ccs+ initiative

EU guide to an integrated carbon accounting infrastructure for the industrial carbon management market

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CCS+ initiative

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List of abbreviations

BECCS	Bioenergy with carbon capture and storage
CATF	Clean Air Task Force
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CCUS	Carbon capture, utilisation and storage
CDM	Clean Development Mechanism
CDR	Carbon dioxide removal
CO_2	Carbon dioxide
CRCF	Carbon Removal Certification Framework
CSRD	Corporate Sustainability Reporting Directive
DAC	Direct air capture
DACS	Direct air capture and storage
DACCS	Direct air carbon capture and storage
EIA	Environmental impact assessment
ESRS	EU sustainability reporting standards
ETS	Emission trading system
EU	European Union
EU ETS	EU Emission Trading System
GCS	Geologic carbon storage
GHG	Greenhouse gas
GHG Protocol	Greenhouse Gas Protocol
ICROA	International Carbon Reduction and Offset Alliance
IEA	International Energy Agency
IED	Industrial Emissions Directive
IPCC	Intergovernmental Panel on Climate Change
LCA	Life cycle analysis
LULUCF	Land use, land use change and forestry
MRR	Monitoring and Reporting Regulation
MRV	Monitoring, reporting and verification
NZIA	Net-Zero Industry Act
O&M	Operating and maintenance
PCI	Project of common interest
QU.A.L.ITY	Quantification, additionality, long-term storage and sustainability
RED II	Renewable Energy Directive
SDG	Sustainable Development Goal
SET Plan	Strategic Energy Technology Plan
TEN-E	Trans-European Networks for Energy
TEN-T	Trans-European Networks for Transport
VCM	Voluntary carbon market
VCS	Verified Carbon Standard

Summary

This guide explores the adoption of an integral carbon accounting 'infrastructure' for industrial carbon management in the European Union (EU), including carbon capture and storage (CCS), carbon capture utilisation and storage (CCUS), carbon capture and utilisation (CCU) and engineered carbon dioxide removal (CDR) technologies. Concretely, the CCS+ Initiative presents a blueprint for carbon accounting to inform the creation of a high-quality, high-integrity certification framework, explores opportunities and challenges for adoption, and identifies synergies with existing regulations and policies to help the EU achieve its climate and industrial goals.

The CCS+ Initiative's work comprises two framework methodologies, a set of tools and variouscapture, transport, storage and long-term utilisation modules to quantify emission reductions and removals through CCS, long-term storage through CCUS and emission removals through engineered CDR technologies.[1] Together, the methodologies, tools and modules compose a comprehensive and integrated 'infrastructure' for industrial carbon management. The CCS+ carbon accounting infrastructure provides a single carbon accounting environment for a wide variety of project value chains that are technologically associated due to overlapping transport and storage needs.

Currently, even pioneering policy instruments and regulatory frameworks supporting those technologies, including the EU's regulations and policy instruments, are yet to define robust standards for certifying emission reductions or removals through CCS, CCUS and CDR. At the same time, the EU is increasingly prioritising the deployment of such projects as part of its long-term climate action. The executive body, the European Commission, is expected to publish a dedicated Industrial carbon management strategy by the end of 2023, covering both emission reductions and removals. This strategy will define the role of industrial carbon management in EU climate action in 2030, 2040 and 2050, and the steps towards the establishment of an industrial carbon management market by 2030.

The European Commission has set out to develop certification methodologies for carbon removal activities. To support this effort, it has launched a public consultation on industrial removal certification methodologies. The goal is to understand whether existing methodologies can ensure accurate quantification, additionally, permanence of storage, and that carbon removal activities are sustainable.[2] The CCS+ Initiative will make a dedicated submission to ensure that the Commission's efforts can build on existing best practices and innovative approaches to carbon accounting methodology development in the voluntary carbon market.

The CCS+ Initiative responds to the EU's ambition of establishing a robust carbon accounting infrastructure, which can support its industrial carbon management strategy. The CCS+ Initiative is a global, not-for-profit, multi-stakeholder initiative developing robust carbon accounting methodologies for industrial carbon management technologies. By enabling the accounting of emissions reduced or removed across project value chains, it seeks to leverage carbon markets to incentivise the scale-up of technologies associated with carbon capture, utilisation, transport and storage processes and accelerate their adoption in compliance markets. The methodologies developed under the initiative will be published as a public good under the Verified Carbon Standard (VCS).

The aim of the CCS+ Initiative is to provide a best practice global standard for quantifying and certifying emission reductions and removals through CCS, CCU and CDR projects. The CCS+ standard provides a comprehensive framework which can be adapted to fulfil the transparency and environmental integrity requirements of regulatory frameworks that may emerge across jurisdictions around the world. Policymakers would therefore have the

[1] For the purpose of this guide, industrial carbon management is frequently used to cover projects involving CCS, CCU with durable storage (CCUS) and engineered forms of CDR, such as DACCS and BECCS. Accurately differentiating projects according to their mitigation outcomes, emission reductions or carbon removals, remains vitally important.

[2] European Commission (2023), 'Call for input: Industrial Removal Certification Methodologies', https://ec.europa.eu/eusurvey/runner/Industrial-RemovalsSurvey#page0

option to build on this framework, which will be endorsed and tested by leading project developers in this field, rather than creating an entirely new framework, which could further delay the adoption of these critical climate technologies.

For the implementation of the CCS+ carbon accounting infrastructure in the EU, this guidance analyses:

- synergies between the CCS+ Initiative's carbon accounting methodology infrastructure and existing laws, regulations and existing and prospective policy instruments in the EU on industrial carbon management;
- opportunities to complement industrial carbon management regulations and policy instruments in the EU;
- opportunities to inform prospective EU regulations and policy instruments;
- challenges in adopting CCS+ methodologies for EU regulations; and
- recommendations for leveraging CCS+ methodologies for the quantification and certification of emission reductions and removals.

Considering the evolving laws, regulations and policy instruments advancing CCS, CCUS and CDR, this analysis focuses on EU policies and regulations that have or can have a significant influence on the quantification and certification of emission reductions and removals:

- **Section 1** provides an overview of the role of industrial carbon management in the EU and the key laws, regulations and policy instruments on activities along the value chain and argues why a comprehensive methodological framework to quantify and certify CCUS activities is needed to complement the current policy and regulatory set-up.
- **Section 2** introduces the CCS+ Initiative and its methodological framework to separately quantify emission reductions and removals from industrial carbon management technologies. It provides an overview of its modules, tools and key technical considerations, such as additionality, leakage, embodied carbon and monitoring, reporting and verification (MRV).
- **Section 3** explores the implementation of the CCS+ Initiative methodologies in the EU, leveraging laws, regulations and policies already in place.
- **Section 4** provides an outlook and recommendations on the adoption of a framework to certify emission reductions and removals through industrial carbon management technologies in the EU. It highlights critical aspects for implementing a high-integrity methodology framework to certify such activities and the role such a framework can play to put industrial carbon management on track for delivering the climate mitigation potential it is meant to provide.

How to use this guidance

This guidance is intended for public use. It aims to support EU regulators in creating a robust methodological framework through which to quantify and certify emission reductions and removals. Further guidance notes focusing on jurisdictions outside the EU, cross-border use cases and carbon trade under Article 6 of the Paris Agreement are under development. Regulators from other jurisdictions may also benefit from learning what it may take to design a carbon accounting methodological framework by integrating it into policy and regulatory frameworks.

More broadly, this guidance provides advocacy groups and the general public with an overview of a blueprint infrastructure for carbon accounting to support the sound adoption of industrial carbon management technologies and how such a blueprint can inform the creation of a high-quality, high-integrity certification framework in the EU. This guidance supports civil society efforts to advocate for the changes needed to certify industrial carbon management technologies, which can help the EU to safely meet its climate and industrial targets.

1 Industrial carbon management in the European Union

Industrial carbon management technologies, including CCS, CCUS and novel CDR approaches, are essential to meet climate goals, both globally and in the EU. Industrial carbon management projects involve the capture of carbon dioxide (CO_2) from point sources (e.g. energy or industrial facilities) or the atmosphere. The captured CO_2 is typically compressed and transported by pipeline, ship, rail or truck to be injected into deep geological formations (e.g. deep saline aquifers, depleted oil and gas reservoirs or reactive rock formations) which can durably trap the CO_2. Alternatively, the CO_2 can be used for long-term storage in building aggregates or used in various short-lived applications, such as urea manufacturing, synthetic fuels and chemicals.[3] Capturing and storing the fossil CO_2 from point sources helps reduce the emissions from industrial processes and fossil fuel energy plants. Additionally, if the point sources use biomass as fuel or if the CO_2 is directly captured from the atmosphere and durably stored, the process can help bring down existing CO_2 concentrations in the atmosphere.

Industrial carbon management technologies are expected to play an important role in the EU's net zero pathway. CCS and CCUS can help decarbonise energy-intensive industries while remaining competitive,[4] while CDR approaches will be required to neutralise residual emissions by 2050 and potentially achieve net negative CO2 emissions after.[5] The EU's current climate strategy, the European Green Deal, reinforces the role of these technologies in achieving the net zero greenhouse gas (GHG) target by 2050. The 'Fit for 55' package, which aims to operationalise the climate policy goals with a shorter-term perspective (i.e. by 2030), creates further incentives for industrial carbon management in the EU, such as a more ambitious emission reduction target (55% by 2030 compared to 1990 levels), an increasing focus on industrial decarbonisation, additional funding for industrial carbon management demonstration projects and an emphasis on the Carbon Border Adjustment Mechanism (CBAM). The CBAM is a proposal to impose reporting obligations from 2023 and a carbon charge from 2026 on emissions associated with imported products. In this way, the CBAM can help EU industries remain competitive while implementing various emission reduction measures, including industrial carbon management. Moreover, it can indirectly incentivise investment in such decarbonisation measures outside the EU. A new proposal, the Net-Zero Industry Act (NZIA) also aims to help deliver on the objectives of the 'Fit for 55' package. It establishes a framework of measures to scale up the manufacturing of net zero technology products in Europe.[6] For industrial carbon management, the NZIA aims to accelerate the development of the CO2 storage capacity needed to support the upscaling of CCS, CCUS and CDR.[7]

The European Commission is expected to publish a dedicated strategy for CCUS deployment by the end of 2023, covering emission reductions and removals. It just concluded a public consultation.[8] This strategy will define the role of industrial carbon management in EU climate action in 2030, 2040 and 2050 and the steps towards the establishment of an industrial carbon management market by 2030. This strategy will have to reflect discussions on the establishment of a 2040 climate target for the EU to serve as a milestone on the path from a 2030 target of 55% reductions compared to 1990 levels to climate neutrality in 2050. The new 2040 target will take into account

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[3] International Energy Agency (IEA) (2022), Carbon Capture, Utilisation and Storage, IEA, Paris https://www.iea.org/reports/carbon-capture-utilisation-and-storage-2, License: CC BY 4.0

[4] IEA (2019), Transforming Industry through CCUS, IEA, Paris https://www.iea.org/reports/transforming-industry-through-ccus, License: CC BY 4.0

[5] Eve Tamme and Larissa Lee Beck (2021), 'European Carbon Dioxide Removal Policy: Current Status and Future Opportunities', Frontiers https://www.frontiersin.org/articles/10.3389/fclim.2021.682882/full

[6] European Commission (2023), 'Net-Zero Industry Act' https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en

[7] Eadbhard Pernot and Toby Lockwood (2023), 'Europe's Net-Zero Industry Act: What does it mean for carbon capture and storage?', Clean Air Task Force https://www.catf.us/2023/03/europes-net-zero-industry-act-what-does-mean-carbon-capture-storage/

[8] European Commission (2023), 'Call for evidence and public consultation launched on industrial carbon management under European Green Deal', https://energy.ec.europa.eu/news/call-evidence-and-public-consultation-launched-industrial-carbon-management-under-european-green-2023-06-09_en

results from the global stocktake under the Paris Agreement and is expected to be proposed in the spring of 2024. It is expected to cover both emission reductions and carbon removals.[9]

A mix of market incentives, technological improvements, infrastructure development and processes (e.g. regulations and methods) can help safely harness the decarbonisation potential of industrial carbon management (Figure 1). Robust carbon accounting and monitoring of emission reductions and removals is essential for the responsible scale-up.[10] Directly, robust accounting and monitoring provides quality assurance by certifying effective emission reductions and removals and fosters adoption by enabling the monetisation of reduced and removed emissions. Indirectly, it helps build trust in the market and contributes to improving the public acceptance of CCS, CCUS and CDR.

