement flexibility needed around registry choice; early delivery (before 2030) very important; securing corporate offtake agreements was pivotal for FID
Certification/Registry Challenges	Registry methodologies are evolving; cannot lock in too early; requires continuous dialogue; buyer-driven registry approval process
Organizational Learning	Organizational upskilling was required; rapid capacity building; international outreach (such as to the US tech sector) successful; domestic outreach limited as the Norwegian voluntary market is immature
Project Development	Early technical investments (e.g., biogenic CO_2 monitoring) made to meet buyer requirements and establish credibility; thorough documentation across the value chain
Sector & Feedstock Characteristics	Waste incineration as a public service, not a dedicated energy production; lower documentation needs than biomass, but must provide proof of proper sorting (residual waste only), customer profiles, and feedstock origin

7.3 Ørsted: Kalundborg CO_2 Hub

The Ørsted Kalundborg CO_2 Hub is a carbon capture and storage project based at sites in Kalundborg and Copenhagen. Beginning in 2026, the project will capture 430,000 tons of CO_2 annually from two combined heat and power plants that are fuelled entirely by biogenic sources – specifically woodchips and straw. The captured CO_2 will be transported and permanently stored in geological formations beneath the North Sea, utilizing the Northern Lights infrastructure.

The projects revenue model lies on a blend of public and private funding besides Ørsted's own capital and operational capabilities: 1) Danish State aid, 2) Revenue from corporate buyers committed to high-integrity CDR credits form the VCM. Additionality, the EIFO (Export and Investment Fund of Denmark provides risk coverage (guarantee) for the project.

1) **Danish State aid:** The most significant direct support comes in the form of a public subsidy from the Danish Energy Agency (DEA), amounting to 8 billion DKK. This subsidy is awarded through a competitive tender ("CCS udbuddet"), which funds projects based on the volume of captured and permanently stored CO_2, on a pay-for-performance basis. The public funding helps cover the capital and operational costs of carbon capture at two bioenergy plants, CO_2 compression, transport to the harbour, shipment to offshore storage, and the associated monitoring and verification required for long-term geological storage.
2) **Sales of certified carbon removal credits:** Beyond subsidies, Ørsted generates significant revenue from the voluntary carbon market by selling certified CDR credits to corporate buyers. These credits are third-party certified (under the VERRA standard) and attractive to companies with ambitious climate targets looking to offset or neutralize residual emissions. The biggest notable buyer is Microsoft, which has agreed to purchase 3.67 million tons of CDR credits. Also, Equinor has committed to purchase 330,000 tons of CDR credits. The specific prices for these transactions have not been disclosed.
3) **EIFO risk guarantees:** EIFO provides risk coverage of the project. Their involvement is not direct funding, but rather a financial guarantee of 400 million DKK (Danish Kroner) that de-risks certain aspects of the project, making it more attractive to Ørsted, corporate buyers, and external lenders.

Ørsted's Kalundborg CO_2 Hub project demonstrates the value of blending public subsidies, private carbon credit sales, and company investment to make large-scale carbon removal possible. Danish support is awarded through competitive tenders based on actual CO_2 captured, ensuring efficient use of public funds. Certification of credits (e.g. VERRA) boosts credibility and attracts international buyers like Microsoft, bringing premium prices and private demand. Public guarantees, such as those from EIFO, reduce project risk and support financing – something Norwegian projects could replicate through similar national schemes. Building long-term partnerships with dedicated corporate buyers also creates price stability and investor confidence. Finally, by integrating with existing regional CCS infrastructure, projects can lower costs and operational complexity, offering further advantages for Norwegian waste incineration plants.

7.4 Stockholm Exergi: BECCS Stockholm

BECCS Stockholm is a pioneering carbon removal project situated in Stockholm at Stockholm Exergi's bioenergy combined heat and power (CHP) plant. The initiative involves capturing CO_2 emissions produced from burning sustainably sourced wood-based biomass. Once captured, this biogenic CO_2 is transported and permanently stored in geological formations under the North Sea, specifically using the Northern Lights infrastructure. The project aims to capture and store up to 800,000 tonnes of CO_2 annually starting from 2027, making it one of the leading large-scale BECCS projects in Europe.

