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IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

establishing a Union certfication framework for carbon removals

{COM(2022) 672 final} - {SEC(2022) 423 final} - {SWD(2022) 378 final}

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ANNEX 1: PROCEDURAL INFORMATION

1. LEAD DG, DECIDE PLANNING/CWP REFERENCES

This initiative is led by DG CLIMA.

Decide planning reference: PLAN/2021/11727

Commission Work Programme reference: COM(2021) 645 final, Annex I, initiative number 2(d)

2. ORGANISATION AND TIMING

This initiative has been first announced in the Circular Economy Action Plan that the Commission adopted in March 2020 (COM/2020/98 final)[1]. In December 2021, this initiative was also presented in the Commission's Communication on Sustainable Carbon Cycles as "an essential stepping stone" towards the 2050 climate neutrality objective of the EU Climate Law.

The publication of the Sustainable Carbon Cycles Communication was followed in January 2022 by a high-level online conference attended by over 2000 participants. The open public consultation and call for evidence were open for feedback on the Have your Say portal between the 7th of February and 2nd of May 2022.

The Inter-Service Steering Group met on the 11th of May[2] and on the 11th of July[3]. During the first meeting, DG CLIMA presented the first draft of sections 1-5 of the Impact Assessment. During the second meeting, the draft of the entire Impact Assessment and of the Annexes were presented.

3. CONSULTATION OF THE RSB

An upstream meeting with the Regulatory Scrutiny Board took place on the 19th April 2022. Following this meeting, DG CLIMA redefined the policy options to clarify their added value with respect to the baseline and their difference with respect to each other. It also reviewed systematically the different approaches to implement the quality criteria and identified best practices in dedicated annexes, while bringing the main conclusions of these annexes in the main text in a clear way.

The first draft of this Impact Assessement was submitted to the Regulatory Scrutiny Board on the 20th July 2022. The Board provided a positive opinion on the Impact Assessment report on

[1] "To incentivise the uptake of carbon removal and increased circularity of carbon, in full respect of the biodiversity objectives, the Commission will explore the development of a regulatory framework for certification of carbon removals based on robust and transparent carbon accounting to monitor and verify the authenticity of carbon removals."

[2] DGs that attended: AGRI, JRC, ENV, COMP, SG, RTD, INTPA, NEAR, GROW, ENER, REGIO, JUST, MARE, EEAS, SJ, CLIMA.

[3] DGs that attended: REFORM, GROW, NEAR, AGRI, JRC, RTD, ENV, ENER, MARE, HR, SG, INTPA, EMPL, COMP, CLIMA, EEAS, SJ.

the 16th September 2022 and provided a list of recommendations that were integrated in the revised report as follows:

- in the introduction, the context of the initiative (i.e. role of carbon removals in the 2050 climate neutrality objective and in the current policy baseline) and the voluntary nature of the initiative were made clearer;
- in the problem definition, new references have been added to confirm the existence and the scale of the identified problems (in particular the lack of trust) and to highlight the importance of internationally harmonising framework in the views expressed by stakeholders;
- in the section about objectives, it was clarified that the shortlisting of the four QU.A.L.ITY criteria follows a general consensus about what constitutes high-quality certification according to most existing certification methodologies, and the presentation of the criteria in the section describing the policy options now includes more arguments from the dedicated annexes;
- to take into account the voluntary nature of the framework, several clarifications were added (e.g. the objective of "level-playing field" has been rephrased as "harmonisation");
- the section about discarded policy options better explains why a mandatory use of the certification framework policy was discarded;
- the section on the assessment of the impacts cites the voluntary nature as a risk that could undermine the success of the initiatives, and measures to mitigate this risk;
- the assessment of policy options better identifies the barriers to upscale of carbon removal activities, and explains how the certification framework will address these barriers; this section also clarifies the uncertainty related to the qualitative statements about expected benefits and costs;
- the section on the one-in-one-out approach has been moved from an annex to the main text;
- the section on monitoring and evaluation of the initiative includes more elaborated operational objectives.

4. EVIDENCE, SOURCES AND QUALITY

This impact assessment was carried out with the support of a 14-month service contract signed in December 2020 and extended for 10 month in January 2022. The consortium providing the service consisted of Umweltbundesamt GmbH (lead), Ramboll, Ecologic and Carbon Counts.

The service contract consisted of 5 main tasks:

- Task 1: Review of existing mechanisms for the certification of carbon removals
- Task 2: Synoptic assessment of technological and nature-based solutions for carbon removals
- Task 3: Organise expert workshop and provide support to stakeholder consultation
- Task 4: Support to assess options to design EU carbon removal certification mechanism
- Task 5: Support the design of a pilot phase

ANNEX 2: STAKEHOLDER CONSULTATION (SYNOPSIS REPORT)

1. INTRODUCTION

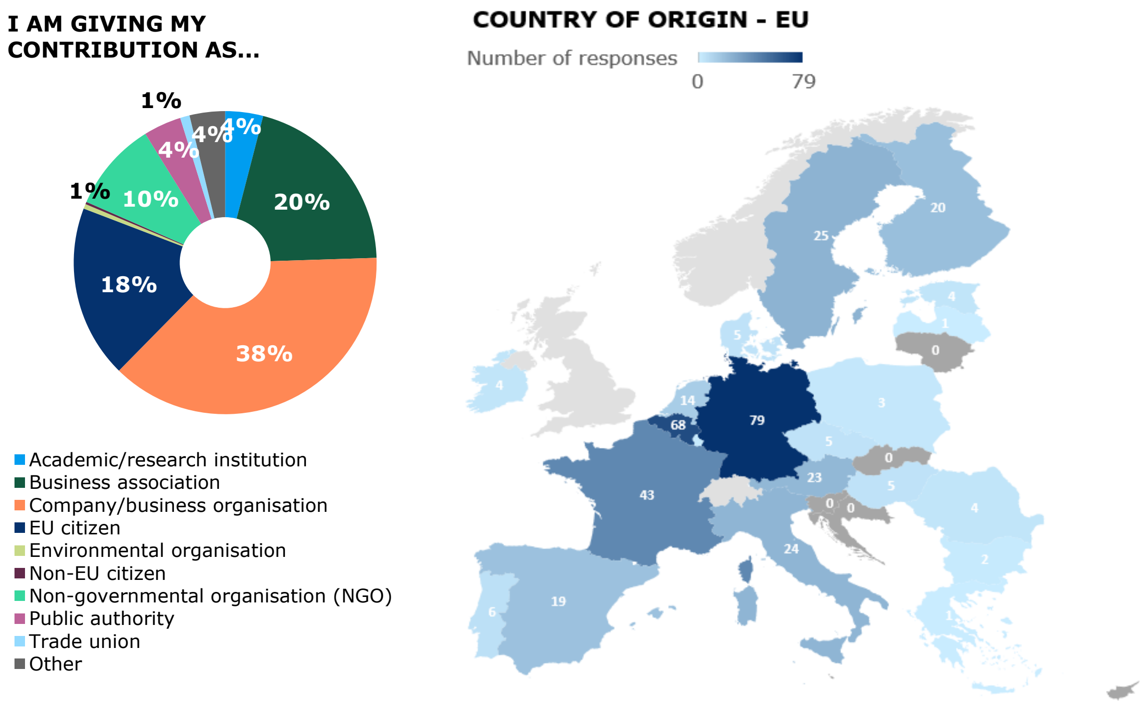
The public consultation (PC) was carried out between the 7th of February and 2nd of May 2022 in all official EU languages and using EU Survey, via the European Commission's website. The purpose of the public consultation was to gather insights from a broad range of stakeholders to inform the initiative aimed at proposing EU rules on certifying carbon removals, notably to monitor, report and verify the authenticity of the removals. The consulted stakeholders include EU citizens, companies that may provide or use carbon removal certificates in the future, NGOs and environmental organisations, research and academia, public authorities, trade unions, and consumer organisations.

2. OVERVIEW OF REPLIES

In total 396 responses were submitted. All questions were asked to all stakeholder categories and did not depend on previous answers. However, as not all respondents answered all questions, the specific response rate for each question was below 396 in some cases. Companies and business organisations were the largest group, consisting of 38% of all respondents, followed by business associations (20%) and EU citizens (18%). These were the most strongly represented stakeholder types. Non-governmental organisations (NGOs) submitted 10% of the responses, while academia, public authorities and other stakeholder types each accounted for 4%. The smallest groups represented were environmental organisations, trade unions and non-EU citizens.

The geographical distribution of the respondents covered 21 of the 27 EU Member States (N=357), as well as 9 non-EU countries (N=39). The largest share of responses came from Germany (N=79, 20%), followed by Belgium (N=68, 17%). The latter is the origin of many cross-European business associations and NGOs, which explains its high response number relative to its population size. The largest number of responses from non-EU countries was received from Norway (N=11), Switzerland (N=9) and the United States (N=8).

Figure 1 Stakeholder types and geographical distribution



The analysis of responses uncovered several small clusters of coordinated responses, but no campaign that would skew the overall results. Therefore, all submissions were analysed and reported, while dividing trends by stakeholder type.

3. Overview of results

The public consultation consisted of 11 questions grouped in four blocks plus a final open question allowing additional remarks. The four blocks were (1) scope, (2) benefits of a certification framework, (3) role of the EU in the certification of carbon removals, and (4) certification methodologies. At the end of blocks (1), (3) and (4), respondents further had the option to provide open comments on the topic of that block.