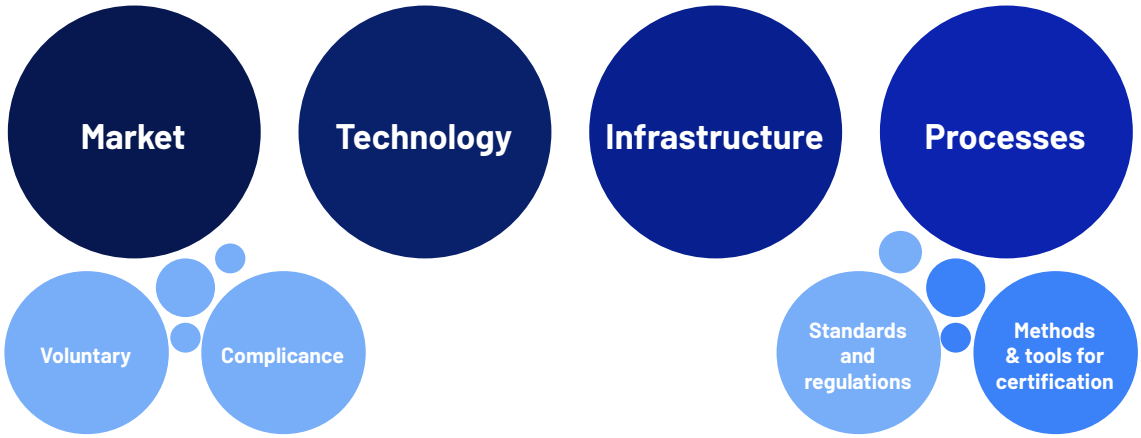

Figure 1: Framework to illustrate various types of requirements for CCS, CCU, and CDR adoption.

1.1 Industrial carbon management in European Union regulations and policy instruments

The EU has been a pioneer in developing industrial carbon management related laws, regulations and policy instruments for the past two decades. It has established regulations and incentives along the industrial carbon management value chain, supporting technology development, infrastructure deployment, processes, such as implementation standards, and market adoption while ensuring that these technologies are deployed safely. Nonetheless, the EU is yet to provide a complete methodological framework for quantifying and certifying emission reductions and removals from industrial carbon management technologies. The adoption of such a framework at the EU level would improve the public acceptability of the technologies by clearly demonstrating their climate benefits and safety through the MRV component of the methodologies. This would incentivise the uptake of industrial carbon management technologies by streamlining the accounting process through a standardised approach across the EU. It would constitute a key building block of a policy framework at EU level to establish an integrated industrial carbon management market.

[9] It is not clear whether there will be a single target or multiple targets specific to reductions and removals. Public responses to a consultation held in the second quarter of 2023 can be viewed at: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13793-EU-climate-target-for-2040/public-consultation_en

[10] European Commission, 'SETIS - SET Plan Information System', https://setis.ec.europa.eu/implementing-actions/ccs-ccu_en

1.1.1 Market

The EU Emission Trading System (ETS) Directive 2003/87/EC indirectly incentivises the adoption of CCS projects within the largest ETS in the world. The EU ETS sets a cap on the total amount of emissions which, in being gradually lowered, reduces the total amount of GHG emissions released annually in the covered energy and industrial sectors. Companies in the energy and industrial sectors receive limited allowances to emit GHGs, which they can use for either compliance purposes or trade. In this way, market supply and demand determine the price of emission allowances. As an emission reduction technology, CCS can help to decarbonise energy and industry sectors within such an incentive system. The ETS directive considers CO_2 captured, transported and geologically stored. Hence, emissions verified as captured, transported and permanently stored eliminate the obligation to surrender emission allowances. Carbon removals are not currently part of the ETS,[11] but their inclusion for the period 2030 and beyond is currently under discussion.

Regulation 2018/2066, also known as the 'Monitoring and Reporting Regulation' (MRR), establishes the compliance procedures for the EU ETS. It includes reporting and monitoring requirements for CO_2 emissions from CCS activities, delineating scope and quantification methods. The MRR also considers CCU with a limited scope. Specifically, the CO_2 that is converted into products has to be reported. The MRR excludes emissions to be accounted for within the ETS emissions if they are "transferred" or utilised to become permanently chemically bound in a product. In that case, the "transferred" CO_2 would not count towards a company's emissions allowance.[12] In its current form, the MRR does not quantify emission reductions or removals. However, in principle, there may be opportunities to leverage specific MRR approaches or requirements to cover the quantification of emission reductions and removals. Such adaptation would call for a more focused analysis beyond the scope of this guide.

1.1.2 Technology

Industrial carbon management technology research and development is supported by key EU funding schemes, such as the Innovation Fund and Horizon Europe. Through the Innovation Fund, which is financed from EU ETS revenues, the EU supports widely diverse climate mitigation activities, including industrial carbon management technology upscaling and other value chain aspects. In the last two years, the EU has supported large-scale CCS projects in the hydrogen, chemical, bio-energy and cement sectors, and it will double the funding for the next large-scale call for projects to around EUR 3 billion. The Innovation Fund replaced the NER 300 programme, a funding programme of about EUR 2 billion for the demonstration – on a commercial scale – of environmentally safe CCS and innovative renewable energy technologies. NER 300 was funded through the sale of 300 million emission allowances from the New Entrants' Reserve (NER) set up for the third phase of the EU ETS.[13]

The EU also supports industrial carbon management research, development and innovation through Horizon Europe and stakeholder engagement, such as the Strategic Energy Technology Plan (SET Plan) and the Zero Emissions Platform, a European Technology and Innovation Platform under the SET Plan.[14] Under Horizon Europe Cluster 5: Climate, Energy and Mobility, the EU supports developing and improving CO_2 capture technologies, while under Horizon Europe Cluster 4: Digital, Industry and Space, it addresses industrial synergies and hubs for circularity. Finally, EU states can also directly fund industrial carbon management projects. In addition to current EU funding, the EU Sustainable Finance Taxonomy, which classifies industrial carbon management as a sustainable economic activity, can help unlock private funds for technology deployment.

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[11] Rickels W, Proelß A, Geden O, Burhenne J, and Fridahl M (2021), 'Integrating Carbon Dioxide Removal Into European Emissions Trading', Frontiers in Climate https://www.frontiersin.org/articles/10.3389/fclim.2021.690023/full

[12] Sonja Thielges, Barbara Olfe-Kräutlein, Alexander Rees, Joschka Jahn, Volker Sick, and Rainer Quitzow (2022), 'Committed to implementing CCU? A comparison of the policy mix in the US and the EU', Frontiers in Climate.

[13] https://climate.ec.europa.eu/eu-action/funding-climate-action/ner-300-programme_en#current-situation-of-the-programme

[14] The Zero Emissions Platform is a member of the CCS+ Initiative's Advisory Group.

1.1.3 Carbon dioxide infrastructure

The development of CO2 transport infrastructure is one of the three priority areas of the Trans-European Networks for Energy (TEN-E) Regulation, a policy aimed at linking key energy infrastructure of EU countries. Furthermore, CO_2 infrastructure projects can apply to become projects of common interest (PCIs) and receive funding under the Connecting Europe Facility.

By the end of 2021, the European Commission had announced support for six trans-European infrastructure projects to develop CO_2 hubs. Besides, through its communication on 'Sustainable Carbon Cycles', the European Commission is currently working on analyses of the deployment of an EU-wide CO_2 infrastructure and regulatory oversight of CO_2 infrastructure, tackling third-party access to transport and storage, tariffs and network development plans.

1.1.4 Standards and regulations

The CCS Directive (2009/31/EC) provides a regulatory framework for safely transporting and storing CO_2. It is one of the EU's main CCS-related regulations and aims to ensure a high environmental standard for the geological storage of CO_2. Moreover, it requires member states to provide access to the CO_2 transport networks to third parties. It has led to amendments in previously established environment and energy regulations. Amendments include discerning CO_2 from waste, requiring new power plants to be 'CCS-ready' and subjecting CCS projects to environmental liability and impact assessment procedures. The CCS Directive also contains provisions on capture activities, although there is existing EU environmental legislation, such as the Environmental Impact Assessment (EIA) Directive or the Industrial Emissions Directive (IED), which already covers capture and transport activities.

A technical update of the four guidance documents is currently taking place and revisions are expected to be adopted by the end of 2023. This update aims to bring the documents in line with recent technical and market developments. This includes clarifications on CO_2 storage in mafic and basalt rocks and mineralisation, on CO_2 storage in depleted hydro-carbon reservoirs and on CO_2 specifications, such as aspects of the CCS value chain, corrosion and safety issues.

1.1.5 Methods and tools for industrial carbon management activities in the European Union

By the end of 2021, the European Commission adopted the communication 'Sustainable Carbon Cycles' specifying EU-wide actions to scale up alternatives to sustainably capture, store and recycle carbon. It lists key actions to support industrial carbon management, including the assessment of cross-border CO_2 infrastructure needs and an initiative to certify carbon removals.

In November 2022, the EU adopted a proposal for the Carbon Removal Certification Framework (CRCF), an EU-wide voluntary framework for certifying carbon removals, including CCS technologies such as bioenergy with carbon capture and storage (BECCS) and direct air capture and storage (DACS). The framework aims to guide the design of high-quality methodologies to certify emission removals. However, these methodologies are yet to be developed. Recently, the European Commission has launched a public consultation on industrial removal certification methodologies. The goal is to understand whether existing methodologies for industrial carbon removals can ensure accurate quantification, additionally, permanence of storage, and that carbon removal activities are sustainable.[15]

[15] European Commission (2023), 'Call for input: Industrial Removal Certification Methodologies', https://ec.europa.eu/eusurvey/runner/IndustrialRemovalsSurvey#page0

Previous EU policies and regulations, in particular the EU ETS and the CCS Directive, have incentivised the adoption of industrial carbon management technologies leading to emission reductions without the need for quantification. The methodologies developed by the European Commission for the quantification of GHG emission avoidance are the exception and they are only narrowly used within the scope of the Innovation Fund. On the other hand, EU instruments to quantify and certify emission removals are still in an early development stage, with a long way ahead towards establishing a complete set of methodologies.

1.1.5.1 Main guidelines in the European Union's Carbon Removal Certification Framework proposal

On 30 November 2022, as part of the European Green Deal, the European Commission presented the legislative proposal for a Union certification framework for carbon removals activities in the EU. The CRCF proposal aims to facilitate the deployment of carbon removals and establish a voluntary Union framework for the certification of carbon removals. Concretely, it seeks to ensure high-quality EU certified carbon removals, through a transparent and credible governance framework.

The proposed regulation aims to quantify, monitor and verify carbon removals through carbon removal approaches, such as DACS and BECCS, and sustainable carbon farming solutions, such as afforestation, reforestation and diverse agricultural practices. The proposal sets out rules for independently verifying carbon removals and recognising certification schemes. Carbon removals shall be eligible for certification under this regulation when they are generated from a carbon removal activity that complies with the quality criteria and when they are independently verified.

The proposed regulation establishes four quantification, additionality, long-term storage and sustainability (QU.A.L.ITY) criteria:

1. **Quantification**: carbon removal activities must be measured accurately and deliver unambiguous benefits for the climate.
2. **Additionality**: carbon removal activities must go beyond existing practices and what is required by law.
3. **Long-term storage**: certificates are linked to the duration of carbon storage to ensure permanent storage.
4. **Sustainability**: carbon removal activities must preserve or contribute to sustainability objectives, such as climate change adaptation, circular economy, water and marine esources and biodiversity.

A carbon removal activity shall provide a net carbon removal benefit, defined as:

Net carbon removal benefit = CRbaseline – CRtotal – GHGincrease > 0

CRbaseline refers to the carbon removals under the baseline, CRtotal to the total carbon removals of the carbon removal activity and GHGincrease to the increase in direct and indirect GHG emissions, other than those from biogenic carbon pools in the case of carbon farming, which are due to the implementation of the carbon removal activity. The three variables are designated with a negative sign (-) if they are net GHG removals and a positive sign (+) if they are net GHG emissions. The proposal recognises that a carbon removal activity delivers a net carbon removal benefit when the carbon removals above the baseline outweigh any increase in GHG emissions due to the implementation of the carbon removal activity.

The amount of durably stored carbon should outweigh the energy-related GHG emissions from the industrial process. Uncertainties in the quantification should be duly reported and accounted for in order to limit the risk of overestimating the quantity of CO_2 removed from the atmosphere.[16]

The proposal considers the CCS-based technologies of BECCS and DACS, which will capture CO_2 of biogenic or atmospheric origin and store it durably. Furthermore, the European Commission will continue funding such carbon removal actions (e.g. BECCS and DACS) through the Innovation Fund.

The certification framework is designed to build on existing climate change legislation, such as the CCS Directive and the Renewable Energy Directive (RED II) (2018/2001/EU). The CCS Directive establishes the overall legal framework for the environmentally safe geological storage of CO_2. The RED II[17] includes a set of sustainability criteria for bioenergy, which are implemented by either competent national authorities or private certification schemes recognised by the European Commission. These certification schemes could also potentially certify the compliance of carbon removal activities with the quality criteria for carbon removals presented in the proposal. Furthermore, the proposed certification framework will ensure that the quantification of carbon removals for industria activities such as BECCS[18] and DACS is in line with the rules set out in the European Commission Implementing Regulation (EU) 2018/2066[19] on the monitoring and reporting of GHG emissions under the EU ETS, and with the detailed EU methodologies developed by the European Commission[20] for quantifying GHG emission avoidance in BECCS and DACS projects under the Innovation Fund.[21]

The proposal specifies requirements for the operators of voluntary certification schemes, for member states seeking recognition for public certification schemes and for the European Commission regarding reporting and review.