The following lessons learned from Stockholm Exergi's experiences with developing their BECCS projects is primarily based on an episode of the podcast "CDR Policy Scoop" with Eve Tamme and

Sebastian Manhardt and their interview in May 2025 with Erik Rylander, the Head of CDR at Stockholm Exergi[17].

Like Ørsted's project, BECCS Stockholm's financial model is anchored in a public-private blend of funding: 1) an EU Innovation Fund grant, 2) Income from corporate buyers purchasing high-integrity, certified CDR credits, and 3) a large Swedish state subsidy. This diversified funding base helps the project overcome the capital intensity and risk of early-scale deployment, positioning it as a flagship for future negative emissions initiatives in the EU and globally:

1) **EU Innovation Fund Grant:** In 2022, the project received a substantial grant from the EU Innovation Fund, totalling €180 million. The Innovation Fund focuses on supporting innovative low-carbon technologies across Europe. By providing funding to BECCS Stockholm, the EU is helping to de-risk early deployment and support the commercialization of large-scale carbon removal.
2) **Carbon Credit Sales:** A second major revenue stream comes from the sale of certified CDR credits to companies seeking to offset their emissions and achieve net-zero goals such as Microsoft and Frontier. The companies entered their carbon removal purchase agreements with an understanding that the negotiated price was contingent on Stockholm Exergi receiving government funding.
3) **Swedish State Aid Subsidy:** The Swedish Energy Agency has committed significant financial support, awarding a 20 billion SEK (Swedish kronor) subsidy. This state aid is crucial for covering the high upfront costs associated with building and operating carbon capture and storage infrastructure, and it demonstrates strong government backing for negative emissions as part of Sweden's net-zero ambitions.

Rather than the Swedish government directly buying carbon removals, they chose to subsidize the market price, enabling both public funds and private buyers to support the project side by side. This collaborative financing model was only possible after substantial efforts were made with the government to refine and improve the state aid scheme, ensuring that public subsidies could effectively stimulate private sector participation in large-scale carbon removal.

For KAN and the Norwegian waste incineration sector, BECCS Stockholm's experience shows that blended finance, early and meaningful corporate buyer engagement, a market-enabling subsidy scheme – instead of a direct government purchase procurement – and strong government-industry collaboration on for instance co-design of the support scheme tailored to the WtE sector are essential ingredients to launch carbon removal projects at scale.

[17] Public Subsidies + Carbon Credits: The winning combo? - with Erik Rylander - The CDR Policy Scoop | Acast

8 Internal actions and roadmap for Norwegian WtE plants

8.1 Summary and keys takeaways

At this stage, we emphasize building credibility for biogenic CO_2 crediting, as well describing what work needs to be perform by each individual KAN member in their project to maximise the chances to fulfil requirements that would enable CDR issue.

The work needed should be described in a technical work description package that can be implemented at late as possible in a project, but before Final Investment Decision. This technical work description package will enable KAN members to quantify the net amount of CO_2 removed, how embodied emissions are accounted for (LCA), how additionality is documented and how to address MRV and other required systems to be able to issue CDR.

The roadmap ownership of this roadmap should be collaborative – all KAN members are stakeholders and play crucial roles in defining the governance as well as implementation of the roadmap in their projects/plants. Through piloting, KAN can gain insight and correct the course of the roadmap as necessary.

In the meanwhile, KAN should continue advocacy activities for obtaining public fundings.

8.2 Assumptions

There are several assumptions that need to be addressed before the roadmap is presented. We assume that:

- The market demand for CDR will be constant. This is a simple starting point so KAN can plan its work without betting on uncertain market growth. It is acknowledged that demand matters a lot, and forecasts (as presented in section 6) show likely rapid growth. The flat-demand assumption helps with initial planning; however, KAN must keep updating its view of the market.
- KAN members will have capacity and skills to execute their roadmap tasks, and/or will be able to hire in help to perform all the relevant tasks.
- KAN members will be able to make the required investments.