3.1. Scope

Q1 asked respondents about the main challenges in integrating carbon removals in the EU climate policy framework. Respondents could select up to three options. The three most frequently selected challenges were *ensuring precise, accurate and timely measurement for removals* (45% of all respondents), *ensuring that strong action to reduce emissions is not undermined by shifting focus on carbon removals* (41%), and *providing sufficient guarantees for the duration of carbon storage and the prevention of reversals* (39%). The precise, accurate and timely measuring was also the most selected challenge for companies and business associations with 53% of each stakeholder type selecting this option. For NGOs and academia, the top challenge was *ensuring that strong action to reduce emissions is not undermined by shifting focus on carbon removals* (63% of NGO respondents; 69% of academia respondents), while the most selected challenge for EU citizens was *setting appropriate baseline and demonstrating the additionality of removals* (49% of EU citizen respondents). For public authorities, the most selected challenge was *providing sufficient* *guarantees for the duration of carbon storage and the prevention of reversals* (43% of public authority respondents).

Q2 asked about the main criteria that should be used for defining and certifying carbon removal solutions. Again, up to three answers were possible. The three most frequently selected criteria to guide the definition of types of removals were *robustness of monitoring, reporting and verification* (MRV) *aspects* (54% of all respondents), the *potential for deployment at large scale* (49%), and *technical readiness and economic feasibility* (45%). The most selected option (*robustness of monitoring, reporting and verification aspects)* was also the most selected one for business associations (71% of these respondents) and academia (50% of academia respondents). Companies mostly selected the *potential for deployment at large scale* (60% of company respondents). NGOs selected the *potential environmental co-benefits* most often (58% of NGO respondents), while public authorities mostly selected *technical readiness and economic feasibility* (63% of public authority responses). These last two options were also the preferred by EU citizens, both at 49% of respondents from this stakeholder type.

Q3 gave respondents the possibility to share their views on a series of carbon removal solutions and the time horizon for including them in a certification mechanism. The solutions were split between carbon farming solutions and industrial solutions for carbon removals. For each solution, one-time horizon (*as soon as possible, after 2030, towards 2050, or never*) could be selected (or *no opinion*). It should be noted that substantial shares of respondents did not indicate an opinion on some solutions. All carbon farming solutions were broadly supported for an implementation *as soon as possible* (between 87% and 67% of the respondents who had an opinion on the solution concerned). Out of the carbon farming solutions, immediate inclusion of *sustainable forest management* was backed by most stakeholders of all types (87% of respondents). With some exceptions, industrial solutions also received support for immediate inclusion from all stakeholder types. Specifically, *direct air capture with long-term or permanent carbon storage* (47% of respondents selected *as soon as possible*; 11% *never*) *and enhanced rock weathering* (35% of respondents selected *as soon as possible*; 22% *never*) received the lowest shares for immediate inclusion. These less favourable responses were largely from NGOs and EU citizens, while companies and business associations generally supported the inclusion of all solutions as soon as possible.

3.2. Benefits of a certification framework

Q4 asked respondents for their agreement with the statement "establishing a robust and credible certification system for carbon removals is the first essential stepping stone towards achieving a net contribution from carbon removals in line with the EU climate-neutrality objective". A large majority of 89% of respondents agreed with the statement. This included clear majorities from all stakeholder types. Only NGO respondents showed some disagreement, with 39% of these respondents selecting *no*.

Q5 gave respondents the opportunity to select up to three answers to define the main objectives for the certification of carbon removals. Three answers stood out with 48-51% of all respondents selecting: (1) *to allow* comparability *and competition between different carbon removal solutions,* (2) *to increase the transparency and level playing field of voluntary carbon markets*, and (3) *to provide better public incentives for nature-based and industrial carbon removals in EU and national funding programmes*. The three most selected objectives were all strongly backed by business associations and companies/business organisations (57% and 49% of, respectively, companies and business association respondents). EU citizens also supported *to allow the comparability and competition between different carbon removal solutions* as well as *to increase transparency in corporate sustainability reporting and foster the credibility of climate-neutrality claims* (55% of EU citizen respondents). The third most selected option (*to provide better public incentives for nature-based and industrial carbon removals in EU and national funding programmes)* was more strongly supported by NGOs (79% of NGO respondents).

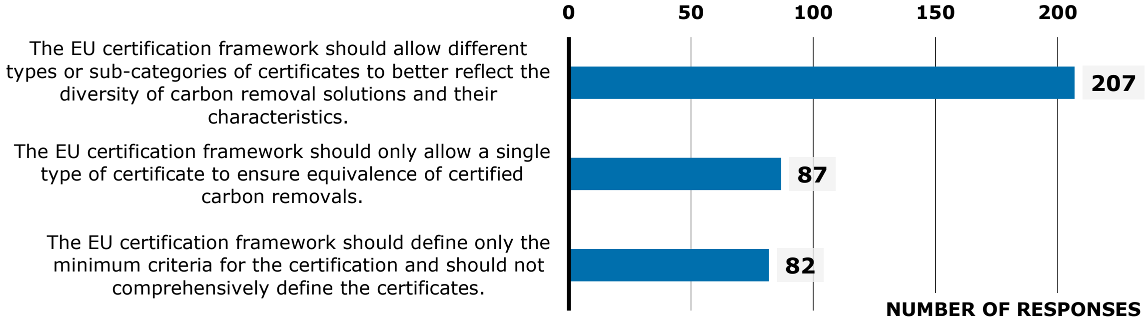
3.3. Role of the EU in the certification of carbon removals

Q6 asked respondents about the role they envisage for the EU in the certification of carbon removals. The question offered three options (1) *the EU should establish comprehensive standard requirements for carbon removals, e.g. on monitoring, reporting and verification, on the duration of the removal or baseline setting and additionality*, (2) *the EU should establish minimum standard requirements on reporting transparency for carbon removals*, or (3) *voluntary carbon markets work well. There is no need for an additional intervention by the EU*. Respondents could select one of the three options. A majority of respondents (55%, 210 in total) mandated the EU to establish comprehensive standard requirements for carbon removals; this option received the majority of responses from all stakeholder types. A more limited role for the EU to establish minimum standard requirements on reporting transparency was favoured by 40% of respondents (155 in total). Companies made up a notable share of the stakeholders who selected this option with a similar absolute number as for the more comprehensive one (69 and 71 responses). EU citizens also had a largely comparable number of responses, while all other stakeholder types with more than five respondents in total had substantially lower numbers. Voluntary carbon markets without further intervention were preferred by only 5% of respondents.

Q7 asked stakeholders about what type of entity (public or private) should carry out the functions in the certification process. Public administration was seen as the most adequate for the *establishment of certification methodologies*. The overall majority (59%) as well as the majority within each stakeholder type considered the public administration as most adequate for this function. Conversely, 33% considered independent private entities to be the most adequate. This group consisted mostly of respondents from business associations, companies and EU citizens. 8% of respondents had no opinion. A large majority of stakeholders considered public administration to be most adequate for the *establishment of the system for the accreditation of certification bodies*. 78% were of this opinion, which builds on a strong majority from all stakeholder types. 15% thought that independent private entities are more adequate organisations to undertake this function. Here, notable shares of respondents came from companies and EU citizens. 7% indicated no opinion on this function. In contrast to the previous functions, independent private entities were seen as most adequate for the *verification of removals made (ex-post)*. 65% of stakeholders expressed this view, with strong support from business associations, companies and EU citizens. Also, public authorities supported the responsibility of independent private entities for this task. On the contrary, 23% of the respondents considered public administration to be better placed. Here, NGOs were a key group that supported public responsibility for *ex-post verification of removals*. Moreover, a majority of respondents from academia and research institutions also shared this view. 12% had no opinion. Lastly, the *validation of the carbon removal projects (ex-ante)* was also seen as best placed in the hands of independent private entities. The number and shares of responses as well as the positions of stakeholder types were nearly identical to those of the ex-post verification.

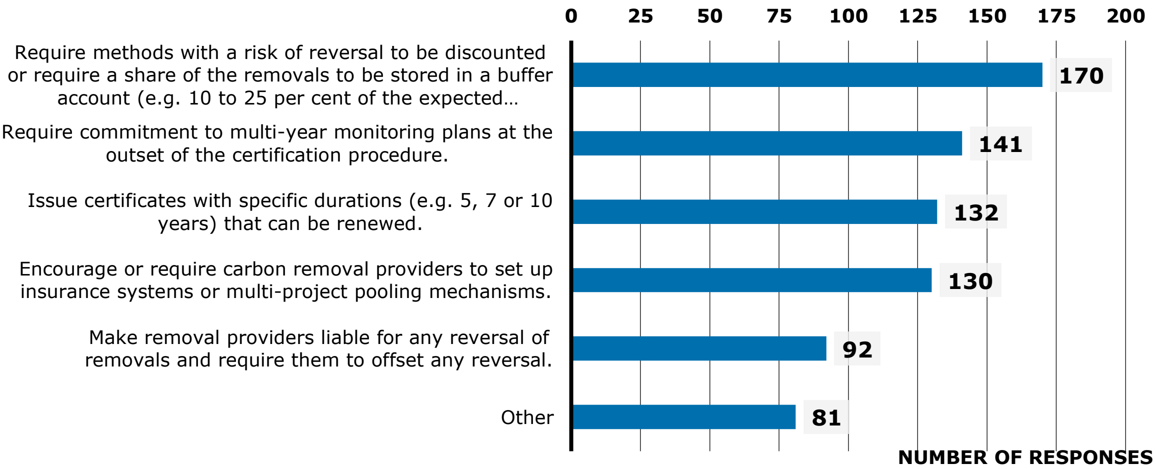
3.4. Certification methodologies

Figure 2 Q8: Do you think an EU certification framework should allow different types of certificates for different types of removals? (N=376)