A project shall demonstrate that a carbon removal activity aims to ensure the long-term storage of carbon. Moreover, projects shall comply with both of the following criteria: monitoring and mitigating any risk of release of the stored carbon occurring during the monitoring period; and remaining subject to appropriate liability mechanisms in order to address any release of the stored carbon occurring during the monitoring period. A standardised baseline should reflect the statutory and market conditions under which the carbon removal activity takes place and simplify the demonstration of additionality for operators.

Operators should take all relevant preventive measures to mitigate the risk of reversal (i.e. releasing the carbon back into the atmosphere) and duly monitor that carbon continues to be stored over the monitoring period laid down for the relevant carbon removal activity.

Activities that store carbon in geological formations provide enough certainty for the very longterm duration of several centuries and can be considered as providing permanent storage of carbon.

The proposal establishes that carbon storage in products is more exposed to the risk of voluntary or involuntary release of carbon into the atmosphere. To account for this risk, the validity of the certified carbon removals generated by carbon storage in products should be subject to an expiry date matching the end of the relevant monitoring period.

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[16] The carbon standard methodologies complete an uncertainty assessment during the methodology development stage. This prevents project sponsors from having to undertake this, something which is important for reducing both transaction costs and the risk to the project sponsor.

[17] Directive 2018/2001/EU.

[18] For BECCS deployment, safeguards are necessary to take into account the limits and availability of sustainable biomass in order to avoid excessive demand of biomass for energy with negative effects on carbon sinks and stocks, biodiversity, air quality and the bioeconomy.

[19] Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of GHG emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334, 31.12.2018, p. 1).

[20] Call for proposals in Annex C: Methodology for the calculation of GHG emission avoidance.

[21] European Commission, information page on EU Innovation Fund: https://climate.ec.europa.eu/eu-action/funding-climate-action/innovation-fund_en

For carbon farming and carbon storage in products, the carbon stored by a carbon removal activity shall be considered released to the atmosphere at the end of the monitoring period.[22]

Appropriate liability mechanisms should be introduced to address cases of reversal. Such mechanisms could include, for example, the discounting of carbon removal units, collective buffers or accounts of carbon removal units and upfront insurance mechanisms. Some liability mechanisms regarding geological storage, CO2 leakage and relevant corrective measures have already been laid down by Directive 2003/87/EC and Directive 2009/31/EC.

Carbon removal activities should be subject to independent third-party auditing. The certificate should contain accurate and transparent information on the carbon removal activity, including the total removals and net carbon removal benefit that complies with the quality criteria set out in the regulation.

Other general provisions include the following:

- **Certification methodologies**: Operators shall apply the relevant certification methodologies.
- **Certification of compliance**: To apply for a certification of compliance with this regulation, an operator or a group of operators shall submit an application to a certification scheme.
- **Certification bodies**: Certification bodies appointed by certification schemes shall be accredited by a national accreditation authority according to Regulation (EC) No 765/2008 of the European Parliament and of the Council.
- **Certification schemes**: To demonstrate compliance with this Regulation, an operator or a group of operators shall use a certification scheme recognised by the Commission.
- **Registries**: A public registry to make publicly accessible the information related to the certification process, including the certificates and updated certificates and the quantity of carbon removal units certified.
- **Recognition of certification schemes**: Only a certification scheme recogni sed by the Commission may be used by individual operators or a group of operators to demonstrate compliance with this Regulation. Such decision shall be valid for no more than five years.
- **Reporting requirements**: Each certification scheme recognised by the Commission shall submit to the Commission an annual report about its open rations, including a description of any cases of fraud and related remediation measures. The report shall be submitted annually by 30 April, covering the preceding calendar year. The requirement to submit a report shall apply only to certification schemes that have operated for at least 12 months.
- **Expected effects of the proposal**: The proposed Regulation affects economic operators such as farmers, foresters, and industrial companies that will develop carbon removal activities on the ground; private organisations and Member States authorities may develop private or public certification schemes to implement and control the certification process.

[22] What is being argued in the CCS+ framework methodology for long-term CCU is that CO_2 can be considered permanently stored if it canbe demonstrated that the CO_2 captured or carbon contained in that CO_2 ends up being chemically bound such that it will not be able to findits way back into the atmosphere, as the conditions for this are very unlikely to occur.

2 CCS+ carbon accounting methodology infrastructure

The CCS+ Initiative is a global, multi-stakeholder platform developing an integrated carbon accounting methodology infrastructure to accelerate emission reductions and removals through industrial carbon management projects. The CCS+ Initiative integrates the collaborations of energy industry leaders with technology, solution and professional service providers. It leverages state-of-the-art expertise in technologies, CO2 monitoring and carbon markets to cover a broad range of CO_2 capture, transport, utilisation and storage technologies across the CCS, CCU and CDR value chains. Furthermore, an advisory group, consisting of non-profit business organisations, international think tanks, technology and innovation developers, industry associations and research organisations, advises on the work to ensure the highest levels of environmental integrity.

The CCS+ carbon accounting infrastructure consists of methodologies, modules, tools and guidelines based on a comprehensive set of criteria and procedures to quantify emission reductions and removals through CCS, CCUS and CDR activities. Through 2023–2025, the CCS+ Initiative aims to have its methodologies adopted and published under the VCS.[23] The outputs can serve as a blueprint to certify emission reductions and removals through CCUS under other voluntary carbon market (VCM) standards or in compliance markets. The CCS+ Initiative spans CO_2 capture from industrial point sources or directly from the air and covers all relevant CO_2 transport, geological storage and long-term utilisation modes.

The main goal of the CCS+ Initiative is to foster trust among the stakeholders of industrial carbon management projects and market participants by increasing transparency, accountability and environmental integrity. For example, the CCS+ Initiative seeks to overcome MRV methodological challenges to facilitate the responsible implementation of industrial carbon management activities. To safely harness the climate mitigation potential, the CCS+ Initiative commits to enforcing standards of high environmental integrity. Furthermore, to ensure the framework's usefulness and effectiveness, the CCS+ Initiative builds on its members' extensive experience in voluntary and compliance carbon markets and on sound guidance from reputable organisations and institutions. By providing accounting methodologies and MRV frameworks, the CCS+ carbon accounting infrastructure aims to unlock additional funding from the VCM to accelerate the adoption of CCS, CCUS and CDR and advance the deployment of such technologies in compliance markets.

2.1 Modules

The infrastructure developed under the CCS+ Initiative takes a modular approach. It consists of two overarching methodology frameworks, namely CCS+ and CCUS+, and project-specific modules for capture, removal, utilisation, transport and storage, which can be selected as needed (Figure 2).

As a first step, the CCS+ Initiative assessed the need for methodologies at each step in the industrial carbon management value chain, from CO2 capture and transport to durable product or geological storage. Second, it is currently developing a coherent, robust methodological framework to integrate the CCS+ methodologies into the VCS. Third, it will provide input on new VCS Program rules to address potential reversal risks. Finally the initiative will oversee the development of a full suite of VCS methodologies and corresponding accounting tools for CCS projects. The ultimate goal is to establish VCS carbon crediting pathways for the full suite of CCS activities (i.e. CCS, CCU(S), BECCS and DACS) and to pilot carbon methodologies acknowledging the diversity of CCS projects and geographies.

[23] See work plan in the Annex

The first set of modules, already developed, addresses the capture of fossil carbon from industrial point sources (e.g. power, heat and industrial processes), the removal of atmospheric CO_2 via DAC, the storage of CO_2 in geological reservoirs and CO_2 utilisation via mineralisation technologies. Other modules that will be delivered are listed in Annex I.

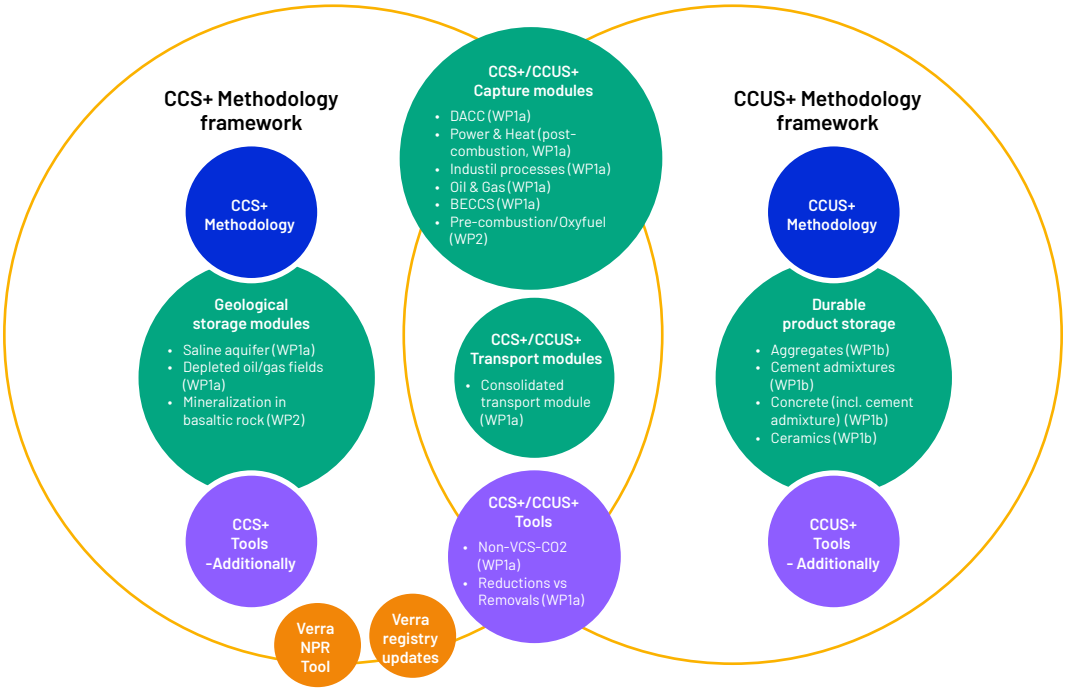

Figure 2: Overview of the modular framework of the CCS+ Initiative

2.2 Tools

The CCS+ Initiative recognises the need for a holistic and consistent approach to CCS and CCUS-based mitigation, which can result in either a permanent reduction in carbon emissions or a net removal of CO2 from the atmosphere. Given the potentially large number of industrial carbon management system configurations and their complex activities, the methodological approach under the CCS+ Initiative is set up in a different manner than traditional methodologies. It is more flexible, with overarching methodology frameworks and individual methodological modules that can be used in a plug-and-play fashion with the frameworks.

This modular setup allows for two central methodology frameworks to include the basic calculations, procedures and requirements for several eligible project types, including the determination of project boundaries and setting the baseline. Additional tools for differentiating emission reductions and removals and quantifying and allocating project emissions in carbon capture project activities provide further guidance.[24]

By combining the overarching methodological frameworks with specific tools, project proponents can choose between various capture, transport, storage and utilisation modules and select those modules that fit their project best. For instance, for a DACS in saline aquifers project, a project proponent selects the CCS+ methodology framework, the dedicated DAC capture module, the consolidated transport module and the storage in saline aquifers module. After adding the project-specific parameters into the methodologies and modules, a project proponent can prepare its project design document and submit it to Verra.

[24] Modules are used to address different types of project activities, while tools are developed to deal with specific issues for carbon crediting (e.g. additionality and the allocation of project emissions between reductions and removals).

2.3 Technical considerations

2.3.1 Project boundaries

Project boundaries are established to determine the significant CCS and GHG removal project stages and processes and the associated mass, energy and significant environmental flows in the analysis. The project boundary consists of the capture facility, transport facility (if applicable) and storage site. It may include multiple capture, transport and storage facilities, and does not include the entire CO_2 source facility, instead only accommodating the part directly affected by or required to capture CO_2 (e.g. flue gas cooling or the connection pipes to the absorber). The individual project boundary for each module includes, if not otherwise stated in the module, the mass, energy and GHG emissions associated with the use of electricity inputs (both for grid and on-site generation), fuel inputs, material inputs (e.g. chemicals) and process emissions (e.g. venting and fugitives).