8.3 Roadmap

This section presents each phase of the roadmap. A timeline and visualization that summarise this chapter is presented in section 8.4.

8.3.1 Establish Governance Structure

The first critical step is the creation of a governance framework dedicated to overseeing the roadmap's execution. This body, which could be named Roadmap Governance Group (RGG) and comprise experienced members from the KAN network, will be tasked with defining clear roles and responsibilities for all participants such as project management and technical experts within relevant thematic areas. Governance should institute periodic reviews to the KAN steering committee.

A brief charter should detail the authority of this group and how it collaborates with the KAN steering committee.

A potential organization chart of the governance structure could look like this:

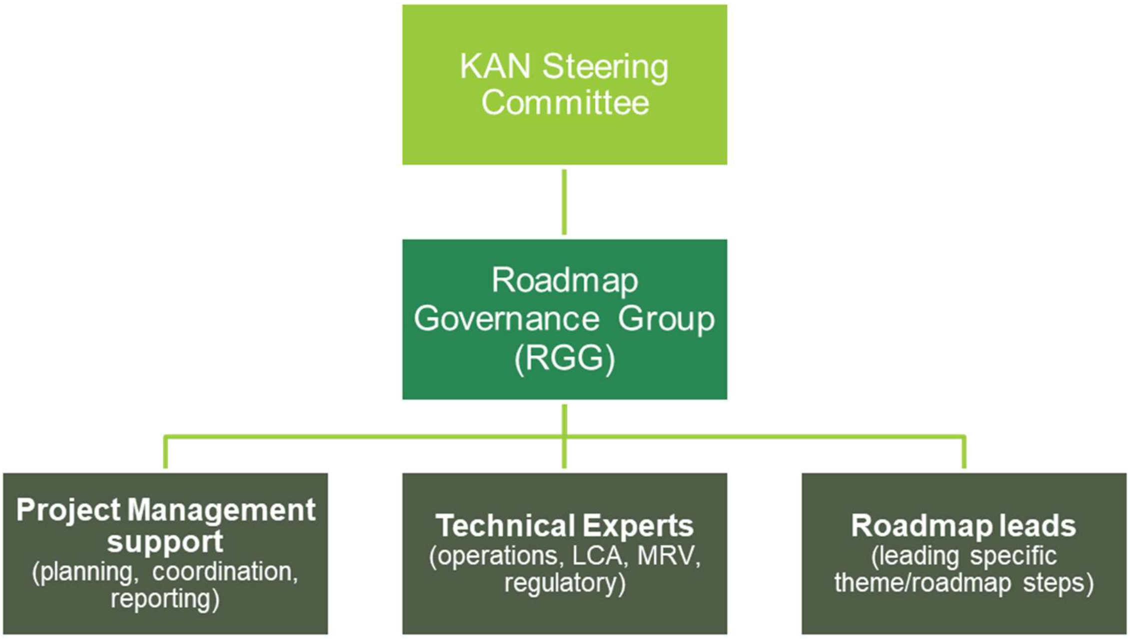

Figure 9: Potential organization chart of the governance structure.

8.3.2 Define early steps to enable CDR negotiations

Before engaging in full-scale Carbon Dioxide Removal (CDR) negotiations, it is crucial to lay the groundwork.

The negotiations with potential buyers are enabled primarily by two factors that require long-terms strategies, as they are interested in high quality capture and storage solutions. The early negotiations are primarily driven by the ability of a CDR supplier to document what is removed, and how it would be permanently stored.

Furthermore, the financial additionality of the project needs to be documented and verified, at least in its preliminary form.

With this information in hand, we believe that KAN members would be able to approach a potential CDR buyer.