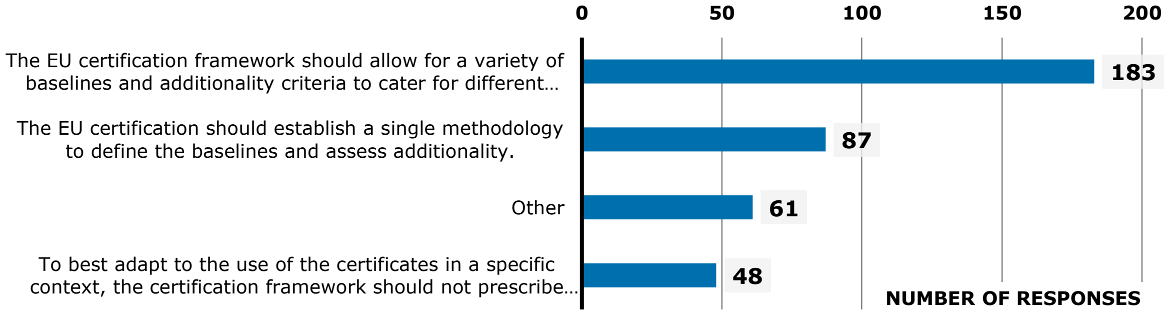
Q8 asked respondents whether an EU certification framework should allow different types of certificates for different types of removals. Respondents were limited to one response; 376 respondents answered the question. The results are illustrated in Figure 2, which shows that 55% of respondents believe that *an EU certification framework should allow for different types of certificates*. 23% of respondents called for *a single certificate type*, while 22% called for *minimum criteria rather than comprehensively defined certificates*. There were some differences across different stakeholder types: the most noticeable result was that NGOs and academic/research institutions are less in favour of allowing *only a single type of certificate*.

Figure 3 Q9: What approach could better manage this risk of intentional or unintentional reversal of carbon removals? (N=396)



Q9 In the ninth question, respondents were asked to identify the best approaches for managing the permanence of carbon removals. Respondents could select multiple responses, and on average each respondent selected 1.9 options. Respondents were also able to provide additional responses in an open text input section; 21% (80) of the 396 respondents provided additional input. The results are illustrated in Figure 3. The results were mixed, with no option selected by more than 43% of respondents. The most popular options were *buffer accounts or discounts* (43% of respondents); 33% of respondents called for a related approach of *insurance or pooling systems*. The second most popular response calls for *multi-year monitoring plans* (36%), though only 23% of respondents would *make removal providers liable for offsetting reversals* (the least popular options). 33% of the respondents called for *certificates with specific durations*. There were significant differences between stakeholder types. *Discount/buffer accounts* was not the most commonly selected response for some stakeholder types, e.g. business associations, environmental organisations, public authorities, and trade unions. For business associations and public authorities, the most selected option was to go for *certificates with specific durations*. Conversely, this was the least popular option for NGOs and for academic/research organisations.

Figure 4 Q10: To what extent do you think the EU certification framework should include the concepts of baseline and additionality? (N = 379)



Q10 asked to what extent respondents think the EU certification framework should include the concepts of baseline and additionality. Respondents were asked to select between three different options, or "other". The results are illustrated in Figure 4. The most popular response was that *the EU certification framework should allow for a variety of baselines and additionality criteria to cater for different types of removals* (48% of responses). A further 23% indicated that *the EU certification should establish a single methodology to define the baselines and assess additionality*. Overall, 71% of respondents called for some EU guidance on baseline and additionality criteria within the carbon removals certification mechanism. 16% of respondents selected the "*other*" option and provided additional information in an open response; these responses varied widely. Most respondent types answered similarly. One exception was the stakeholder group NGOs, which disproportionately responded "*other*" (50% of their responses).

Q11 asked respondents what information the certification for carbon removals should disclose and provided a list of 13 possible options (including one "other" option). Respondents could tick as many options as they felt necessary; on average, they provided 8 responses. Most respondents indicated that the certification should disclose the *quantity of carbon removed* (94% of respondents), closely followed by the *type of carbon removals* (89% of respondents). Around three-quarters of respondents answered that this should include *information on MRV processes, the duration of carbon storage* and *information on the carbon removal provider*. Approximately half of respondents indicated that the certification should provide *information on the certificate owner*, *the baseline and additionality of the removal*, *the use of the certificate and its contribution to the Paris Agreement*, *environmental benefits and risk coverage and sustainability objectives*.

Respondents seemed less interested in the *social benefits* and *the price of the certificate* (40% and 29% of respondents, respectively). 52 respondents used the "other" option to provide additional feedback: no major differences emerged between the views of stakeholder types on what information the certification for carbon removal should disclose. However, some stakeholders on average picked more answers than others (e.g. NGOs selected more options compared to company/business organisations).

Respondents were also able to provide **additional comments** on certification methodologies (i.e. questions 8-11) in an open text input section; 145 respondents provided additional input. These covered many different topics, in some cases overlapping with other sections of the questionnaire. Topics addressed by respondents included (but were not limited to): general comments on how to implement the certification framework, methodologies, registries and certificates (including the trade thereof), co-benefits and the certification framework, and existing standards. Moreover, some respondents provided additional insights into their responses or used the opportunity to highlight specific issues. At the end of the questionnaire, respondents were asked whether there are any other important aspects that should be considered in establishing a regulatory framework for the certification of carbon removals in the EU. In total, 267 respondents provided final remarks. The two topics that were most often addressed are the expected objectives of the certification (75 mentions) and the risk of negative impacts on stakeholders (60 mentions).

3.5. Summary of views per stakeholder type

This section summarises the key overall positions of the stakeholder types for which more than five submissions were made. Reflecting the similar background and different number of replies, some stakeholder types are grouped together.

Companies (150 respondents) and **business associations** (81) expressed their preference for a clear mechanism that offers incentives to a wide range of solutions while being robust and credible. The most selected criteria for incentivising removal solutions were the robustness of MRV and the potential for large scale deployment. These stakeholders called for the immediate inclusion of almost all solutions. Only DACCS (53% of respondents with an opinion did not select as soon as possible) and geological storage of non-fossil CO_2 (32%) received notable shares of replies for later inclusion. Comparable and competitive carbon removal markets were the primary objective for companies and business associations. The views on the distribution of functions were clear cut: public administration was seen as appropriate to define certification methodologies and accredit certification bodies, while independent private entities should validate and verify removal projects and quantities. Different baselines for different removal types were preferred by companies and business associations. Opinions on how to address reversals varied with relatively even shares, with a slight preference for requiring discounting or buffers to account for the risk of reversals. Disclosure of the quantity, types, MRV and provider of the removal was seen as essential, while items such as the duration, baseline or the owner received substantial shares of responses as well. In additional remarks, companies most often pointed to the expected objectives of creating incentives for growth in the market of carbon removals.

EU citizens (73) had more diverse views than the other stakeholder groups. For instance, in response to the criteria for incentivising specific solutions, three answer options were almost equally popular: *potential environmental co-benefits, technical readiness and economic feasibility,* and *robustness of MRV aspects*. While the majority of EU citizens were in favour of including a wide range of both carbon farming and industrial removal solutions in the certification mechanism, a substantial share of respondents called for the later inclusion of industrial solutions[4]. In the allocation of functions, EU citizens showed the same trend as companies and business associations. A notable difference, however, was that for the establishment of certification methodologies, 50% selected public administration while independent private entities were close with 45% of respondents. For reversals and additionality, the variety of views of EU citizens was again apparent: in both cases, two options received comparable numbers of selections. For reversals, *discounting or buffer accounts* and *insurance or multi-project pooling* were the preferred options. For additionality*, different baselines for different removal types* and a *single baseline* received the same number of selections. EU citizens asked for the disclosure of a wide range of items. Only the social benefits and the trading price items were selected by less than 50% of EU citizen respondents. Most additional responses submitted related to the risk of negative impacts on other stakeholders caused by giving priority to the offsetting needs of carbon intensive industries over the economic, social and cultural contributions of the agricultural or forestry sector.

NGOs (38) and **environmental organisations** (2) expressed preference for an approach that is comprehensive, transparent and driven by public authorities. A key topic for these stakeholder groups was the priority of GHG emission reductions over removals. Respondents from NGOs and environmental organisations most often selected *potential environmental co-benefits* as the criteria for determining which specific solutions to incentivise through the certification mechanism. Like EU citizens, the majority of NGO respondents called for including a wide range of both carbon farming and industrial removal solutions in the certification mechanism, but the selection was more cautious than other stakeholder types. Particularly industrial solutions received more replies for later or no inclusion than the overall responses. The majority of NGOs and environmental organisations expressed a preference for public administration to take over all functions in relation to certifying removals. In the views of these stakeholders, defining additionality and preventing reversals were important challenges that need to be tackled as comprehensively as possible. Similarly, the disclosure should enable full transparency on all aspects of the removal. Regarding what information should be disclosed, NGOs and environmental organisations had the highest average number of options selected with 9.7 and 10.5 out of 13 options. Additional remarks from NGO respondents most often related to nature-based solutions and the potential to create effective co-benefits for ecosystem restoration and biodiversity.

Respondents from **academia and research institutions** (16) were for the majority of questions closely aligned with the trend of NGOs responses. A few considerable differences existed, however. First, academia respondents were more widely of the opinion that also industrial removal solutions should be implemented as soon as possible. Second, to reflect the risk of reversals, research stakeholders preferred the option of discounting removals or setting up buffer accounts (63% of research respondents selected this option).

[4] For the options of industrial solutions, the share of EU citizen responses that express an opinion but select later than as soon as possible is (in increasing order): Bio-based products with long lifetime (including for construction) (27%); Utilisation of non-fossil CO_2 in long lifetime products (45%); Biochar (47%), Bioenergy with carbon capture and long-term or permanent storage (BECCS) (51%); DAC with long-term or permanent carbon storage (62%); Geological storage of non-fossil CO_2 (70%); Enhanced rock weathering (78%).