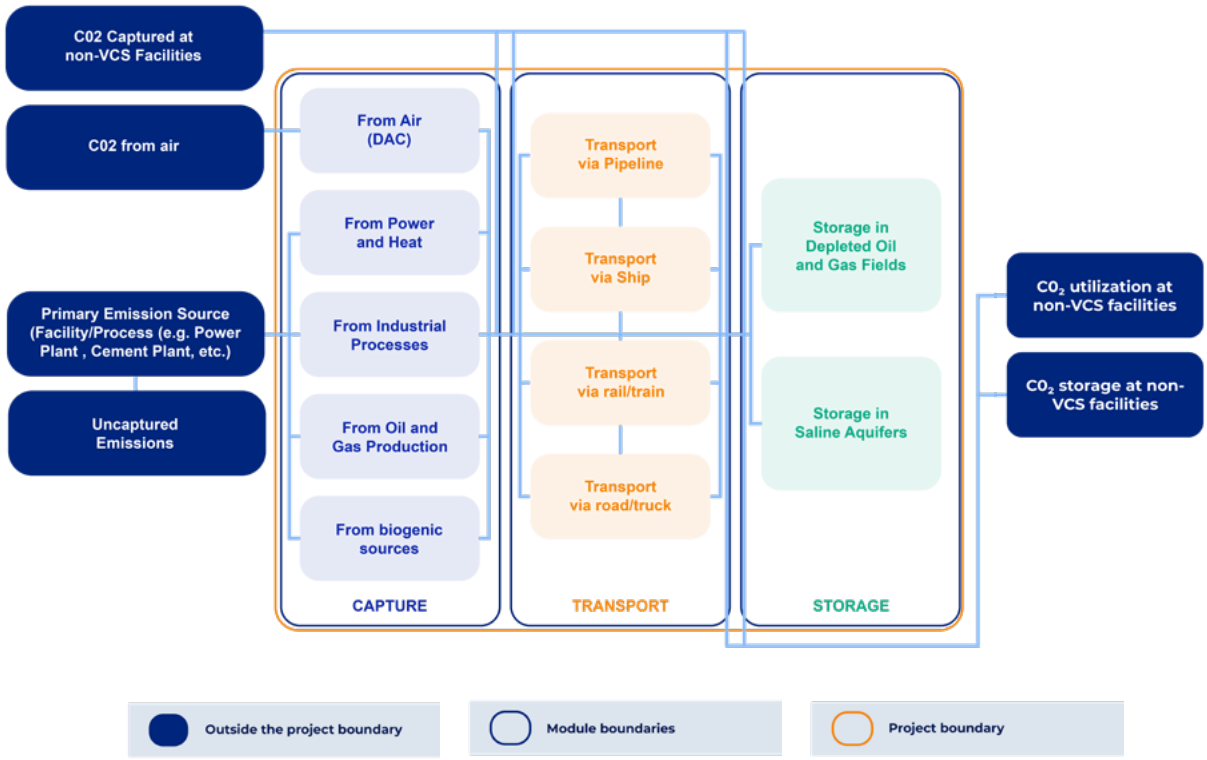

Figure 3: Project boundary of CCS+ projects

Moreover, the project boundary must also include secondary project emissions unintentionally caused by the project activity to reduce o remove emissions. This methodology framework recommends establishing a materiality threshold of 2% for all emission sources included in the GHG accounting boundary.

2.3.2 Additionality through investment analysis

The methodology establishes criteria and procedures to assess and demonstrate additionality in industrial carbon management project activities. To demonstrate additionality, Steps 1 to 3 outlined below must be applied following the project method.

Step 1: Regulatory Surplus: Projects must demonstrate regulatory surplus, i.e., the project activity, as of the start date, is not mandated by any law), regulation, statute or another regulatory framework of the region/ country in which the project activity is designed, developed and implemented. Schemes and policies at the national or local level that provide financialincentives to CCS activities are not considered mandatory regulations requiring the implementation of CCS activities. The regulatory surplus must be demonstrated for each capture activity.

Step 2: Implementation Barrier: Project activities must demonstrate that they face an investment barrier that can be overcome by the carbon revenues associated with the sale of GHG credits. To analyse the investment barrier, project developers must conduct an investment analysis with the latest version of CDM Tool 01, "Tool for the demonstration and assessment of additionality", and CDM Tool 27, "Investment Analysis".

Furthermore, the following guidelines must be considered for the investment analysis:

- The source facility is not included in the boundary of the assessment.
- Financial additionality must be demonstrated for each capture activity included in the project activity or added later as a project expansion. The costs (or revenues) from transport (if applicable) and storage activities must be incorporated into the financial assessment and shall reflect the actual usage rate of transport and storage by each capture activity.
- All revenues and cost savings resulting from implementing the project activity must be included as cash flows in the investment analysis, including but not limited to direct payments and indirect financial benefits.

Additional guidance on the investment analysis reflecting the specific risk situation and uncertainty of CCS project activities includes:

Selection and validation of appropriate benchmark

Where internal company benchmarks/expected returns are used, these shall reflect the risk associated with investing in:

- Technologies which are not mature and whose performance in the field, in specific applications and over an extended period has yet to be proven and documented at the time the decision to invest in the project is taken
- Projects applying technologies that are not mature and are highly capital intensive,
- Projects where different technologies and processes are combined in ways that result in a system of considerable complexity that has not been implemented at commercial scale in any market, and
- Business models with which there is minimal experience.
- Internal company benchmarks/expected returns that have been applied in the past by the company to assess investments deemed to pose similar risks as those faced by the CCUS project may be applied.

- If the company has no prior experience in undertaking projects with technologies/business models deemed to pose similar risks as those posed by the CCUS project, then the level of returns that are expected from venture capital investments may be used as aproxy for the returns to be expected when applying the investment analysis.

Operating and maintenance (O&M) cost

Contingency costs account for costs that cannot be anticipated/forecasted when applying the investment analysis tool. The following options can be used to determine such costs in the context of operating and maintenance (O&M) costs in a CCS or GHG removal project:

- **Option 1**: Apply the value used for contingency costs when assessing other projects with a similar level of technological maturity and risk to the CCS or GHG removal project, at the time such a project was conceived.
- **Option 2**: Based on historical incremental costs incurred when implementing other projects using technologies with similar levels of maturity and risk to the CCS or GHG removal project. The incremental O&M costs are calculated by subtracting the O&M costs incurred by a project over a given period minus the O&M costs that were assumed would have been incurred over the same period, based on the estimated O&M costs presented in Feasbility Studies, etc.
- **Option 3**: Using other approaches applied in a relevant industrial sector to determine contingency costs.

Contingency cost values estimated using options 1 and 2 shall be expressed as a % of the O&M costs originally estimated and used for the investment analysis on such past projects.

Step 3: Common Practice.
The project shall not be common practice, determined as follows:

1. The project type must not be common practice in the respective sector/region, compared with projects that have not received carbon finance.
2. Where it is common practice, the project proponent shall identify barriers faced compared with existing projects.
3. Demonstrating that the project is not common practice shall be based on guidance from the Greenhouse Gas Protocol (GHG Protocol), jointly operated by the World Resources Institute and the World Business Council for Sustainable Development, in 'The GHG Protocol for Project Accounting', chapter 7.

Projects that pass all three steps (i.e. regulatory surplus, implementation barrier and common practice) are additional.

2.3.3 Additionality through positive lists

For a select set of nascent CDR technologies and applications and for product mineralisation solutions, the CCS+ Initiative is expected to develop an alternative approach to demonstrating additionality for projects using such technologies. The exact approach remains to be determined, taking into account the novelty of the technologies and challenges with substantiating and validating the establishment of a maximum activity penetration for BECCS and direct air capture and storage (DACS) projects.[25] Depending on the eventual approach, a project in a given sector and country could be be deemed automatically additional if:

1. The adoption of the technology[26] used in the project or the application of the technology in a project does not exceed a percentage-based adoption threshold defined by Verra[27] (for example less than 5-10 % or a level to be deemed appropriate by Verra); and
2. The public funding that is available is insufficient to make a project type commercially viable[28] in a given sector, in a given country; or that the level of the public funding provided is conditioned by the level of the revenue that such projects are able to generate in the market through for example the sale of carbon credits (to avoid overfunding); or
3. There is no public funding, then projects will see no revenue (other than the carbon revenue they might receive from credits) and cannot be implemented. Therefore, all projects implemented below the adoption threshold in countries where there is no public funding support are deemed to be additional without need for any further assessment.

The VCS shall need to assess, based on the above, whether a given technology or application may be deemed to be additional. It is expected to develop ways to demonstrate additionality for projects once the adoption threshold is reached to safeguard market stability.

Approach

The intended approach to demonstrate additionality is a stepwise one:

- **Step 1**: Demonstrate regulatory surplus
- **Step 2a**: Positive list demonstration of additionality
- **Step 2b**: Investment analysis (for project activities that are not covered by a positive list)

Steps 1 and 2b are described in the methodology framework. The intention is to offer an alternative to investment analysis through Step 2a, which will demonstrate additionality based on a positive list for projects that reduce or remove CO_2 emissions with carbon removal technologies.

Under the intended approach, the VCS shall develop the positive lists of CDR technologies and their applications based on the technical work performed by members of the CCS+ Initiative and/ or other parties.

Technologies and their applications in such positive lists shall be deemed additional without the need for any further assessment. Such lists shall be developed per country and per sector (where appropriate) for projects that provide long-term storage for CO_2 that is captured directly from the atmosphere or from biogenic sources.

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[25] Dedicated questions are included in the public consultation of the CCS+ Initiative's first methodologies under Verra, available here.

[26] For example, capture equipment that uses different types of amine are not considered a different technology type

[27] Low market adoption is considered an indication that the CDR technology or its applications faces barriers that prevent it from being widely adopted. Such barriers may exist at the national, subnational and/or sectoral levels, i.e. in certain sectors of the economy.

[28] The forthcoming work shall establish a definition of 'commercially viable', differentiating this from reaching the break-even point and making windfall profits. This definition will acknowledge the need for projects to generate an operating profit allowing for investment in the next project and for research and innovation while taking into account the long-term investment risks associated with such projects.

2.3.4 Baseline

The CCS+ framework methodology utilises project methods to determine the crediting baseline scenario. The following baseline scenarios are considered:

- Baseline scenario for greenfield capture facilities: the absence of CO_2 capture from the source facilities or the absence of CO_2 capture from the atmosphere, as applicable. The CO_2 captured and stored under the project activity in the baseline scenario is the refore either emitted or not captured from the atmosphere.
- Baseline scenario for capacity addition project activities: Any CO_2 captured at a capture facility existing before the project activity must be treated as non-VCS CO_2.
- Baseline scenario for continuation project activities: the discontinuation of the capture activity has to be proven based on the application of methodology Step 3 (investment analysis) from the last version of 'CDM Tool 2: Combined tool to identify the baseline scenario and demonstrate additionality'.

The baseline emissions are determined by the amount of CO_2 injected at storage sites. In some cases, the project emissions will be co-captured, transported and stored. As a result, the measured baseline emissions are higher than the real baseline emissions from the source facilities/atmosphere. Nevertheless, this co-captured part of emissions will be deducted from the baseline emissions, resulting in correct net emission reductions or removals.

2.3.5 Monitoring reporting and verification (MRV)

In general, CCS+ project activities shall comply with the MRV requirements set out in the latest Verra 'Geologic Carbon Storage (GCS) Requirements' for CCS monitoring programmes. Additional MRV requirements described in the respective modules.

The storage modules state that monitoring plans must support the permanent storage of CO_2 injected by ensuring containment of the plume over time. This includes surface, near-surface and subsurface equipment for continuous monitoring and defined monitoring campaigns. To ensure the implementation of the rules, additional requirements for monitoring plans at storage sites are provided to address the issues of loss of CO_2 containment and conformance. This includes requiring project proponents to describe techniques, define the detection threshold and determine the expected mean time to detect a loss of containment, among other parameters.

The project proponent must establish, maintain and apply a monitoring plan and GHG information system that includes criteria and procedures for obtaining, recording, compiling and analysing data, parameters and other information for quantifying and reporting GHG emissions relevant to the project and baseline scenarios. The monitoring system must detect connections between the reservoir and surface and determine their significance. Monitoring procedures must address the following:

- Types of data and information to be reported
- Units of measurement
- Origin of the data
- Monitoring methodologies
- Type of equipment used
- Monitoring times and frequencies

[29] The EU is considered a 'country' in the context of this document.

- Quality assurance/quality control (QA/QC) procedures
- Monitoring roles and responsibilities
- GHG information management systems

All data collected as part of monitoring must be archived electronically and kept for at least two years after the end of the last project crediting period (CP). If a loss of containment occurs, the procedures outlined in the VCS Program 'Registration and Issuance Process' document and the Geologic Carbon Storage Non-Permanence Risk Tool shall apply. All monitoring provisions related to GCS must be fulfilled as per the latest version of the VCS Standard and the Geologic Carbon Storage Non-Permanence Risk Tool. Additional criteria and procedures for monitoring the project may be established in the respective capture, transport and storage modules and related VCS and CDM tools.

2.3.6 Embodied carbon

The CCS+ Initiative is accounting for embodied emissions (e.g. chemical consumables) as these could be material for some project types. Proposals for the materiality threshold and method to estimate embodied carbon have been defined for CCS projects. Currently, emissions associated with construction (e.g. capture) are not included within the project boundary.[30]

The CCS methodology framework uses a materiality threshold of 2% to decide which emissions should be excluded. It includes one-time and upstream/downstream effects for embodied carbon. One-time effects are changes in GHG emissions associated with the construction, installation and establishment or decommissioning and termination of the project activity in the capture facility, excluding the transport and storage of embodied emissions from construction < 2%. Upstream and downstream effects are recurring changes in GHG emissions associated with energy and material inputs. It is requested that embodied emissions from construction allocated over a lifetime instead of the first CP be fully compensated for before project closure.

2.3.7 Verified Carbon Standard and non-Verified Carbon Standard carbon dioxide flows

CO_2 captured under the project activity may leave the project boundary and be used for other purposes. However, CO_2 leaving the boundary (i.e. non-VCS CO_2) must be quantified and excluded from the project's emission reductions or removals.