8.3.2.1 Build credibility of the biogenic fraction of the CO_2 captured

For a typical WtE plant, the substrate used in the incineration might present variations. Potential buyers are often interested primarily in the biogenic fraction of the CO_2. To date, only two "mixed" emission CDR deals in Norway are registered, both by Hafslund Celsio. Recently, Microsoft has signed a CDR deal with the Danish company Gaia (a joint venture between Copenhagen Infrastructure Partners (CIP) and Vestforbrænding). Gaia will provide Microsoft with 2.95 million tons of carbon removal credits delivered from its WtE CCS retrofit at a plant in Nordhavn, Denmark.

In this respect, investing in measurement equipment and campaign to document the biogenic fraction over a longer period of time will give potential CDR buyers confidence about the source of CO_2. The frequency of these campaigns should be at least quarterly to satisfy the most stringent of the register, however more frequent measurement can be performed to support credibility in front of potential buyers.

Performing measurement campaigns will also enable the sales of ex ante credit, otherwise the only option remaining is ex post (i.e. after the CO_2 removal is verified).

As such, KAN members should consider investing in either equipment (which will support the lifetime of the project and therefore reduce OPEX over time) or accredited measurement campaigns of the flue gas with for example the Carbon-14 method. The measurement should be performed over time, as most of the register requires historical data. For the frequency, In addition, using this method, each KAN member could produce a specific biogenic factor for their plant, which would be lower than the standard factor used by the Norwegian authorities[18] to determine the biogenic fraction – and therefore reduce the applicable CO_2 tax.

8.3.2.2 Have control of the full value chain, with focus on the permanent storage

KAN is already taking concrete steps in this regard, by developing a LCA tool to address the entire value chain, from capture to storage.

Potential buyers are currently very interested in ensuring that the CO_2 captured for which CDR are generated is permanently removed and stored, and they have high focus on documentation regarding the entire value chain. Some parts of the value chain are directly owned and under the control of the various KAN members (i.e. capture, temporary storage), while others (primarily transport and storage) are not and are supplied by third parties/suppliers. Some registers require that the CDR supplier provide evidence that their CO_2 is intended for permanent storage in eligible storage sites, and that such evidence is provided in the form of a contract or other binding arrangement,

However, these do not necessarily need to be finalised to enable negotiations with potential buyers, but it is advisable to start working on both preliminary agreements (i.e. Letters of Intent) as well as preliminary analysis (included but not limited to LCA) for the entire value chain.

8.3.2.3 Preliminary document of the project financial additionality

The ability to document and verify financial additionality (as discussed in section 4.3.2) is included in all the main registry, and it might be necessary to have the information available to enable discussions with potential buyers. The potential clients are, for the time being, very interested in additionality and how can make CCUS project happens, and having information about the financial additionality will also support price negotiation (currently, this criterion appears to the one driving the pricing).

As a preliminary analysis, it should be sufficient to prepare the same documentation required by the various registers to document their financials: Net Present Value (NPV) or Internal Rate of Return (IRR), plus some form of cash flow analysis and investment analysis (providing evidence that eventual subsidies are not sufficient to incentivise the project).

8.3.3 Prepare technical work description package for FEED

The third step is the development of a comprehensive technical work description package for implementation in the Front-End Engineering Design (FEED) phase of each project. At this time, we believe that the implementation work should be postponed as late as possible, but before Final Investment Decision is reached. This is mainly due to the following:

1) The technical work necessary to issue CDR is, as this stage of the market, connected primarily with the market driving forces. These are primarily private companies which are looking at additionality and based on this additionality principle select potential seller. Until a structured marketplace is establish, there is potentially no return in anticipating implementation of technical work.

2) The same applies for registers: while the market has a preference for ICVCM and ICROA approved registers, there are a lot of development happening in the register area and one input from talking to companies who has sold credits to the market has been that the selection of which register should be employed in the CDR sales should be postponed to as practical late as possible (as elaborated in section 7.2).

3) The implementation of systems, equipment and procedure on the final project will have a cost. These costs (both CAPEX and OPEX) need to be evaluated to ensure a robust FID.

The technical package should cover the following topics:

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[18] A factor of 0,592 is used to convert the ton of waste to ton of fossil CO_2 emitted.