Finally, in relation to additionality, a variety of baselines was the most selected option (43%). Remarks most often related to the integration of carbon removals with EU and international climate instruments such as the Paris Agreement.

Public authority respondents (16) on the other hand were more closely aligned with companies and business organisations. For instance, they considered independent private entities as most appropriate to carry out verification and validation steps. Divergence from other responses lied primarily in the approach to the risk of reversals. Public authority respondents selected the option of specific durations of certificates with options for renewal most often.

4. CALL FOR EVIDENCE – FEEDBACK

In addition to the public consultation, stakeholders had the opportunity to share feedback and input on the initiative for the certification of carbon removals through a call for evidence. In total, 231 submissions were made. After removing duplicate submissions, 219 distinct feedbacks remained. Like in the public consultation, the countries with the most submissions were Germany (42) and Belgium (41), while the Netherlands (16), Sweden (13), Italy (13), Finland (12) and France (12) were also well represented. Several of these simply referred to the position paper of the organisation. The summary of the analysis of these papers is provided in Chapter 5 because of the large overlap between submissions through the call for evidence and the public consultation.

110 submissions were made by **companies** (64 submissions) and **business associations** (46). The key topics of these responses related to the support towards the initiative, while seeing a priority for GHG emissions reductions. For the certification mechanism, business stakeholders generally called for a market-based approach with competition for removals as well as verification activities. Therefore, a flexible and technology-neutral design is preferred by these stakeholders. At the same time, credibility and acceptance were often mentioned as key parameters to grow the market for carbon removals. The growth of removal development was a strong motivation expressed by businesses that would buy removal certificates to offset emissions. For these, the alignment with instruments such as the EU ETS was also of concern. Removal providers from farming and forestry sectors expressed that the removal certification would have to create viable financial incentives to have an impact. Concerns over reducing the availability of biomass for use in product value chains were also expressed.

44 submissions came from **NGOs** and **environmental organisations**. These stakeholders also widely supported the Commission’s initiative. NGOs highlighted the importance of an ambitious mechanism that contains robust provisions for MRV, additionality and permanence. Further topics raised were the importance of emissions reductions to achieve climate targets and the need for holistic assessments of environmental impacts of removal solutions beyond the carbon balance.

35 submissions were made by **EU citizens**. These responses included very large divergence as some respondents stated their full support in short words while others expressed their rejection of any climate policy. More elaborate answers called for clear and useable rules to support the climate mitigation efforts while being transparent to citizens.

11 submissions came from **academia and research institutions**, which expressed strong support to the coordination and certification of carbon removals. These stakeholders called

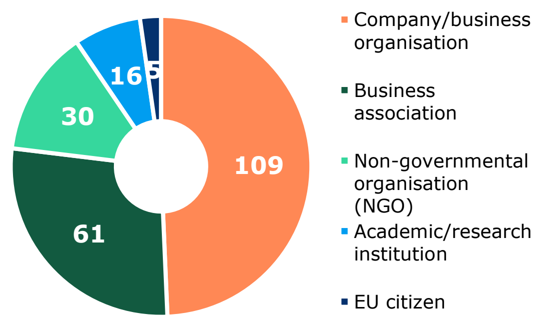
for detailed certification rules based on the global scientific evidence body and aligned with the international climate policy framework.

From the other stakeholder groups, a total of 18 submissions were received, of which 14 selected "other" as their stakeholder category. These reflected largely the key topics of the main stakeholder type to which they most closely belonged.

5. ANALYSIS OF POSITION PAPERS

Position papers were submitted via multiple channels. In total, 108 stakeholders attached position papers to their survey answers (of which 95 were distinct); 74 were submitted through the call for feedback on the roadmap for sustainable carbon cycles in 2021[5]; 45 additional papers came from the call for evidence; and 11 additional papers were identified as highly relevant by the support study project team. As such, a total of 221 position papers formed the basis of the position paper analysis. Their distribution across stakeholder types is shown in Figure 5.

Figure 5: Number of position papers per stakeholder type (N=221)

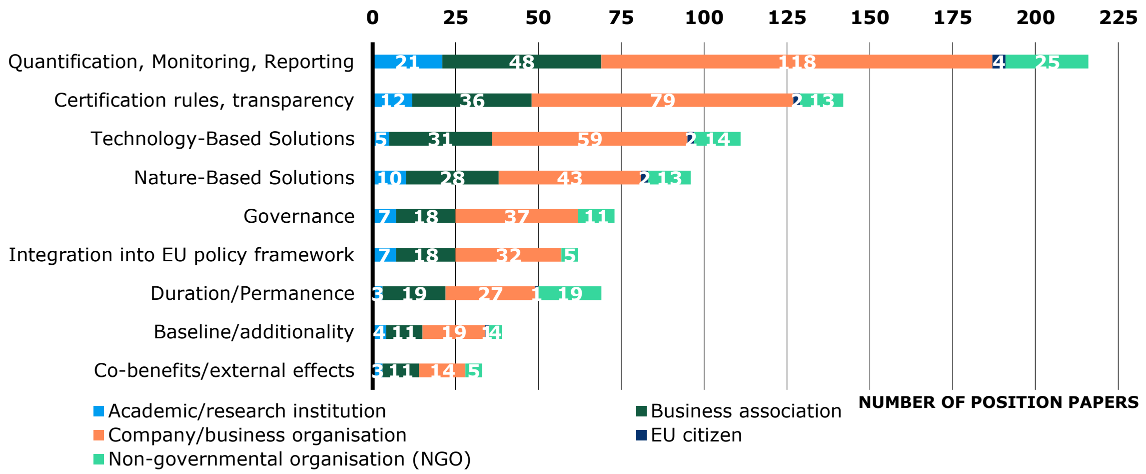


The majority of position papers were submitted by companies/business organisations and business associations. Together, these stakeholder types represented 74% of the distinct documents submitted. Of the papers submitted, several key topics emerged. Some of the most discussed areas included certification rules, accounting, technology-based solutions, as well as monitoring, reporting and verification. A further breakdown of the topics covered by the position papers is shown in Figure 6.

The expected objectives of the certification were similar across all position papers, with two main themes. First, stakeholders expressed support for carbon certification as a way to provide economic opportunities for sectors such as agriculture, forestry, and land-use sectors. In essence, these stakeholders stressed that a certification for carbon removals should be used as a tool to accompany other measures and investments that reduce emissions. Second, another key objective across stakeholders was the importance of internationally harmonising the frameworks regarding carbon removals. Some other notable objectives included sufficiently and credibly rationalising and incentivising negative emissions for investors, as well as the desire for government engagement to promote stability within the system.

[5] Climate Change – Restoring sustainable carbon cycles (link)

Figure 6: Topics covered by position papers and per stakeholder type



Some risks were flagged throughout the papers. Stakeholders were concerned about the risk of greenwashing and lower mitigation efforts if removals are valued higher than emissions reduction. Another risk that appeared in papers related to carbon farming solutions is the risk to farmers. High certification costs can act as a bottleneck for farmers, and rewarding carbon removals without maintaining instruments that manage and enhance existing carbon sinks can disincentivise the farmers that have already successfully removed carbon through other smart climate practices.

Most stakeholders expressed that carbon farming solutions should be included in the framework. The potential for carbon sequestration in soil is recognized as a viable, cost-effective approach towards carbon neutrality. However, concerns were raised that the global credit economy (as it exists today) is not set up for carbon removal, because carbon farming offset options lack international standards, and they are riskier in terms of permanence. For industrial solutions, there was widespread support for BECCS and DACCS.

Stakeholders are generally calling for robust and transparent MRV rules because of the critical support that these provide to the credibility of removals. Two ideas seen throughout the papers are 1) the recommendation that the MRV system should be built on existing LCA principles, and 2) the idea that the system should allow for different modelling approaches to help reduce the cost barrier associated with MRV. Stakeholders generally agreed that carbon removal units must prove to be additional, and that clear guidance on project additionality can help reduce the risks and complexity in project development, while enabling credit operators to invest into the schemes. Regarding permanence, it is important to distinguish between true carbon removals and avoided emissions. Regarding transparency within the framework, many stakeholders listed double-counting as their main concern. As such, it is integral to ensure the traceability of issued carbon credits to minimize the risk of double counting. Other suggestions included aligning the framework with the European carbon accounting system; creating a carbon removal authority; and establishing and outsourcing third-party verification to accredited independent entities. Some stakeholders referred to California as an example, whereby they suggested integrating the carbon sequestration from soil in the EU ETS, as is the case with the state's cap-and-trade system.

Stakeholders stressed the importance of international harmonisation of the framework and the need to integrate carbon removals into climate policies towards 2050 to scale demand-driven negative emissions. Some suggested for the Commission to create a carbon bank to guarantee a minimum price for carbon removals and retaining policies incentivising the conservation of existing carbon stocks. Many expressed that the Commission should focus on clearly defining the concepts related to the purpose, functionality and integrity of the system. Some closing remarks in the papers voiced support for increasing research and development for carbon removal projects, especially for industrial solutions. Lastly, carbon removal projects should respect indigenous rights and support ecological integrity through strict safeguards.

5.1. Sectoral analysis

The **agriculture** sector highlighted the risks and concerns regarding the cost of the MRV process for farmers as the current costs of recognized modelling approaches for direct measuring are very expensive. An alternative is to allow for indirect proxies, physical indicators, or technologies. Although they are less accurate than soil sampling, it will often be cheaper and simpler than direct measurements, thus reducing the barriers of high MRV costs for the project developers, which will help facilitate the development of carbon projects.