The project activity may share the transport or storage facilities with CO_2 streams not credited as part of a VCS project. In that case, the project must employ appropriate measures to monitor, quantify and differentiate between the CO_2 from VCS and non-VCS project activities as per the latest version of the 'Tool for Baseline Quantification and Allocation of Project Emissions in Projects with VCS and non-VCS-CO_2 flows in Carbon Capture and Storage Projects'. Moreover, any CO_2 captured at a capture facility existing before the project activity must be treated as non-VCS CO_2.

2.3.8 Reductions vs removals

The differentiation between emission reductions and removals as a mitigation outcome from a project is vitally important from a carbon accounting perspective. The CO_2 molecule's origin when it is captured, along with the durability of the storage, determines the type of contribution a project makes to climate mitigation and the attribution to that action in a given carbon market.

[30] A prospective VCS Program update regarding the allocation of one-time emissions may lead to a revision of the materiality threshold to 1% and include construction emissions from capture.

The CCS+ methodology differentiates between emission reductions and removals. A tool known as a reduction/ removal tool differentiates the baseline for emission reductions and removals and allocates the project emissions and leakages between them. The draft tool, which is currently under review, includes the following options to differentiate GHG emission reductions and removals in a project which includes both components:

- **Options 1**: Accounting all project emissions towards claimed removals: this method aims to look at the net change in the atmospheric content of CO_2. Accordingly, project emissions are to be deducted from the removals achieved under the project.
- **Option 2**: Differentiation method: this method can be used when project emissions can be categorically differentiated based on the physical location and measurement of emissions. This means that separate equipment is used for reduction and removal streams for capture, conditioning or transport with separate metering of energy consumption. Differentiated project emissions are then deducted from the respective baseline emissions, i.e. project emissions from emission reduction activities are deducted from baseline emissions that qualify as emission reductions and project emissions from removal activities are deducted from baseline emissions that qualify as removals.
- **Option 3**: Pro rata allocation: this method allocates project emissions to emission reductions and removals on a pro rata basis to baseline emissions eligible to be accounted as emission reductions or removals. This method is feasible when it can be demonstrated that the pro rata allocation of project emissions is not resulting in an underestimation of project emissions related to removal activity, e.g. if the combined CO_2 flows go through the same conditioning processes and travel identical distances inside the project boundary.

2.3.9 Permanence and crediting period

The current methodology, especially the applicability conditions, is written to reflect the long-term storage target of CCS+ project activities and the time for which emission reductions or removals generated by the project are eligible for issuance as Verified Carbon Units. The VCS Standard sets out the rules concerning the length of the CP and renewal of the project CP.

The CP is addressed in the latest VCS standard, which has undergone public consultation: "For CCS projects, the project crediting period shall be at most seven years and may be renewed at most five times, with a total project crediting period not to exceed 35 years." Permanence and risks in CCS+ projects are managed through regulatory approaches (e.g. the VCS Standard) by setting minimum criteria for project and proponent eligibility and setting operational and closure requirements.

2.3.10 Risk assessment

Risk of GHG reversals refers to the reversal/leakage of stored CO2 into the atmosphere. Reversals can be attributed to many factors, including natural risks (e.g. earthquakes and floods) or technical issues around proper storage site selection, monitoring and injection processes. In the case of CCS+ projects, GHG reversal refers to the leakage of CO2 into the atmosphere after the injection period.

Under Verra's VCS Program, reversal risks are managed through a buffer pool into which a share of non-tradable emission credits is deposited and set aside for the project's duration. In the event of GHG reversals, Verra will cancel an appropriate number of these credits from the buffer pool to nullify the effect of GHG reversals.

2.3.11 Broader sustainability requirements

Most crediting programmes apply the 'do no significant harm' principle, but their requirements and approach regarding environmental and social safeguarding differ. The CCS+ Initiative follows the VCS Standard v4.2 (2022), which establishes that the project proponent shall demonstrate how the project activities contribute to sustainable development and at least three Sustainable Development Goals (SDGs) by the end of the first monitoring period and in each subsequent monitoring period.

SDGs that could be meaningfully addressed in CCS+ and CCUS+ projects include SDGs 7, 8, 9, 12, 13 and 17:

- **SDG 7/Affordable and clean energy**: if CCU projects use CO_2 that is captured from the atmosphere or from a biogenic emission source to produce synthetic fuels, they may replace fossil sources.
- **SDG 8/Decent work and economic growth**: generally, CCS+ and CCUS+ projects require high skill and precision to be developed and implemented. Such projects would enable skill development and provide individuals with stable direct jobs in the formal sector.
- **SDG 9/Industry Innovation and Infrastructure**: CCS+ and CCUS+ projects would enable industries and facilities to become more sustainable by upgrading or retrofitting their infrastructure (e.g. adding a capture facility to a cement plant to avoid the release of GHGs into the atmosphere). Furthermore, using the potential of carbon markets, CCS+ projects can encourage scientific research, technological improvements and the innovation of novel technologies and processes (e.g., DAC technology) to reduce GHG emissions or increase GHG removals.
- **SDG 12/Sustainable Consumption and Production**: CCU involves some steps that require waste reduction, reuse and recycling where capture technologies provide CO_2 which would otherwise be directly emitted as a feedstock and reuse that CO_2 in different applications.
- **SDG 17/Partnership for Goals**: CCS+ and CCUS+ projects often would be cross-country, i.e., capture sites and storage sites are in different countries. Such a relationship would enhance cooperation between state and non-state actors across various regions.

Environmental integrity is critical to ensuring effectiveness in mitigating climate change, the main goal of industrial carbon management, while minimising trade-offs with other sustainability issues. The technical considerations of MRV, embodied carbon and risk assessment help ensure effectiveness in mitigating climate change. They help monitor and verify emission reductions or removals, account for upfront embodied carbon (where relevant) and offer provisions which compensate for possible reversals. Broader sustainability considerations, such as the do no significant harm' principle and the requirement for projects to demonstrate their contributions to the SDGs, aim to avoid having the burden shift to sustainability issues beyond climate change.

Such technical considerations are crucial for all CCS, CCU and CDR projects as the methodologies must help ensure that the captured CO_2 remains isolated from the atmosphere for the expected duration, and that the capture, transport and storage activities do not threaten human health or natural ecosystems. For BECCS in particular, project developers must ensure that the biomass is sustainably sourced, e.g. they must ensure the use of sustainable, biogenic CO_2 sources, avoiding substantial upfront emissions and biodiversity impacts from direct and indirect land-use change.

3 Leveraging the CCS+ carbon accounting infrastructure

The CCS+ Initiative presents a blueprint for an integrated carbon accounting infrastructure covering industrial carbon management project value chains to quantify emission reductions and removals through CCUS in an industrial carbon management market. Such an integrated infrastructure is a crucial missing piece to spurring the responsible and timely adoption of such projects as required by the EU climate and industrial strategies. This section introduces the coverage of the CCS+ Initiative's carbon accounting infrastructure in comparison to EU regulations and policy instruments andexplores opportunities for implementing the CCS+ Initiative methodology framework in the EU.

Considering the EU's interest in advancing methodologies to quantify and certify carbon removals, this guide presents an overview of CCS+ work insofar as it addresses the main guidelines of the CRCF (Table 1). More broadly, Table 2 shows how diverse CCS+ modules and EU regulations and policy instruments tackle key aspects for the quantification and certification of emission reductions and removals. Rather than relying on a completely new set of regulations, the CCS+ Initiative methodology framework can build on several existing policy and regulation instruments in the EU. This section explores those synergies which can facilitate establishing a robust methodology framework (Table 4). Given the current dynamic regulatory environment around industrial carbon management, especially for removals, The assessment considers EU-level instruments, both established and upcoming, which can significantly influence the quantification and certification of emission reductions and removals through industrial carbon management.

CRCF's main guidelines	CCS+ coverage	CCS+ coverage details
QU.A.L.ITY criteria		
Quantification: Carbon removal activities must be measured accurately and deliver unambiguous benefits for the climate.	COVERED	CCS+ provides a full suite of methodologies to quantify emissions reduction and removal, including robust MRV requirements.
Additionality: Carbon removal activities must go beyond existing practices and what is required by law.	COVERED	Two approaches considered to evaluate additionality: investment analysis (considering regulatory surplus, implementation barriers, and common practice) and positive lists (mainly for DACS and BECCSprojects).
Long-term storage: Certificates are linked to the duration of carbon storage to ensure permanent storage. Monitor and mitigate any risk of release of the stored carbon occurring during the monitoring period; remain subject to appropriate liability mechanisms.	COVERED	DACCS and BECCS monitoring plans must support the permanent storage of CO2 by ensuring containment of the plume over time through surface, near surface, and subsurface continuous monitoring, and monitoring campaigns. Permanence and risks are managed through regulatory approaches (VCS standard) by setting minimum eligibility criteria and setting operational and closure requirements.
Sustainability: Carbon removal activities must preserve or contribute to sustainability objectives.	COVERED	The CCS+ Initiative follows the VCS Standard v. 4.2, 2022. Projects shall contribute.
Other CRCF guidelines		
A carbon removal activity shall provide a net carbon removal benefit, considering a baseline and a potential increase in direct and indirect greenhouse gas emissions from the implementation of the carbon removal activity. A standardised baseline should reflect the statutory and market conditions and simplify the demonstration of additionality	COVERED	Similar approach with a nuanced definition of the baseline and the project emissions. Three possible baseline scenarios: greenfield, capacity addition, and continuation of project. The project boundary consists of the capture facility, transport facility, and storage site, considering the mass, energy, and GHG emissions associated with process emissions and energy and material inputs, and unintended secondary project emissions, with a materiality threshold of 1%.
Uncertainties in the quantification should be duly reported and accounted to limit the risk of overestimation. liability mechanisms should be introduced to address cases of reversal (e.g., discounting of carbon removal units, collective buffers or accounts of carbon removal units.	COVERED	Reversal risks are managed through a buffer pool into which a share of non-tradable emission credits is deposited, which are set aside for the project's duration. In the event of GHG reversals, Verra will cancel an appropriate number of these credits from the buffer pool to nullify the effect of GHG reversals. Verra's Geological Storage Non-Permanence Risk Tool (under development) establishes requirements for post injection monitoring.
Build on existing climate change legislation, such as the CCS Directive, Renewable Energy Directive, MRR, ETS, and Innovation Fund.	POSSIBLE	The CCS+ Initiative's integrated carbon accounting infrastructure aims to support the safe adoption of CCS-based technologies (including CDR), which is aligned with EU climate policies. Particular CCS+ modules and tools could be adapted to build on specific EU regulations, as required (examples of synergies in Section 3)
Monitor and mitigate any risk of release of the stored carbon occurring during the monitoring period; remain subject to appropriate liability mechanisms	COVERED	Permanence and risks are managed through regulatory approaches (VCS standard) by setting minimum criteria for project and proponent eligibility and setting operational and closure requirements.
Carbon removal activities should be subject to independent third-party auditing. The certificate should contain accurate and transparent information on the carbon removal activity	COVERED	The quantification of emissions removal is subject to independent third-party auditing. Robust MRV