- Description of the net amount of CO_2 removed
- Accounting of embodied emissions
- Documentation of additionality
- MRV supporting documentation and systems

Topics not covered:

- Project information and baseline documentation (i.e. regards GHG) is assumed to be part of the FEED standard documentation, and it does not need to be specifically addressed for this purpose

The objective is to provide a single set of "instructions" so that all project teams receive a playbook during FEED, ensuring availability of KAN best practices.

8.3.3.1 Description of the net amount of CO_2 removed

The net amount CO_2 removed is necessary to determine the amount of CDR that can be generated and issued. This needs to be quantified by deducting supply chain emissions, leakage, reversals, and, where needed, applying discounts for uncertainty.

8.3.3.2 Accounting for embodied emissions

Embodied emissions (of the new equipment, preexisting facilities are excluded by all the main registers) can be accounted via LCA. The methodology to select should implement the principles of ISO 14040/44, such as the KAN LCA tool. The emissions need to be documented in a format that may be third-party verified.

8.3.3.3 Documentation of additionality

Both regulatory and financial need to be documented. While most likely the financial part would be typically covered in the business case description of any project, there might be specific topics such historical data on income that need to be documented. With regards to the regulatory additionality, the disclosure of relevant information needs to be documented.

Both financial and regulatory additionality will be most likely verified during independent audits.

8.3.3.4 MRV supporting documentation and systems

Within the MRV topic, the following aspects are important and need to be addressed:

1. Describe the biogenic fraction attribution strategy (typically, a system compliant with IAEA/ASTM D6866 for ^{14}C or EN 15440 – ref. also to section 8.3.2.1). In addition to the strategy, both equipment and survey/reporting services should be described and included in the CAPEX and OPEX of the project.

   Biogenic fraction attribution might include also waste characterization – the project is to document how incoming waste, including compositional (proximate and ultimate), is analysed and reported. This is primarily to address the sustainability of the biomass as well if there is hazardous waste in the MSW that might trigger additional MRV.

   Additional installations might be required to enhance the information that need to be reported, they need to be included in the project scope and in the project budget.

2. Describe the emission monitoring strategy, primarily CEMS based. It includes a description of which system, logs and relevant activities (calibration, maintenance) need to be included. Additional installations required need to be included in the project scope and in the project budget.

3. Data protocols and digital infrastructures:

   - Digital chain-of-custody should be modelled and documented (for example according to ISO 22095). Implementation should be planned (i.e. setup for logbooks), and requirements for other project stakeholders (i.e. for the storage supplier, storage monitoring requirements) should be analysed and their cost included in the project. Project specific risk assessment (in accordance with the EU CCS Directive 2009/31/EC), including reversal risk, shall be made available in due time.

- Centralized digital monitor platforms need to be specified, included in the project scope of work and in the project budget. These platforms will need in due time to be integrated into the registry to support real-time monitor, data storage, historical trace-back. Access controls for third-party auditors will need to be provided.

  As part of this effort, MRV automatic logging should be implemented, specified in the relevant packages and included in the project budget.

8.3.4 Pilot technical work description package and gather feedback

Once the technical work description package is assembled, it should be piloted in a KAN member undertaking (or updating) the FEED on a current project.

KAN governance representatives should be consulted as possible to provide lessons learned, and to ensure that the implementation deliver knowledge transfer back to the KAN governance.

Feedback might reveal areas requiring clarification, gaps in the provided materials, or opportunities to remove activities from the scope. All collected feedback need to be documented, and a formal process for updating and improving the package should be included before broader deployment.

8.3.5 Monitor market and regulatory environment & stakeholder engagement

Continuous monitoring of the market context and regulatory landscape is vital, especially given the dynamic nature of the CDR market. The governance should assign a specific task to track legislative changes, emerging technologies, activities from other WtE companies across Europe and the world, and double check whether KAN expectations and priorities are not changed.

Additional engagement with new stakeholders may be necessary – including other KAN projects, regulatory bodies, industry associations.