The **food** sector largely echoed the sentiments expressed by the agricultural sector. MRV is expected to be data intensive and expensive, therefore it is important that the method is kept simple, to avoid administrative burden for producers. It is important to make sure that such a certification scheme represents a long-term positive business model for both farming and processing activities.

The **forestry** sector highlighted the need to ensure that the reduction of fossil emissions remains the number one priority. Carbon farming solutions should not just lead to increased carbon removals, but also help reverse the degradation of ecosystems (particularly forests) and the co-benefits that come with them.

The **industrial sector**, especially **energy, minerals & materials**, expressed high support for both carbon farming and industrial solutions, as all of them should be promoted based on their technological potential and cost-effectiveness. For technological solutions such as BECCS, greater incentives are required. The certification for carbon removals must be complementary to the EU ETS system, as the two are needed to reach the climate objectives. Additionally, it is essential to consider transport and storage infrastructures for hard-to-abate industrial sectors.

Climate organisations highlighted that an overreliance on removals risks a deeper climate breakdown and shifts the risks and burden to the underprivileged and future generations. The certification for carbon removals should consider the importance of environmental benefits (and not just focus on carbon) and prioritize carbon farming solutions. Many organisations highlighted the opportunity of scaling up industrial solutions such as DACCS and BECCS, however they also identified the risks of greenwashing and failing to bring the technologies to scale.

6. CONFERENCE ON SUSTAINABLE CARBON CYCLES

The Sustainable Carbon Cycles Conference took place online on 31st of January 2022. Over 2000 participants attended the event organised around four main panel sessions, whereby public authorities, industry and civil society exchanged on the role and potential of carbon removals in the EU. First, a plenary session was held as a high-level panel discussion on sustainable carbon cycles. Keynote speakers and panellists from EU policymakers and international businesses discussed how public and private stakeholders can work together to scale up carbon farming initiatives and industrial solutions. Session 2 was split to focus on the areas of carbon farming and industrial solutions. Speakers and panellists included policymakers, researchers, and the industry sector representatives that could offer carbon removals under the respective solutions. The removal potential and main opportunities and challenges of deploying such solutions in practice at the EU level were discussed. A third session focused on the expectations from society. Speakers and panellists from NGOs and companies discussed the needs and expectations of different stakeholders for the deployment of carbon removals. Finally, a fourth session on the potential EU certification brought together representatives from current removal certifiers, NGOs, and experts to discuss the design of a possible regulatory framework ensuring the high quality of carbon removals deployed in the EU. The importance of scaling up carbon farming and industrial solutions was recognised by all speakers and panellists during the conference. Many highlighted how carbon removals will play a crucial role in the journey towards climate neutrality by 2050 for the EU, and for company-level net zero or net negative strategies in the coming decades.

ANNEX 3: WHO IS AFFECTED AND HOW?

1. PRACTICAL IMPLICATIONS OF THE INITIATIVE

An EU framework for the certification of carbon removals will bring additional benefits from increased trust in the quality of procedures and certification methodologies. This section reports potential costs and benefits from this initiative for each actor that choose to voluntarily opt in.

1.1. Economic operators

The operators develop and operate activities to remove carbon from the atmosphere. The two types of operators potentially affected by the initiative are:

- *Project operators*. Entities that establish, manage and implement carbon removals activities. They can include technology developers (e.g. for industrial removal solutions) or landowners, foresters and farmers that host nature-based removals solutions.

- *Programme developers*. Entities acting as intermediate and specialising in the identification, development, registration and implementation of emission carbon removal crediting activities. These firms often develop methodologies and help to aggregate activities across multiple operators. They usually take a share of the revenues received from the sale of resulting credits.

Business scenarios

Based on the objectives set out in the Communication on Sustainable Carbon Cycles (5 Mt of permanent storage and contribution towards the additional net removals of 42 Mt in LULUCF), the following scenarios on revenues and costs can be developed:

- Scenario 1: The aspirational objective of 5 MtCO2 of carbon removal by 2030 from industrial solutions set in the Communication on sustainable Carbon Cycles is reached with 3.5 Mt of BECCS, 1.5 Mt of DACCS with carbon removal credits sold at 150 EUR/tCO2.
- Scenario 2: 5 MtCO2 of carbon removals from Afforestation (3,75 Mt), Agroforestry (0,75 Mt) and Soil Carbon (0.5 Mt) sold at 50 EUR/tCO2
- Scenario 3: 20 MtCO2 of carbon removals from Afforestation (15 Mt), Agroforestry (3 Mt) and Soil Carbon (2 Mt) sold at 50 EUR/tCO2

A separate line shows the costs for Monitoring, Reporting, and Verification (MRV). Those MRV costs are based on estimates from current certification schemes that use best practices (as explained in the sections on the QUALITY criteria) and should also be representative of the MRV costs under the preferred option Q2+G2.

Also based on current experience, the remaining margins should be sufficient to cover investment and operating costs.

	5 Mt of Industrial removals [6]	5 Mt Carbon Farming[7]	20 Mt Carbon Farming[8]
Typical project capacity	1 MtCO2	25-500 tCO2	25-500 tCO2
Number of individual projects	5	42.500	170.000
Rough estimate of revenues generated[9]	750 M€	250 M€	1.000 M€
Estimate of MRV costs	500.000 €	40 M€	160 M€

MRV costs

Going into more detail on the estimation of the MRV costs, the table below shows that the MRV cost can vary significantly among carbon removal solutions. These estimates only provide general indications with a high level of uncertainty.

Table 1-1 Potential ranges of monitoring, reporting and verification (MRV) costs by removal activity types[10,11,12]

Activity type	Activity size (tCO_2 removed/yr)	MRV cost (per activity)			Monitoring frequency (years)	Cost (€/tCO_2 removed)
		Upfront (€)	Recurring (€)	Annualised (€/yr)		
Afforestation	50-10,000 (av. 500)	1000-1250	3700-7800	877-1711	5	0.1-34
Agroforestry	5-445 (av. 50)	1000	3700-7800	877-1657	5	2-330
Soil carbon	8-116 (av. 25)	1000	3700-7800	877-1657	5	4-200
BECCS	100,000-500,000 (av. 200,000)	200,000	50,000	73,000	1	0.1-0.7
DACCS	5,000-500,000 (av. 200,000)					0.1-15

In the most extreme cases, the costs of meeting elevated MRV requirements could prove prohibitive to the certification to some types of carbon farming solutions; this arises because of the need to apply dedicated MRV to each activity site even where these are individually delivering only low levels of removals. In these circumstances, MRV costs become the most significant part of overall implementation costs. This is particularly true

[6] Assuming 3.5 Mt of BECCS and 1.5 Mt of DACCS
[7] Assuming 3.75 Mt2 of afforestation, 0.75 Mt of agroforestry and 0.5 Mt of soil carbon enhancement
[8] Assuming 15 Mt2 of afforestation, 3 Mt of agroforestry and 2 Mt of soil carbon enhancement
[9] The revenue was estimated for a carbon price of 100 euro for industrial removals and 50 euro for carbon farming removals.
[10] Sources: Project sizes from McDonald et al. 2021 (link).
[11] MRV costs derived from ETS MRV report (link).
[12] MRV cost for carbon farming from Farming Ahead (link).

for activities sequestering carbon in soil (including agroforestry). Soil sampling and testing can be very expensive, above 100 euro per soil sample. However, innovative technologies combining remote sensing and artificial intelligence can significantly decrease this cost[13] and an average MRV cost of 20 to 30 euro per tonne of $CO2$ removed and sequestered in soils can probably be achieved in the future. Existing monitoring and reporting under the LULUCF, the land parcel information system under the Common Agriculture Policy, the LUCAS soil survey, national forest inventories, as well as data from the Copernicus space observations could help building a reliable monitoring system, which will become more granular and more affordable over time.

As MRV costs can become prohibitive for small-scale activities, certification schemes have developed two solutions in this respect:

- Some certification schemes such as the Clean Development Mechanism and the Woodland Carbon Code include simplified methods for small-scale activities. Adopting simplified MRV procedures for some small-scale activities can increase the adoption of carbon removal practices but can reduce the levels of accuracy and a balanced compromise need to be found to preserve climate benefits.
- Carbon removal programmes aggregate multiple projects of the same carbon removal activity in a single collective project. This approach can reduce the MRV costs for small individual projects without sacrificing the quality of the MRV. Such programmes often provide in parallel advice to the farmer on how to manage the land to increase carbon sequestration and therefore potential climate benefits but also economic benefits for the land manager. Part of the economic risk is carried by the programme developer and the project operators face less uncertainties. Most of carbon farming projects targeting soil carbon sequestration build on these programmes. The cost for the individual economic operator to join the programme can be fixed (e.g. Soil Capital requires about EUR 1400[14] per year to join its programme and the sale of the certificate goes to the farmer with a minimum of EUR 27 per carbon certificate guaranteed; other programmes such as Nori or Indigo Ag have a fee for each certificate sold, typically between 5% and 25%).

Finally, for other types of activities, for example BECCS and DACCS, the MRV cost represent only a small fraction of the overall cost and are diluted by the large volume of removals that can be generated by individual activities.

Impact of the preferred options on benefits and costs

An economic operator applying the EU certification standards, in net, will see benefits associated with increased visibility and trust that an EU framework for the certification of carbon removal would provide. They would be able to access a larger pool of potential investors in carbon removals that would create additional demand for their activities. The

[13] Smith et al. (2020) How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal (link).