CCS+ initiative

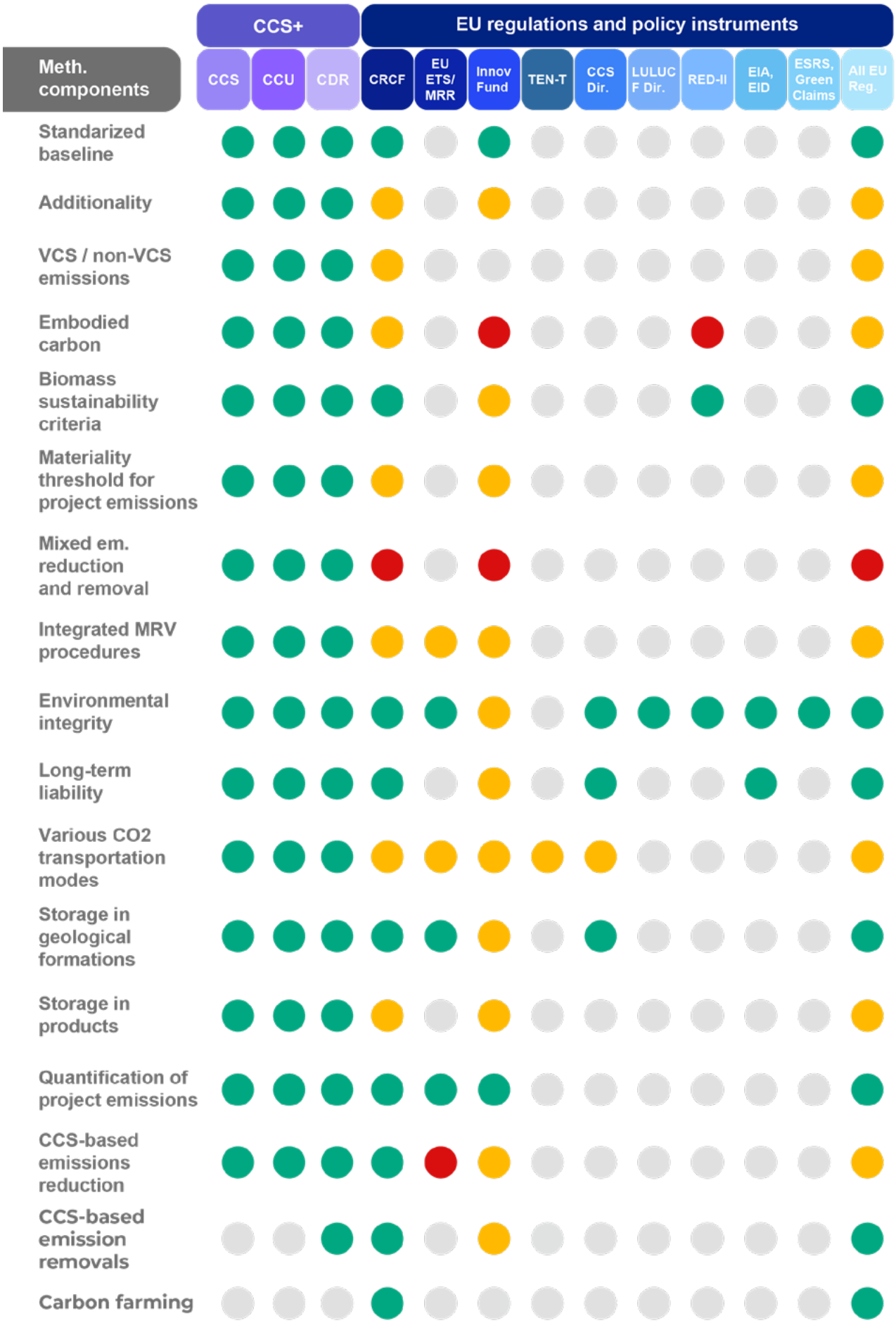

Table 3 provides an overview of the main EU instruments tackling the quantification of emission reductions and removals, and other crucial aspects, from industrial carbon management to ensure environmental integrity. While they have limited scope to quantify emission reductions and removals, various EU instruments already provide valuable features for ensuring high-quality standards for certifying such activities. Hence, they already provide a foundation to satisfy some of the requirements of the CCS+ Initiative methodology framework.

Table 3: Overview of main aspects covered in CCS-related EU regulations and policy instruments

Quantification and certification aspects covered to some extent or largely not covered y EU instruments	Capture 	Transport 	Storage 
CCUS	From point sources and the atmosphererail/train,	Via pipeline, ship, road/truck oil reservoir, products	Saline aquifer, value chain
Main EU instruments	MRR in the EU ETS, RED, Innovation Fund's quantification of GHG emission avoidance	TEN-E Regulation, CCS Directive, MRR in the EU ETS	CCS Directive, EID, EIA
Other EU instruments	Carbon Removal Certification Framework (certification of removals), Corporate Sustainability Reporting Directive (reporting), Green Claims Initiative (reporting and claims), Renewable Energy Directive (relevant for biomass)		
Main coverage	• Quantification of emissions, including leakages (MRR ETS) • Regulations to ensure environmental integrity of storage sites (CCS Directive, EIA, EID...) • Regulations for storage site closure and long-term liability for CO2 stored • Reporting and sustainability claims • Infrastructure support to some extent		
Aspects excluded	• No quantification of emissions reduction or removal (only emissions). • Baseline only partly tackled (only the Innovation Fund tackles avoidance) • Additionality is not covered • Lack of integral MRV processes • Lack of a modular approach to consider numerous system configurations • Unsuitable to combine emissions reduction and removal • Key transportation modes are not properly incentivised • CO_2 impurities in the transport modes are not covered		

3.1 Relevant European Union regulations and policy instruments to certify industrial carbon management activities

3.1.1 From measuring emissions to measuring emissions reduction and removal

Current EU regulations and policy instruments, such as the MRR, quantify the emissions of industrial carbon management projects. Other instruments and standards, such as the CCS Directive, the EIA Directive and the Environmental Liability Directive, provide solid safeguards for the sustainable planning, operation and closure of CCUS projects. However, EU instruments do not yet provide a comprehensive framework for quantifying emission reductions or removals from CCUS activities. Hence, these mechanisms are currently unsuitable for certifying emission reductions and removals through industrial carbon management.

The Innovation Fund has a methodology for GHG emission avoidance calculation (current version 3.0, 1 November 2022). However, its use is limited to the application for an Innovation Fund grant and reporting performance for verification and knowledge sharing. Although it considers several use cases for industrial carbon management, including removals, it lacks clear procedures through which to assess additionality, risks, embodied carbon and the attribution of emission reductions and removals for projects involving both. Incorporating additionality and the joint assessment of emission reductions and removals could help maximise the impact of EU investments within the Innovation Fund.

3.2 Synergies and opportunities for building on existing instruments

The CCS+ carbon accounting infrastructure can build on the various existing regulations and policies to ensure the responsible adoption of industrial carbon management technologies: ensuring high environmental integrity, establishing long-term liability for stored CO2 and responsibly incentivising carbon removals, among other concerns (Table 4).

Table 4: Synergies between the CCS+ carbon accounting infrastructure and EU regulations and policy instruments: strong and moderate synergy or currently not possible.

Meth. quality	CCS+ Initiative	EU regulations and policy instruments	Synergy EU / CCS+
Quantifying and certifying emissions removal through CDR	Two dedicated capture methodology modules for CDR, 1) DACS and 2) BECCS, which can be combined with three storage modules, 1) Saline aquifers, 2) Depleted oil/gas fields, 3) Mineralization in basaltic rock; and 4) durable carbon storage in products	The CRCF proposal sets out rules for independently verifying carbon removals and recognising certification schemes. The EU Commission, supported by an expert group, will develop certification methodologies for carbon removal activities, such as DACS and BECCS	CCS+ provides a blueprint to inform the development of EU methodologies (e.g., under the CRCF)
Quantifying and certifying emissions reduction though CCS	Four dedicated capture methodology modules for CCS, 1) Power & heat, 2) Industrial processes, 3) O&G, and Precombustion/ Oxyfuel, which can be combined with three storage modules, 1) Saline aquifers, 2) Depleted oil/gas fields, and 3) Mineralization in basaltic rock	Current EU regulations such as the ETS and the CCS Directive focus on the quantification of emissions, not emissions reductions. The Innovation Fund's quantification of GHG emission avoidance measures reductions but its application is limited to evaluate and monitor projects, not for the certification of emissions reduction throughout projects' lifecycle	CCS+ provides a blueprint to inform the development of EU methodologies to certify emissions reduction. However, current interest for certification is limited to removals
Quantifying and certifying emissions reduction or removal though CCUS	Four dedicated CCU methodology modules for durable carbon storage in products: 1) Aggregates, 2) Cement and mixtures, 3) Concrete, and 4) Ceramics, which can be combined with any of the CCS or CDR capture modules	The CRCF proposal and planned certification methodologies for carbon removal activities consider also storage in products	CCS+ provides a blueprint to inform the development of EU methodologies to certify emissions reduction and removal (removal is of immediate interest for the CRCF
Quantifying leakages	Full suite of methodologies to quantify emissions reduction and removal, including robust MRV requirements, which includes continuous surface, near-surface, and subsurface monitoring.	The CCS Directive and the EU ETS Directive, already establish sound frameworks for environmental integrity and quantification of leakages	CCS+ and EU regulations can align to facilitate compliance and increase consistency
Ensuring environmental integrity	Comprehensive sustainability considerations: embodied emissions, risk assessment, and contribution to sustainable development. The CCS+ Initiative follows the VCS Standard v. 4.2, 2022. Projects shall contribute to sustainable development and at least to three SDGs	Regulations such as the the Environmental Impact Assessment Directive, Industrial Emissions Directive, Environmental Liability Directive, Water Framework Directive, and the Waste Framework Directive cover wide environmental implications. Besides, the CRCF aims to preserve or contribute to broader sustainability objectives	CCS+ provides a high standard which can complement EU regulations in some aspects
Establishing long-term liability	Regulatory approaches (VCS standard) setting eligibility criteria and setting operational and closure requirements. CCS+ MRV infrastructure can help improve traceability of volumes, localisations, and liabilities of CO2 stored.	The CCS Directive establishes a legal framework for storing CO2 in geological formations, including a long-term transfer of responsibility from the site operator to the regulatory authority.	EU regulations already provide a robust liability framework. CCS+ MRV could help improve traceability of liabilities for the CO2 stored and cross-border transportation

Meth. quality	CCS+ Initiative	EU regulations and policy instruments	Synergy EU / CCS+
Reporting sustainability claims	CCS+ can quantify and certify emissions reduction and removal, considering the implementation of integrated MRV processes	The Corporate Sustainability Reporting Directive introduces sustainability reporting standards. And the Green Claims Initiative aims to empower consumers to more compare products' environmental performance	CCS+ can facilitate the disclosure and harmonisation of emissions reduction and removals
Ensuring net emissions removals	Quantifies all material emissions from DACS and BECCS (materiality threshold of 1%) from land, materials, and energy use.	The CRCF aims to ensure that projects provide a net carbon removal benefit, considering projects' direct and indirect emissions. The Renewable Energy Directive sets sustainability criteria for biomass. It also supports the LULUCF regulation and the Biodiversity Strategy for 2030.	CCS+ can support the quantification of emissions reduction and removal for DACS and BECCS projects (under regulations like LULUCF and RED-II) to ensure net removals.
Including main transport modalities	CCS+ establishes criteria and procedures for CO2 transportation via various media, namely via pipeline, ships/barges, road/trucks, and rail, considering also the integration of multiple transport modes in a single project.	The system for accounting emissions via transportation modes other than pipelines may not be ready yet, e.g., under the ETS, which may compromise the integrity of the emissions accounting system.	CCS+ transportation modules can inform the development of transportation modules for the certification of emissions removal (planned). They can also support harmonisation with the accounting of emissions, e.g., for industrial carbon management projects under the EU ETS
Integrating MRV processes	The CCS+ Initiative defines consistent monitoring procedures throughout its carbon accounting infrastructure: among capture, transport and storage modules and also among the CCS+ Initiative tools.	The Monitoring and Reporting Regulation (MRR) already establishes monitoring requirements for CCS activities, its scope is limited to quantifying emissions.	CCS+ can provide a blueprint to broaden the scope of current MRV instruments EU and harmonise their use along industrial carbon management value chains.
Standardised transfer of data for EU inventories	CCS+ does not currently facilitate the standardised transfer of data for EU level inventories (e.g., for NDC inventories).	There is currently no such inventory data at the EU level for CCS-related activities, only for some conventional land-based removals.	CCS+ could be adapted to facilitate the standardised transfer of data for EU inventories.
Combining emissions reduction and removal	CCS+ created a tool for quantifying and differentiating between emissions reduction and removal. Hence, it can quantify emissions reductions and removals of power and/or heat CCS installations using fossil or biogenic fuels. Likewise, it can estimate emissions removal through DACS and emissions reduction from other installations if a system integrates both types of CCS activities.	Current EU instruments do not enable the combined quantification of emissions reduction and removal. Since no certification proposals are under development for emissions reduction, integrating the certification of emissions reduction and removals seems unlikely	The joint quantification of em. reduction and removal can help maximise projects' mitigation potential. CCS+ tools can help leverage such synergies, e.g., if implemented under the InnovFund, which already considers reductions / removals.

3.2.1 Quantifying and certifying emission removals through carbon dioxide removal

The CCS+ Initiative separately accounts for emission reductions and removals with two dedicated capture modules the DACS module, covering the quantification of captured atmospheric CO_2 through DACS, and the BECCS module, focusing on the quantification of CO_2 captured from flue gases where the carbon originates from renewable biomass, e.g. BECCS, or other exhaust or off gases of biogenic origin, e.g. CO_2 from anaerobic digestion or fermentation processes. In the current methodology structure, the DACS and BECCS modules will initially be adopted under the conventional CCS methodology framework while ensuring the adequate accounting of climate benefits as reductions or removals.

For the DACS module, the baseline scenario for all activities eligible under this module (i.e. greenfield and brownfield expansion) is no capture of CO_2. Project proponents have to demonstrate that either no capture facility was existing prior to the project activity, or that new capture facilities are installed under the project activity. Shared use of auxiliary facilities or equipment (e.g. utilities) by the existing and new facilities is allowed.

The module details quantification procedures. The quantification approach includes the quantification of:

- Project emissions from fuel combustion in on-site stationary equipment; and embodied emissions from stationary fuel consumption, project emissions (i.e. fugitive and venting) from on-si-te fuel use, electricity consumption and heat related to cogeneration; project emissions from the consumption of capture materials, such as potassium hydroxide, amine supported on cellulose, metal organic frameworks and membranes; and embodied project emissions from DAC module construction over the design lifetime of the DAC facility.
- For the BECCS modules, key technical considerations include sustainability criteria for biomass, such as land use and biodiversity, forest management, soil health, water conservation, food security, social sustainability, chain of custody and traceability, along with the baseline scenario for all activities eligible under this module, including greenfield and brownfield expansion and continuation. As the baseline assumes no capture of CO2, project proponents must validate either that no capture facility existed before the project activity or that new capture facilities have been installed under the project. The methodologies allow the shared use of auxiliary facilities or equipment, such as utilities, by both the existing and new facilities. Another crucial methodological element is the tool for differentiating between emission reductions and removals that allows for the separate accounting of emission reductions and removals in a single project activity with mixed CO_2 streams (e.g. CO_2 with a fossil origin vs an atmospheric origin), such as in waste-to-energy plants.