The result of these monitoring activities should be used to update the technical package in order to maintain it relevant and compliant. The roadmap might also need to be adapted as a result of this exercise. Finally, it should contribute to achieve one of the main objectives in KAN: increase information sharing and, together, find better solutions around CCUS and the WtE industry.

8.3.6 Advocacy for public funding

Securing public funding will be vital for enabling large-scale deployment of CDR technologies within the KAN network. The largest carbon removal projects to date (Stockholm Exergi, Ørsted, and Hafslund Celsio) have only been possible with public funding.

Strategic actions include updating and continue to communicate KAN's position[19], developing a unified KAN advocacy further articulating the sector’s contribution to both waste reduction and carbon removals. More concrete actions can be setting up regular targeted meetings with key ministries, as well as with relevant parliamentary committees. Furthermore, technical briefings illustrating the co-benefits of CCS-at-WtE facilities, etc. should be developed to demonstrate how public funding (and the role of mixed private-public found) can trigger private investment and accelerate deployment.

A wide variety of public funding instruments can be deployed by policymakers to unlock large-scale carbon capture from WtE facilities. However, to ensure the efficient and sustainable development of carbon removals in this sector, it is crucial that these instruments reflect the unique characteristics, challenges, and opportunities of WtE, and are carefully sequenced to transition from supporting demonstration projects to full-scale commercial deployment.

To address WtE sector specifics, a bespoke public funding scheme could balance up-front support with market-creating mechanisms:

[19] https://www.kanco2.no/posisjon-juni-2024

- Up-front capital grants (CAPEX support). These grants can cover a significant portion (e.g., of the cost of retrofitting capture units, CO_2 conditioning/compression, and infrastructure adaptation). This is especially critical for municipally owned plants unable to raise large amounts of project finance.
- Contract-for-Difference (CFD) or Reverse Auction Subsidy: The Norwegian government should carefully consider the design of a subsidy scheme to scale CDR developments. One type of models could be Carbon Contracts for Differences, a model that establishes a guaranteed minimum price for carbon removal credits. This model aims to provide revenue certainty for project developers in a market characterized by uncertain market prices. The model has been tested in the UK in the offshore wind market. Another approach is the Reverse Auction Subsidies model, which identifies carbon removal providers via competitive bidding. In this system, successful bidders are granted fixed subsidies for each tonne of verified CO_2 permanently stored geologically. This model aims to optimize the allocation of public funds by leveraging market competition to secure the largest volume of carbon removals at the lowest possible cost. Notable examples include the Swedish BECCS Reverse Auction, where Stockholm Exergi secured a SEK 20 billion subsidy contract, and the Danish CCUS and CCS Reverse Auction.
- Administrative effectiveness: Application procedures should be as streamlined as possible for municipally owned or smaller WtE operators with limited administrative capacity.

8.3.7 Rollout the finalized technical work description package

Drawing on insights from the pilot and monitoring activities, the refined technical work description package can be rollout to all the KAN members and – eventually – translated in English and made available across KAN platforms.

Potential follow up plans against the KAN members need to be evaluated, with focus on lessons learned. A "handover" to each of the KAN member is suggested, to maximise lessons learned transfer, and allow for potential coaching sessions – in these sessions there could also be demonstrations of materials and tools. This follow-up should also include feedback sessions to address any potential challenge encountered in the implementation.

8.4 Roadmap visualization and timeline

A suggested timeline and responsibility of each activity of the roadmap is presented in this section. The timeline describes the process before entering a contract with a buyer of CDR. The process and timeline will need to be tailored to the actual KAN member and the potential buyer. The payment from buyers is not realised before the CO_2 is physically permanently stored. This will occur for all KANs members' projects beyond this timeline.

		2025		2026				2027	
Activity	**Responsible**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
Establish Governance Structure	KAN								
Define early steps to enable CDR negotiations	KAN members								
Prepare technical work description package for FEED	Specific project								
Pilot technical work description package and gather feedback	One KAN member								
Monitor market and regulatory environment & stakeholder engagement	KAN								
Advocacy for public funding	KAN								
Rollout the finalized technical work description package	KAN members								

Figure 10: Roadmap timeline.

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