[14] The price for a typical farm is £980 excluding VAT for the baseline assessment and £980 excluding VAT for each annual diagnosis, so a total of £5,880 excluding VAT for the complete a 5 year programme. The costs of any soil analyses (one at the beginning of the programme and another at the end of the programme) are not included in the programme. All other costs related to certification, possible audits and the sale of certificates are included in the price and no additional costs are charged during the programme.

recognised quality of their carbon removals would also allow them to get a better price for their removals than economic operators opting to register their removals to a certification scheme not recognised by the EU framework. The Ecosystem Marketplace 2021 report[15] indicates that the global average price of a ton of CO2 removal on voluntary markets was approximately 8 €/t in the period 2020 – 2021. However, market places specialised on high-quality carbon removal with robust MRV requirements such as Puro.earth, Label Bas Carbon, Indigo Ag, Soil Capital or Woodland Carbon Code display price between 20 and 70 euro or more.[16] Specific purchase contracts supporting the development of permanent carbon removal solutions can reach 500 €/t to 2.000 €/t.[17]

Furthermore, in particular for carbon farming, the proposed option for time-limited contracts could be attractive for many land managers because it reduces their risks and offers a continuous income in case of contract renewal.

Economic operators participating in the EU certification scheme could have additional indirect benefits such as better access to finance. As the governance options have been designed in such a way that certifiers and verifiers, who are already active as regards organic farming labelling or bio-energy sustainability, will be able to expand their business and include the certification of carbon removals in their offers, the economic operators should have the choice from a large number of certification schemes and expect a healthy competition between those schemes.

The MRV costs under an EU certification scheme are expected to be equal to those MRV of current schemes that already implement the identified best practices, in particular with regard to regular verification. Of course, a project operator who is currently using a certification scheme which e.g. does not require third-party verification will experience higher MRV costs; these should however be offset by a higher carbon price thanks to the higher trust in the quality of the generated carbon removals.

1.2. Financiers of carbon removals

The investors in carbon removals would get a reputational benefit from investing in high-quality that would offset the extra-cost of these removals compare to cheaper removals of lower quality. This is something particularly important for food and biomass processors that want to establish net-zero value chains in full transparency. This is also something beneficial for investors supporting the development of industrial removals such as through the "Frontier" initiative.[18]

An EU certification framework recognising certification scheme with high-quality carbon removals can also reduce the search costs for organisations willing to invest in high-quality certified removals to avoid the risk of being accused of greenwashing.

[15] Ecosystem Marketplace report 2021 (link).
[16] Etude comparée des standards de compensation existants (link).
[17] Marginal Carbon database of all known purchases of durable carbon removal (link).
[18] Frontier An advance market commitment to accelerate carbon removal (link).

1.3. Certification schemes and Validation & Verification bodies

The cost for adjusting the certification schemes to the transparency and reliability requirements of an EU framework should be relatively low for existing and large certification schemes since many have already in place robust and transparent processes for the validation of projects and verification of the removals. Large certification schemes have already in place high-quality registries able to ensure the registration of the activities and the traceability of removals generated. Other schemes can rely on third-party managed systems that offer registry capacity for relatively low prices (e.g. 0.07 euro per tonne of CO2 registered or transferred for Woodland Carbon Code[19]).

Once recognized under the EU legal certification framework, certification schemes could benefit from increased certification activity. Benefits would accrue from increased visibility and trust (from removals buyers and sellers), potential access to a larger pool of buyers and sellers, and resultant potential increases in supply, demand, and the overall volume and scale associated with their schemes. The net result for certification schemes is likely to be increases in revenue arising from increased registry fees relative to the baseline. Registries typically charge a one-off fee for account per new account, plus ongoing fees at the time of issuance. Issuance fees are usually per issued certificate, with tiered pricing according to volume. For instance Verra requires USD 500 for each accounted opened in its registry and then USD 0.05 for the first 10,000 certificate issued to USD 0,025 per certificate after 1,000,000 certificates have been issued.[20] The Verra's 2020 Financial report indicates that 89% of Verra's revenues comes from registration (4%) and issuance (85%) fees.[21] For Gold Standard the revenues from the registration (18%) and the issuance (54%) fees represent 72% of the total revenues.[22]

It should also be considered that the governance options have been designed in such a way that certifiers and verifiers, who are already active with organic farming labelling or bio-energy sustainability, will be able to expand their business and include the certification of carbon removals in their offers.

The development of standard methodologies by public administration is another benefit through cost saving for certification schemes that will not need to carry the cost of their development or the administrative cost of their approval.

Most existing certification schemes in the voluntary carbon market require the use of validation and verification bodies as third-party accredited auditors to evaluate documentation at various stages in the activity cycle, primarily at activity registration (often referred to as validation) and to support issuance of credits based on the results of monitoring (verification). Some existing schemes also involve VVBs in the methodology development process.

[19] For instance HIS Markit is providing the registry services for Woodland Carbon Code (link) but also other certification schemes.
[20] VCS Program Fee Schedule (link).
[21] Verra 2020 Annual report (link).
[22] Gold Standard Annual report (link).

An increase in trust for certification scheme recognised by the EU framework could increase the demand for certification and therefore the business of independent validation and verification bodies.

Taken together, it is not expected that the larger and existing certification schemes will experience significant adjustment costs should they opt for the recognition in line with the EU legal framework. The data on smaller certification schemes is not complete and some of them can have larger adjustment costs if they want to upgrade to the best practices of the EU certification scheme.

Experience from the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) application process can provide indications on administrative costs expected for certification schemes to prove their compliance with the requirements of a future EU Framework. Under CORSIA, schemes are required to complete a questionnaire with a series of closed and open questions related to1) descriptive information, 2) a summary of the scheme, 3) a detailed description of procedural aspects of the scheme (methodology development, transparent methods, registry, verification/validation procedures, governance etc), 4), description of scheme integrity criteria (i.e. management of double-counting, leakage, MRV, etc), and 5) an open comments section. Schemes are required to provide evidence, including descriptions, links to additional documentation, etc. The completed questionnaires are approximately 60-90 pages long, and potentially require approximately 1-3 person months to complete (e.g. gathering of evidence preparing submission). The precise amount of time would depend on whether the certification scheme already has all necessary evidence and information, form complexity, and if initial submissions are unsuccessful and need to be resubmitted. Using the EU standard cost model[23], this equates to an initial one-off cost of approximately €4,000-€12,000 per scheme operator. It could be expected that the accreditation costs would recur every five years, resulting in annual costs of €800-€2400 per scheme operator.

Between 2019-2022, 32 schemes applied for approval from CORSIA's Technical Advisory Board. In addition, between 2020-2022, there have been 13 schemes that have submitted additional information for reassessment. These applicants are generally the larger, international voluntary carbon crediting schemes; so far, the smaller, national or sub-national schemes present in Europe (e.g. Label bas Carbone, MoorFutures, Woodland Carbon Code) have not applied for CORSIA accreditation. It is important to note that the scope of CORSIA's accreditation goes beyond only carbon removals, including emission reductions and avoided emissions (including from carbon stock conservation by avoided nature loss). Another indication is provided by the certification of biofuels under the Renewable Energy Directive with 16 applications from certification schemes received by the Commission since 2011. Based on this numbers, the total administrative cost for certification schemes to be recognised in the EU certification framework could be roughly estimated to a one-off cost of €64,000 to €364,000 and recurring costs of €12,800 to €76,800 every five years. Lot of uncertainty remain in these estimates and variations will depend in particular on the specificities of the future carbon removal methodologies that the certification scheme will have to implement.

[23] Tool #60. The standard cost model for estimating administrative costs (link).

1.4. National authorities

As the setup of public certification schemes is not mandatory, only those Member States who see a benefit in national certification schemes will incur the related costs.

2. SUMMARY OF COSTS AND BENEFITS

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
	Direct benefits	
Development of certification methodologies by EU	**Certification schemes:** Increase in issuance of carbon removal certificates and therefore in registry revenues (**very significant**) **Economic operators and certification schemes:** Avoid the cost of developing and approving carbon removal methodologies (**moderate**)	**Recognised certification schemes** would benefit from increased visibility and trust (from removals buyers and sellers), potential access to a larger pool of buyers and sellers, and resultant potential increases in supply, demand, and the overall volume and scale associated with their schemes. The net result for certification schemes will be increases in revenue arising from increased registry fees relative to the baseline. Registries typically charge a one-off fee for account per new account, plus ongoing fees at the time of issuance. **Economic operators** have clearly indicated in their reply to the public consultation their preference for public administrations to establish carbon removal methodologies.
Implementation of EU certification methodologies	**Economic operators:** Establish a level playing field in the EU and recognise the specificities of different types of carbon removal solutions for fair competition (**very significant**).	**Economic operators** will have their carbon removal solutions better recognised on the basis of their characteristics on long-term sequestration or co-benefit generated. It would ensure fair competition among carbon removal solutions and the use of carbon removal certificates in full consideration of specific carbon removal properties.
	Indirect benefits	
Development of certification methodologies by EU	**Financiers**: It reinforces the trust in the whole certification process and therefore the reputational benefits of investing in carbon removals (**significant**) **Economic operator**: Avoid that certification schemes pass-through the cost of developing and approving methodologies (**minimal**)	The main driver to establish trust in the system should be the recognition of certification schemes but this trust would be reinforced if the methodologies are developed by public administration in full consultation with stakeholders.
Implementation of EU certification methodology	**Economic operators** will benefit from increased visibility and trust in certification schemes that would generate a higher demand for carbon removals. Reputational benefits and potential to attract new investors. (**significant**)	Participation in a recognised certification scheme could have additional indirect benefits such as a better access to other types of finance.