3.2.2 Quantifying and certifying emission reductions or removals though carbon capture and storage

In addition to modules focused on DACS and BECCS projects, the CCS modules target conventional CCS projects, mainly point-source fossil emissions, for a range of sectors, technologies and value chains. The modular framework considers:

- **Three sector modules**: Power and heat, industrial processes and oil and gas production and processing.
- **Two technology modules**: pre-combustion and oxy-fuel).
- **Three storage modules**: saline aquifers, depleted oil and gas fields and geologic storage via mineralisation in igneous rock formations.

The modules can be seamlessly integrated in a plug-and-play fashion and can also be used in conjunction with the CCS+ tools, namely the tool for the differentiation between emission reductions and removals and the tool that discerns between CO_2 captured from a carbon crediting project and CO_2 originating from other sources in shared infrastructure. Together, the CCS modules and tools ensure accurate and nuanced accounting, reflecting the complexity and diversity of CCS project activities.

3.2.3 Quantifying and certifying emission reductions or removals through carbon capture utilisation and storage

The CCUS framework methodology enables net CO_2 emission reductions and/or removals that result from the production of CO_2-derived products to be quantified. The methodology includes the utilisation and durable storage of CO_2 in useful products, such as building materials (e.g. cement and concrete), aggregates and other products, where it is possible to demonstrate the permanence or long-term storage of CO_2.

The methodology is not applicable to short-term CCU products or applications, such as oxy-fuel combustion processes or the production of chemicals and polymers (e.g. plastic), where it is not possible to demonstrate the permanence or long-term storage of CO_2.

The same modular approach will be applied: three utilisation modules (i.e. aggregates, concrete and ceramics) will be developed together with the CCUS+ framework methodology and will share the transport and capture modules developed in the previous work package concerning CCS.

Key technical considerations include:

Baseline emissions: how an intermediate or end product that is produced using the CCUS process would have been manufactured, used and managed at the end-of-life stage and what would have been the fate of the CO_2 used to manufacture it.

- **Project emissions**: emissions associated with fossil fuel, energy and utilities consumption; CO_2 emissions associated with the consumption of materials and chemicals; project emissions associated with the transportation of raw materials and waste; and leakage emissions.
- **Leakage emissions**: the utilisation of certain wastes to obtain CO_2-derived intermediate or final materials may prevent others from using them, thereby resulting in more CO_2 being emitted elsewhere.
- **Demonstration of additionality**: the activity penetration method is proposed for demons trating additionality.
- **CCUS-specific MRV requirements**: monitor the amount of CO_2 fed in for processing, minus that which leaves; laboratory analysis or modelling of the CO_2 stored in a given year.

3.2.4 Ensuring environmental integrity and quantifying leakages

The CCS+ Initiative methodology framework does not replace robust EU regulations on environmental integrity. Projects within the CCS+ Initiative methodology framework would still have to comply with those regulations when implemented in the EU, as they would with comparable regulations in other jurisdictions. Furthermore, the CCS+ Initiative framework considers various additional aspects related to environmental integrity, such as embodied emissions, risk assessment and broader sustainability considerations. Such additional considerations provide a stricter and more comprehensive sustainability standard.

Two main regulations, the CCS Directive and the EU ETS Directive, already establish sound frameworks for environmental integrity and the quantification of leakages. The CCS Directive establishes a legal framework for the environmentally safe geologic storage of CO2. CCS facilities operating under the EU ETS Directive are subject to the CCS Directive and must surrender allowances if CO_2 leakages occur. Furthermore, CO2 storage facilities under the CCS Directive must conduct an EIA.

The EIA Directive lays out the procedures for the EIA of various industrial and infrastructural activities, including CO_2 capture and transport. It defines the EIA requirements for specific installations listed in the EIA Directive

Annex I or installations with a capture of at least 1.5 million tonnes per annum of CO_2. Annex I also covers CO_2 transport pipelines for geologic storage with a diameter of more than 800 millimetres and a length of more than 40 kilometres. For other installations, member states define the EIA requirements.

The IED or Directive 2010/75/EU aims to minimise emissions from energy and industrial installations. It applies best available techniques and energy efficiency and waste management measures. It requires new combustion power plants of > 300 megawatt output to be built 'CCS-ready' regarding access to CO_2 transport and suitable storage sites, while existing sites must be retrofitted for CO_2 capture with technical and economic feasibility in mind. Nevertheless, such a requirement has not led to any CCS deployment.

The Environmental Liability Directive (2004/35/CE) specifies rules based on the 'polluter pays' principle. It covers environmental damage from CO_2 storage sites, excluding climate damage from CO_2 leakages. The EU ETS Directive covers leakages as an emission activity, which results in surrendering emission allowances.

The Water Framework Directive (2000/60/EC) prohibits discharging pollutants into groundwater. Nonetheless, it allows projects under the CCS Directive to inject CO_2 "into geological formations which for natural reasons are permanently unsuitable for other purposes."

Finally, two regulations covering waste, namely the regulation on shipments of waste (Regulation [EC] No 1013/2006) and the Waste Framework Directive (Directive 2008/98/EC), exclude CO_2 from their scope as the CCS Directive already covers the transportation and permanent storage of CO_2.

3.2.5 Establishing long-term liability for stored carbon dioxide

The CCS+ Initiative methodology framework can provide clear traceability for volumes, localisations and liabilities of stored CO2 thanks to its integrated MRV procedures. In the case of cross-border projects in particular (i.e. capturing CO2 in country A and storing it in country B), it is important to identify which country the captured CO_2 is coming from and within which national boundaries it is being stored for the purposes of national inventory services, accounting and liabilities.

The liability requirements of the CCS+ methodology framework could be adapted to align with the requirements of the 2009 CCS Directive and leverage the directive's liability transfer mechanism. The 2009 CCS Directive establishes a legal framework for storing CO_2 in geologic formations, outlining a regulatory framework to explore and select storage sites and clear criteria for obtaining CO_2 storage permits.

Its goal is to safely contain the stored CO_2, preventing negative impacts on human health and the environment. The directive imposes strict operational, closure and post-closure obligations, such as monitoring and reporting, and insists that irregularities or leakages be resolved immediately.

Remarkably, the directive establishes a long-term transfer of responsibility from the site operator to the regulatory authority. Given the long-term responsibility that the geologic storage of CO_2 implies (i.e. storage over a timescale of centuries), such a transfer mechanism provides a valuable incentive for project proponents to undertake industrial carbon management projects with geological storage.

This way, project developers assume diligent responsibility for a feasible period of a couple of decades instead of centuries, which would likely exceed the viability of private organisations and would entail insurance requirements that may render projects commercially unviable. Furthermore, it also encourages the implementation of robust measures during the first years of project implementation to ensure that the CO_2 will be entirely and permanently contained, though these become less strict during the last years of corporate liability.

3.2.6 Reporting and sustainability claims

The CCS+ Initiative methodology framework can support the disclosure of emission reductions and removals through industrial carbon management. The framework would ensure that the certified emission reductions and removals comply with high-quality, high integrity standards. If such a framework is adopted at EU level, it can provide a sound, harmonised standard to facilitate compliance with the new CSRD. This Directive introduces detailed EU sustainability reporting standards (ESRS). Among other aspects, the ESRS will specify the information about emission reduction and removal measures that companies must disclose. A sound, harmonised certification standard would also increase transparency and facilitate comparisons among diverse industrial carbon management activities which companies may undertake. Hence, it could support the proposed Green Claims Initiative aimed at empowering consumers to more reliably compare products' environmental performance (e.g. emission mitigation).

3.2.7 Ensuring net emissions removal

All projects' substantial emissions (i.e. CCS+ considers a materiality threshold of 2%) must be quantified to ensure net emission removals through DACS and BECCS. For DACS, materials and energy use may significantly contribute to a project's emissions over its life cycle. For BECCS, biomass supply might cause substantial direct and indirect emissions due to land use change. Hence, the CCS+ Initiative is currently developing methodologies to quantify emissions upstream and downstream of the capture and storage processes, wherever applicable.

These methodologies, developed under CCS+, could support the coherent quantification of emissions, reductions and removals for BECCS projects regulated under RED II. Meanwhile, the EU has proposed the CRCF as a framework for the eventual development of methodologies for certifying CCS-based removals, but some EU instruments already tackle broad life cycle considerations, especially for BECCS, such as guidelines for sustainable biomass sourcing under RED II.

The RED II sets targets for renewable energy production and consumption and sustainability criteria for biomass. It also supports the LULUCF regulation and the Biodiversity Strategy for 2030.The EU's biodiversity strategy for 2030 aims to protect nature and reverse the degradation of ecosystems. Likewise, the EU aims to increase absorptions, reduce emissions and achieve net removals in the LULUCF sector in 2030 by considering the use of soils, trees, plants, biomass and timber. Policies that prevent direct and indirect emissions from land use will greatly facilitate the accounting of emissions from biomass use. The RED II and LULUCF goals thereby contribute to reducing the risk of indirect emissions from biomass sourcing from BECCS.

3.2.8 Including all transport modalities

The CCS+ Initiative methodology framework considers multiple transportation modes, namely via pipeline, ships/barges, road/trucks and rail. Therefore, the tools and methodologies already consider specific guidelines for certifying industrial carbon management activities using the diverse possible transportation modes. The initiative is developing a consolidated module for CO_2 transportation, i.e. one document that establishes criteria and procedures for CO_2 transportation via various media. The module also prescribes criteria and procedures when there are multiple transport modes in a single project. It establishes applicability conditions for all the transport modes, together with procedures to quantify project emissions associated with CO_2 transportation. This quantification can also be based on actual terms and, in some cases, provide conservative defaults.

The TEN-E Regulation establishes a platform to integrate an interoperable European infrastructure for transport, energy and telecommunication. Three priority areas established in a 2022 revision include smart electricity

grids, smart gas grids and cross-border CO_2 networks. Currently, it only recognises pipelines as PCIs for the EU emission reduction targets. PCIs benefit from accelerated permitting procedures and funding. The inclusion of new transportation methods has been proposed, but they are not yet eligible.[31] The timeline for the inclusion of other modes is unclear.

Pipelines and other transportation modes, such as via ships, are, in principle, viable alternatives for transporting CO_2 under the EU ETS. However, the system for accounting for emissions via transportation modes other than pipelines may not yet be ready. As a result, the integrity of the accounting system may become compromised when CO_2 is transported via ships or other modes.[32]

3.2.9 Integrating monitoring, reporting and verification processes

While the MRR already establishes monitoring requirements for CCS activities, its scope is limited to quantifying emissions. It helps track the emissions of installations subject to the EU ETS and quantifies the transferred CO_2 to capture installations, transport networks and storage sites. The CCS+ Initiative, on the other hand, defines consistent monitoring procedures throughout the methodology framework: among the capture, transport, utilisation and storage modules, and also among the tools. The consistent MRV processes of the CCS+ Initiative can provide a blueprint for broadening the scope of current MRV instruments in the EU and harmonising their use along the value chain of a given industrial carbon management project.

3.2.10 Combining emission reductions and removal

Current EU instruments do not enable the combined quantification of emission reductions and removals. A typical example is the combined use of fossil and biogenic sources in EU ETS installations. While installation operators do not have to surrender emission allowances for the CO_2 captured through CCS, they do not benefit from the CO_2 captured when they use biomass as a fuel, even if the biogenic emissions are captured and stored and could result in net emission removals. For this reason, removals from the use of biogenic fuels cannot be counted.

The CCS+ Initiative created a tool for quantifying and differentiating between emission reductions and removals. It establishes criteria for allocating GHG emission reductions and removals to projects that include multiple facilities for capturing CO_2 from different sources with different technologies, categorised as either emission reductions or removals. This way, it can quantify emission reductions and removals from power and/or heat at CCS installations using fossil or biogenic fuels. Likewise, it can estimate emission removals through DACS and emission reductions from other installations if a system integrates other types of CCS activities.

[31] Transport modalities, such as rail, truck, ships and barges, are needed to ensure equitable access directly to storage or to pipelines linked to storage. The revised TEN-E Regulation expanded the scope of PCIs to CO2 storage. Transport modalities other than by pipeline were left outside the scope. It was thought that it would be a better fit for the Trans-European Networks for Transport (TEN-T) Regulation, but this was not picked up in the subsequent TEN-T Regulation update.

[32] Viktor Weber (2021), 'Are we ready for the ship transport of CO2 for CCS? Crude solutions from international and European law', Reciel https://onlinelibrary.wiley.com/doi/full/10.1111/reel.12399

4 Outlook and recommendations for certifying carbon capture, utilisation and storage in the European Union

Despite progress in technology and policy, the deployment of industrial carbon management projects is currently not on track to meet climate targets, both globally and in the EU (see IEA and the Clean Air Task Force [CATF]).[33,34] Hence, substantially more efforts are needed to harness the dual mitigation potential being able to both reduce and remove emissions. The EU can help bridge the deployment gap in two ways: creating market incentives to drive long-term demand signals for industrial carbon management based emission removals, and broadening the market options for industrial carbon management based emission reductions. In both cases, an integral carbon accounting infrastructure is essential to build trust and ensure mitigation effectiveness.