	Validation and Verification Bodies: An increase in trust for certification scheme would increase the demand for certification and therefore the business of independent validation and verification bodies (**very significant**)	
Administrative cost savings related to the 'one in, one out' approach*		
Development and implementation of EU certification methodologies	**Economic operator.** Reduction of search costs between schemes thanks to harmonised methodologies. **Financiers**: reduction of search costs to finance high-quality carbon removals. **Certification schemes**: Reduction of costs related to developing and approving certification methodologies	EU certification will reduce the search costs for economic operator willing to engage in a certification process as well as for investor in carbon removal certificate.

*(1) Estimates are gross values relative to the baseline for the preferred option as a whole (i.e. the impact of individual actions/obligations of the preferred option are aggregated together); (2) Please indicate which stakeholder group is the main recipient of the benefit in the comment section;(3) For reductions in regulatory costs, please describe details as to how the saving arises (e.g. reductions in adjustment costs, administrative costs, regulatory charges, enforcement costs, etc.;); (4) Cost savings related to the 'one in, one out' approach are detailed in Tool #58 and #59 of the 'better regulation' toolbox. * if relevant*

The most relevant and quantifiable costs additional to baseline are indicated in Table II. The baseline assumes that, in the absence of an EU regulatory framework, carbon removal projects would get certified by large and existing private schemes that require comparable third-party verification as under the future EU certification scheme (which is the major cost part of certification).

On the costs related to the 'one in, one out' approach, overall the initiative should generate only minimal costs to businesses compared to baseline since the initiative does not introduce new significant administrative requirements and in any case is of voluntary nature. Economic operators developing carbon removal solutions are already facing similar administrative requirements when applying today to existing certification schemes. The adjustment costs to voluntarily comply with more stringent quality criteria for a robust certification will be largely offset by the opportunities generated by the future EU framework for the certification of carbon removals.

II. Overview of costs – Preferred option							
		Citizens/Consumers		**Businesses**		**Administrations**	
		One-off	**Recurrent**	**One-off**	**Recurrent**	**One-off**	**Recurrent**
Implementation of EU Certificati	Direct adjustment costs						
	Direct administrative costs			+	+	+*	+*

on Schemes	Direct regulatory fees and charges						
	Direct enforcement costs					+*	+*
	Indirect costs						
Development of Methodologies	Direct adjustment costs						
	Direct administrative costs			-			
	Direct regulatory fees and charges						
	Direct enforcement costs						
	Indirect costs						
Costs related to the 'one in, one out' approach							
Total	Direct adjustment costs			+/-	+/-		
	Indirect adjustment costs						
	Administrative costs (for offsetting)			+/-	+/-		

** only if a new competent authority is set up (optional)*

3. RELEVANT SUSTAINABLE DEVELOPMENT GOALS

III. Overview of relevant Sustainable Development Goals – Preferred Option(s)		
Relevant SDG	**Expected progress towards the Goal**	**Comments**
2 (Zero Hunger) *Name of relevant impact indicator in the Impact Assessment:* ***Rural areas and food security***	In the specific case of carbon farming, certification can create new business opportunities and economic diversification in rural areas, and ensure long-term food security through better soil quality and resilience. However, even if a payment from carbon farming can provide additional revenue to the farmer, it cannot constitute a primary source of income, which lowers the risk of land use change away from food production.	The initiative can enable the EU Long-Term Strategy for Rural Areas flagship initiative on building up carbon sinks by investing into rewetting wetlands and peatlands. The process of monitoring and verifying carbon removals activities will also create new economic opportunities within rural communities, i.e. new types of high-quality jobs and new sources of income for rural economies. A farmer can expect an additional revenue of approximately 50 €/ha/year, to be compared to a potential 1440 €/ha revenue from soft wheat production in 2021 or the average 297 €/ha/year income support from the CAP that an EU young farmer could receive. The higher carbon sequestration potential from afforestation of 5t to 10t of CO2 captured per

		hectare can generate an annual average of 250 €/ha for the first 30 years, with lot of uncertainty regarding the fluctuation of the carbon price during this long period.
8 (Decent Work and Economic Growth) *Name of relevant impact indicator in the Impact Assessment:* ***Sectoral competitiveness and internal market***	The preferred option ensures a unified set of certification methodologies and a harmonised recognition process favouring the cross-border operations of larger certification schemes. Thus, it performs better than the other options in terms of creating a well-functioning internal market for carbon removal certification, which will create more demand and a larger market size for all actors involved in this process (economic operators, certification schemes, validation and verification bodies).	See overview of benefits in Table I above.
9 (Industry, Innovation and Infrastructure) *Name of relevant impact indicator in the Impact Assessment:* ***Innovation and digital economy***	Increased certification activities can help spur innovation in the field of carbon removals. The commercialisation pathway and the policy perspective offered by certification can help these research activities accelerate innovation towards market deployment. Furthermore, more stringent criteria on monitoring quality will spur research and innovation to enhance the available monitoring techniques.	Europe hosts several key global carbon removal demonstration sites which already involve many leading EU research institutes, and many more such demonstrators are in the planning. In the EU, remote sensing technology (e.g. the Earth observation systems under Copernicus) and uses of cloud computing systems and artificial intelligence will likely be critical to lowering the cost and improving the accuracy of nature-based removals monitoring.
12 (Responsible Production and Consumption) *Name of relevant impact indicator in the Impact Assessment:* ***Conduct of business***	The higher requirements against the quality criteria may result in adjustment costs for economic operators and/or certification schemes that are not currently applying the best practices. The governance framework will also create some administrative costs in terms for certification schemes related to the application for the recognition of their activities.	See overview of costs in Table I above.
13 (Climate Action) *Name of relevant impact indicator in the Impact Assessment:* ***Climate***	The framework will promote carbon removal activities by requiring a higher quality of the certified carbon removals, by lowering the barriers to the uptake of carbon removal activities, and by lowering transaction costs. It will also indirectly promote climate action by increasing the demand for carbon removal certificates through the creation of more trust in the certification of carbon removals.	Higher quality of carbon removals: - High accuracy of quantification - Net climate effect compared to best standard practices - Clear duration and liability rules Addressing barriers to uptake: - Competitive advantage to permanent solutions - For carbon farming: baseline that recognises first-movers, short-term commitments, remote sensing to decrease MRV costs - Research into certification methods for carbon storage products Lowering transaction costs: - Lower search costs for financers looking for high-quality carbon removals

		Lower switching costs for providers of carbon removals that seek alternative or complementary sources of finance
15 (Life on Land) *Name of relevant impact indicator in the Impact Assessment:* ***Environment***	The sustainability criteria will include minimum requirements to provide co-benefits for the environment, and safeguards to avoid the certification of activities that harm environmental objectives. The Commission will prioritise the order of the certification methodologies to be developed through Delegated acts based on their potential to provide co-benefits for the environment.	Indicators to identify and monitor co-benefits should be coherent with the indicators from existing environmental legislation, such as the proposed Nature Restoration Law, in order to ensure synergies. Similarly, criteria to identify and exclude activities that harm environmental objectives can be based on the relevant Do No Significant Harm criteria from the Taxonomy Regulation.
16 (Peace, Justice and Strong Institutions) *Name of relevant impact indicator in the Impact Assessment:* ***Public authorities; Participation***	The preferred option will not create administrative costs for public authorities in the Member States as the governance framework will be implemented directly by the Commission. Only those Member States who see a benefit in setting up a national certification schemes will incur the related costs. The Commission will develop the certification methodologies in consultation with the relevant experts and stakeholders through a dedicated Expert Group. Thanks to the Transparency criteria, the EU certification framework can level up the quality of the internal administration of certification schemes and make information more easily accessible to stakeholders and other certification schemes.	

ANNEX 4: ANALYTICAL METHODS

1. ASSESSMENT OF EU NEEDS IN CARBON REMOVALS TO ACHIEVE THE OBJECTIVE OF CLIMATE NEUTRALITY

The modelling framework and scenario used for the estimation of the future needs of the European Union in carbon removals - with a view to compensate for residual emissions and reach climate neutrality in 2050 – are originating from previous assessments carried out in the context of the EU long-term strategy “A Clean Planet for All”[24] and the package of legislative proposals to deliver the European Green Deal[25]. The modelling framework used has a successful record of use in the Commission's energy and climate policy impact assessments and covers:

- The entire energy system (energy demand, supply, prices and investments to the future) and all GHG emissions and removals.
- Time horizon: 1990 to 2070 (5-year time steps)

[24] COM (2018) 773. A Clean Planet for all (link).
[25] COM (2021) 550. Fit for 55 (link).

- Geography: individually all EU Member States, EU candidate countries and, where relevant Norway, Switzerland and Bosnia and Herzegovina

- Models used: PRIMES (all energy sectors), CAPRI (agriculture), GLOBIOM-G4M (forestry land use), GAINS (non-CO2 emissions); E3ME and GEM-E3 (macro-economy).

A detailed description of the models can be found on DG CLIMA website[26]. A summary of the needs for carbon farming and industrial removals is presented in Annex 5. More information can be found in the Staff Working Document "Sustainable carbon cycles for a 2050 climate-neutral EU - Technical Assessment".[27]

2. REVIEW AND ANALYSIS OF CARBON REMOVAL SOLUTIONS

Scientists, landowners and entrepreneurs have identified and developed various carbon farming and industrial solutions to remove carbon from the atmosphere. Each of which differs in potential to remove GHGs from the atmosphere, costs, co-benefits and negative externalities (e.g. biodiversity impacts, farm productivity, land demand, etc.) as well as in the uncertainty in quantifying removals. These solutions pose different challenges and opportunities for a carbon removal certification framework, requiring different design elements to ensure that carbon removals fulfil high-quality standards on quantification, additionality, long-term sequestration and environmental sustainability. A comprehensive review has been conducted in order to systematically evaluate carbon removal solutions and build a solid understanding of the potential and suitability of carbon farming practices and industrial technologies in the EU.