The EU can foster CCS, CCUS and CDR adoption in both compliance and voluntary markets. In the compliance market, it already considers industrial carbon management activities for emission reductions under the EU ETS. While the EU could also incorporate CDR into the ETS in the future, it can already incentivise CDR adoption today in the voluntary market. Specifically, a credible authority, such as the EU, can foster trust in the voluntary market by standardising high-quality carbon accounting practices.

A harmonised, robust carbon accounting infrastructure would ensure the fulfilment of a minimum quality criteria for all mitigation activities and facilitate the transparent communication of outcomes to the public. Such a carbon accounting infrastructure can also be seen as another vital pillar needed to sustain a robust industrial carbon management market in addition to developing the required CO_2 transport and storage infrastructure and integrating mitigation activities that involve mixed emissions, such as waste-to-energy plants.

4.1 Certifying industrial carbon management for emission reductions in the European Union

An EU-wide certification framework for emission reductions via industrial carbon management, coupled with the right incentives, could create new opportunities for deployment. The EU ETS already provides an incentive in the compliance market for CCS-based emission reductions. The EU could also support adoption for emission reductions in the voluntary market by establishing a harmonised carbon accounting methodology framework. Nonetheless, such an EU-wide framework is currently under development only for emission removals without plans to develop a similar framework for emission reductions via CCS and CCUS.

The regulations controlling CCS and CCUS activities under the EU ETS already provide a solid foundation for the certification of emission reductions. These regulations, such as the MRR and the CCS Directive, provide clear guidelines for quantifying the emissions of such projects. Therefore, a carbon accounting infrastructure for the certification of emission reductions could build on these guidelines to ensure efficiency and consistency.

This guide provided a glimpse into the methodology elements necessary to complement current EU regulations for the certification of emission reductions. A more thorough assessment could identify the specific processes needed to fully integrate such an accounting infrastructure into the existing regulations controlling industrial carbon management activities in the EU.

[33] IEA, 'Carbon Capture, Utilisation and Storage' information page, https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage

[34] Toby Lockwood and Tim Bertels (2022), 'A Policy Framework for Carbon Capture and Storage in Europe', CATF https://www.catf.us/resource/a-policy-framework-for-carbon-capture-and-storage-in-europe/

4.2 Recommendations for certifying carbon capture an storage-based emission removals in the European Union

Achieving the CRCF proposal's goal requires: 1) robust quality criteria for carbon removal activities, 2) rules for the verification and certification of carbon removals, including rules to verify the permanence of removals, and 3) rules ensuring the functioning of certification schemes and their recognition under the European Commission. The proposal, currently in the legislative process, provides general guidelines, while the complete methodologies required have not yet been developed.

Further development of the methodologies requires various crucial clarifications, some of which are already under discussion:

- Providing clear definitions of 'carbon removals', 'carbon removal activities', 'verification of permanence' and other key aspects to ensure clarity and consistency.
- Deciding whether to certify existing carbon accounting methodologies or create new ones. In both cases, the methodologies must meet the requirements set out in the CRCF and align with existing regulations and policies.
- Setting out the requirements under which carbon removals should be eligible for certification.
- Defining standards of reliability, transparency, accounting and independent auditing.
- Setting robust guidelines for monitoring to ensure the permanence of storage in the geosphere and technosphere (e.g. through mineralisation in materials used for products).
- Establishing interoperable public registries to ensure transparency and full traceability of carbon removal certificates at the national and industrial-entity levels and avoid the risk of fraud and double counting.
- Setting out the structure, format and technical details of the reporting activities of certification schemes (and of the public registries to be established) to obtain homogeneous data within the EU on the evolution of the net zero emission objectives of the different member states.

The CCS+ blueprint for a carbon accounting infrastructure already covers some of those requirements, e.g. clarifying definitions of 'carbon removals' and 'carbon removal activities' in its methodology framework, defining detailed certification methodologies for carbon removals through BECCS, DACS and CCU(S) and tackling standards of reliability, transparency, accounting and independent auditing to be applied by certification schemes. Furthermore, it could be adapted to fulfil other requirements or to ensure harmonisation with complementary regulations and policies.

4.3 Unlocking the voluntary carbon market to put industrial carbon management on track

A robust methodology framework against which to certify emission reductions and removals can help responsibly incentivise support from the private sector through VCMs. Such additional support can help bridge the gap between current and required deployment levels to meet the EU climate targets.

While the EU has already embraced the challenge of establishing a robust methodological framework for industrial carbon management based carbon removals, a similar effort could help unlock resources from the private sector to support related emission reductions. Robust methodologies for certifying emission reductions can help put industrial carbon management on track and unlock additional resources from VCMs to complement existing compliance incentives (e.g. through the EU ETS). Additional incentives are urgently needed, particularly for hard-to-abate sectors that depend on these technologies to meet their decarbonisation goals.

The CCS+ Initiative offers a blueprint of a carbon accounting infrastructure for industrial carbon management projects involving CCS, CCUS and CDR. The methodology frameworks align with the same comprehensive, consistent taxonomy and definitions. Together, they offer a versatile, projectbased carbon accounting infrastructure for a full suite of industrial carbon management projects. As industrial carbon management is based on different activities in different parts of the value chain, the CCS+ Initiative offers a modular, plug-and-play design. This way, each activity in the value chain is represented by a methodological module that can be seamlessly combined with the relevant modules of other activities. The CCS+ tools help leverage synergies among diverse projects while providing a high standard for the attribution of mitigation outcomes. The tool for the differentiation between emission reductions and removals allows for the separate accounting of emission reductions and removals. This way, projects mixing CO_2 streams (e.g. CO_2 with a fossil origin vs an atmospheric origin) can benefit from economies of scale while emission reductions and removals are separately accounted for. Likewise, the tool for distinguishing CO_2 captured from a carbon crediting project and from other sources can help profit from the use of shared infrastructure while mitigation outcomes are properly quantified and attributed to each source.

Policymakers and the public can benefit from the world-class expertise behind the development of the CCS+ carbon accounting infrastructure. CCS+ leverages decades of experience in carbon credit standards, particularly in the development of high-quality frameworks for measuring, reporting and verifying the mitigation outcomes of projects. This experience is essential for properly defining projects, eligibility conditions, boundaries and procedures to demonstrate additionality and ensure the permanence of storage, all critical considerations for the certification of emission reductions and removals. Leading carbon consultants integrate the group's efforts into the design and development of the methodologies. Industry and technology leaders provide real-world use cases and invaluable technical input in the domain of capture, transport, utilisation and storage, while a diverse advisory group provides guidance and oversight to help define a final product of the highest possible value to the public. Hence, EU regulators and the public can build on the robust solutions available and decades of experience in carbon accounting while pushing the boundaries of today's carbon credit standards. Leveraging CCS+ outputs and experience can contribute to a greater consolidation of quality assurance approaches across markets and could reduce transaction costs in the market significantly.

VCMs are no substitute for compliance markets; however, they can spur the adoption of industrial carbon management to create the momentum needed. As the EU decidedly adopts entrepreneurial policies to support the adoption of industrial carbon management (e.g. through the Innovation Fund) and gradually introduces further incentives in the compliance market (e.g. in the EU ETS), it can also play a crucial role in catalysing further involvement of the private sector. Providing VCMs with robust methodologies to certify industrial carbon management activities is essential for unlocking additional resources from the private sector, something which is very much needed given the industrial carbon management adoption gap. Perhaps more importantly, robust industrial carbon management methodologies at EU level can foster involvement and trust in a widely misunderstood but critical set of technologies for attaining the EU's industrial and climate goals.

Annex I: CCS+ Workplan

Table A 1 Coverage and expected publication date of modules (covered issues: overarching, capture, transport, storage and utilization) developed under the CCS+ Initiative

Overarching Modules

Module 1.1: 'Guidance and Principles' document

Module 1.2: CCS+ methodology

Module 1.3: CCUS+ methodology

Tool for differentiation between emission reductions and removals in carbon capture project activities

Tool for baseline quantification and allocation of project emissions in carbon capture project activities

Capture Modules

Module 2.1: Carbon capture from air

Module 2.2: Carbon capture from power and heat

Module 2.3: Carbon capture from industrial processes

Module 2.4: Carbon capture from oil and gas production and processing

Module 2.5: Carbon capture from bioenergy

Transport Modules (consolidated)

Module 3.1: Transport via pipeline, ships/barges, road/trucks, rail

Storage and Utilisation Modules

Module 4.1: Geologic carbon storage (storage in aquifers and depleted oil and gas fields)

Module 4.2: Conversion of CO_2 => $CaCO_3$ for "construction" additives

Module 4.3: Mineralisation of CO_2 injected into the concrete production for ready mix and precast

Module 4.4: Injection of CO_2 into the baking process to produce ceramics

Module 4.5: Admixture to cement, reducing clinker usage

Module 4.6: CO_2 storage via geological mineralisation in igneous rock formations

Module 4.7: CO_2 utilisation and storage in medium-lifetime products, e.g. plastics

Module 4.8: CO_2 utilisation and storage in short-lifetime products, e.g. e-fuels

Compliance Guidances

Compliance Guidance 5.1: EU guide

Compliance Guidance 5.2: Article 6 guide

Compliance Guidance 5.3: US guide

Compliance Guidance 5.4: Guide to domestic regulations (including accounting) for threeselected countries

Compliance Guidance 5.5: VCM guide

Compliance Guidance 5.6: Gulf region guide

Compliance Guidance 5.6: Guide to three cross-border use cases

Annex II: Key Terms and Concepts

This section introduces key terms and concepts of the CCS+ methodology frameworks.

Mitigation of climate change

Mitigation of climate change is defined as "a human intervention to reduce emissions or enhance the sinks of greenhouse gases" (Intergovernmental Panel on Climate Change [IPCC]. 2018). Mitigation thus comprises human activities that either result in a reduction of GHG emissions (relative to the baseline scenario)[35] or a removal of GHG from the atmosphere into permanent storage.[36]

Carbon capture and storage (CCS)

Carbon(dioxide)capture and storage is defined as "a process in which a relatively pure stream of carbon dioxide(CO_2) from industrial and energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere" (IPCC, 2018). For the CCS+ Initiative, CCS includes carbon capture directly from the atmosphere and its storage for long-term isolation from the atmosphere.

Carbon capture and utilisation (CCU)

CCU is defined as "process in which CO_2 is captured and then used to produce a new product. If the CO_2 is stored in a product for a climate-relevant time horizon, this is referred to as carbon dioxide capture, utilisation and storage (CCUS)." (IPCC, 2018).

CCU in short-lived products relates to when CO_2 is captured, irrespective of the source, and utilised in short-lived products before going back into the atmosphere. This replaces fossil-based CO_2, and such activities could potentially achieve GHG emission reductions. A rigorous LCA must be applied to ensure that the CCU application is comprehensively assessed.

Carbon capture utilization and storage (CCUS)

Carbon capture utilization and storage (CCUS) includes carbon captured from the atmosphere and its storage in long-lived products and materials, potentially leading to either emissions reduction or carbon removal. Durable product storage refers to processes in which captured CO_2, based on CO_2 from a fossil or geogenic (e.g. cement) carbon source, is injected into a product or material (e.g. CO_2 in concrete or cement) and the resulting product is long-lived, thereby representing durable storage and achieving a reduction in GHG emissions. When CCUS utilises CO_2 captured from the atmosphere or biogenic emissions and is stored in long-lived products, this can result in CDR.

Net greenhouse gas (GHG) reductions and net GHG removals

CCS can result in either a net reduction in GHG emissions, when the CO_2 originated from a fossil fuel or cement (i.e. geogenic) source is captured and durably stored, or in net GHG removals, when CO_2 is captured from a biogenic source or from the air and durably stored (e.g. BECCS and DACS).

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[35] Such emission reductions can arise from preventing emissions by capturing CO_2 at the source (e.g. a cement or powerplant) and storing it underground.

[36] For a detailed explanation of the terminology of 'mitigation' in relation to emission reductions and CDR (or negative emissions) in international environmental law, refer to Honegger et al. (2021).

In order to determine the overall mitigation outcome of a project (i.e. its net emission reduction or net removal result), all GHG flows (i.e. emissions and removals) caused by the operation of the project activity have to be taken into consideration in the life cycle analysis (LCA) (i.e. determination of project emissions).

Durable storage

For both CCS+ and CCUS+ projects, the CCS+ Initiative considers that durable storage is a concept which is still evolving as there are yet no universally agreed-upon time-periods that would determine a particular percentage-probability of permanence over a specific time-window to be permanent or not.

The closure of the geological storage site should be such that it promotes best practices and prevents any reversal post project period. The Geologic Carbon Storage Non-Permanence Risk Tool, currently being developed by Verra, refers to the already existing standards for closure, such as the International Organization for Standardization. It also establishes requirements for post-injection monitoring.

CCS+ initiative

Support the CCS+ Initiative and contribute to advancing key climate technologies

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