With the support of a consultant[28], a short-list of the most relevant carbon removal solutions was established using five screening criteria: 1) global carbon removal potential, 2) technological feasibility, 3) Main challenge for implementation, 4) long-term sequestration, and 5) costs. The short-list resulting from this screening is presented in Table 2.

For each short-listed solution, a fiche covering all aspects relevant to understand potential and suitability for inclusion in a certification framework was prepared. [29] To complete the fiches, the consultant researched each short-listed solution in a broad corpus of existing scientific and grey literature. The investigation focused primarily on available meta-studies, which would typically provide a review of several carbon removal solutions. Additionally, they reviewed scientific articles and other publications focusing on individual solutions, and presented the results of our research to a panel of experts and their feedback has been taken on board in the final version now available online, with the full set of references. A summary of the main characteristics of the carbon removal solutions is provided in Annex 5.

[26] DG CLIMA modelling tools for EU analysis (link).
[27] SWD (2021) 451. Sustainable carbon cycles for a 2050 climate-neutral EU - Technical Assessment (link).
[28] Consortium consisting of Umweltbundesamt GmbH (lead), Ramboll, Ecologic and Carbon Counts
[29] Bey N. et al (2021) Certification of Carbon Removals - Part 1: Synoptic review of carbon removal solutions (link).

Table 2: Short-list of carbon removal solutions analysed

Type of solution	Name	EU GHG removal potential	Cost	Technological Feasibility	Main challenge to implementation	Long-term sequestration
Carbon Farming	Afforestation	High	Low	High	Land competition,	High
Carbon Farming	Agroforestry	Medium	Low	High	Potential impact on production	Medium/ High
Carbon Farming	Blue Carbon	Low	Medium/High	Medium/High	Competition for coastal waters	Medium/ High
Carbon Farming	Soil carbon on mineral soils and grassland management	Medium	Low	High	Short-term impact on production	Low/ Medium
Carbon Farming	Peatland rewetting	Medium	Low	High	Impact production	High
Carbon Farming	Improved forest management	Medium	Low	High	Reduced near-term yields	Medium/ High
Industrial	Direct air carbon capture and storage (DACCS)	High	High/ Very High	Medium	Energy requirements	Very high
Industrial	Bioenergy with carbon capture and storage (BECCS)	High	Medium	Medium	Biomass requirements	Very high

Type of solution	Name	EU GHG removal potential	Cost	Technological Feasibility	Main challenge to implementation	Long-term sequestration
Industrial	Enhanced rock weathering	Medium	Medium	Low	Large mineral requirements	Very high
Industrial	Biochar	Medium/High	Medium	Medium/High	Biomass requirements	Medium/High
Industrial	Biomass in buildings	Low	Medium	Medium	Biomass requirement	Medium
Industrial	Carbon Capture & Utilisation (CCU)	Low/Medium	High	Medium	Energy requirement	Low/ medium

3. REVIEW AND ANALYSIS OF EXISTING SCHEMES FOR THE CERTIFICATION OF CARBON REMOVALS

Within the landscape of existing certification schemes, certificates and credits are predominantly issued for emission reductions in various sectors worldwide. However, an increasing number of those cover industrial and carbon farming solutions for carbon removals. These diverse regulatory and voluntary certification mechanisms typically provide a set of rules, procedures and requirements for a range of eligible activities in order to verify that they have reduced emissions or removed GHGs through sink enhancements and are eligible for certification/payment. These mechanisms have two main objectives: first, to ensure that carbon credits are real, measurable, additional, sustainable, not resulting in leakage, not double-counted, and long-term; second, to achieve wide scale uptake and implementation, to maximise potential impact on the climate. To achieve these objectives, certification schemes operate at two levels:

- **Methodologies** – The schemes provide methodologies for quantifying and certifying on-the-ground emission reductions or carbon removals. These methodologies are specific to particular carbon removal solutions and contexts, including specific rules for eligibility. They are technical, including calculation methods, default data (e.g. emissions factors), and instructions to quantify removals, as well rules and tests to demonstrate the quality of removals (e.g. related to additionality, sustainability, leakage, etc.). A single certification scheme can have single or multiple methodologies, each focussing on different solutions or contexts.
- **Governance mechanism**– Every certification scheme also has an overarching governance mechanism that applies principles and approval frameworks to evaluate and certify methodologies and their associated removals to ensure that that they are of acceptable quality. The architectures of certification schemes differ depending on factors such as scale or objectives but generally feature governance structures to validate projects/participants, verify and register removals, approve, develop or manage new methodologies, and facilitate uptake, among other roles.

In order to inform the Impact Assessment on the functioning of existing certification schemes, an in-depth review and analysis of these existing schemes has been carried out with the support of a consultant[30]. This review proceeded in two steps:

1. **Identification and prioritisation of mechanisms/methodologies**: Having identified a long-list of potential schemes/methods to evaluate, the consultants selected a shortlist of 11 mechanisms (see Table 3) and 16 methodologies (see Table 4) based on screening criteria such as market size, maturity, scope coverage, availability of information, etc. The short-list covers all major carbon farming and industrial, as well as different governance scales and approaches (including voluntary and regulatory, project-based, jurisdictional and national scales). Where there were multiple mechanisms/methodologies focussed on the same solution, priority was given to those methodologies with more sophisticated Monitoring, Reporting, and Verification (MRV) approach, bigger market size, and how established the method/mechanism was.
2. **Fiches:** Fiches were completed based on a desk research, including existing studies conducted by the Commission, documentation of the certification mechanisms and

[30] Consortium consisting of Umweltbundesamt GmbH (lead), Ramboll, Ecologic and Carbon Counts

their methodologies, and related academic and grey literature. All fiches are fully referenced to enable the reader to access additional knowledge related to specific areas of the synopsis provided in the fiche. Where necessary, interviews with external experts were carried out or mechanism administrators reviewed fiches and provided additional information to enrich the quality of information provided in the fiche, as well as using input and feedback gathered at an Expert Roundtable organised by the Commission. In addition, selected fiches have been externally reviewed by experts and they are now available online[31], with the full set of references.

[31] McDonald et al. (2021) Certification of carbon removals -Part 2: A review of carbon removal certification mechanisms and methodologies (link).

Table 3: Overview table of assessed architecture and governance mechanisms form various certification schemes

Certification scheme	Verified Carbon Standard (Verra)	Label Bas Carbone	Australian Emissions Reduction Fund	New Zealand ETS/ NZ Permanent Forest Sink Initiative	MoorFutures	Woodland Carbon Code
Short Scheme description	International, project-based voluntary mechanism for carbon mitigation and removals (Founded in 2005 by consortium including IETA, World Economic Forum, World Business Council. Now the largest voluntary mechanism worldwide.	Framework for voluntary carbon reduction and removal projects that was adopted by the French Government in November 2018. Current methods are focused on carbon removals and GHG emission reductions in the forestry and agriculture sector.	The Australian ERF, created in 2015, is a voluntary scheme that aims to provide incentives to adopt new practices and technologies to reduce emissions, with the overarching objective to achieve the lowest cost abatement possible, achieved using reverse auctions	New Zealand Emissions Trading Scheme (NZ ETS) has operated since 2008. It was intended to be an all sector, all gas system, including the forestry sector as both a source and sink. Removals by forestry, alongside free government allocation, are the key source of credits within the NZ ETS.	MoorFutures is a result-based voluntary scheme to incentivise the rewetting of peatlands to reduce GHG emissions. Projects are rewarded in the form of voluntary carbon credits for the reduction in GHG fluxes that arises from rewetting. Created in 2010, the Mscheme operates in three states in Germany.	The UK Woodland Carbon Code incentivises UK land-owners for woodland planting (i.e. afforestation and reforestation – for simplicity referred to as af-forestation throughout this fiche) for carbon removal through a voluntary stand-ard.
Baselines	Method dependent e.g. Wetlands: historical (20 years data), project specific Jurisdictional method: historic data (10 years data); project specific /standardised	Method dependent e.g. Forestry methods: Scenario, specific CarbonAgri: Historic data, participant-specific, revised after 5 years	Differs per method	Historical baseline (based on Kyoto eligibility e.g. baseline = 1990 forest status) Standardised	Scenario, project-specific. Baseline reset minimum every ten years	Scenario, standardised (i.e. based on previous land-use, look-up tables) Small participants: assume baseline= 0
Additionality	Relative to baseline + additionality assessment tool: Financial additionality: cost-benefit/investment test Barrier test: qualitative explanation	Relative to baseline +financial additionality +regulatory (e.g. discounting if participant also receives other funding)	Regulatory additionality (guidelines exist) Uncommon practice test (e.g. <20% penetration rates)	No additionality test: Kyoto aligned: all forests planted post-1989 are considered additional. No other additionality tests apply (as ETS designed to cover all sectors).	Relative to baseline +financial additionality	Relative to baseline + Regulatory additionality +Financial additionality: carbon payments>15% of project establishment/planting costs AND investment test + Barrier test, if financial additionality failed

Certification scheme	Verified Carbon Standard (Verra)	Label Bas Carbone	Australian Emissions Reduction Fund	New Zealand ETS/ NZ Permanent Forest Sink Initiative	MoorFutures	Woodland Carbon Code
Leakage	Quantitative: Method-specific leakage assessment criteria and management (incl. leakage assessment tool)	Qualitative leakage identification/management	no information found	No leakage management (as ETS designed to cover all sectors)	Quantitative identification of leakage, which is deducted from net removals	Small projects: assume no leakage Standard: Qualitative/quantitative assessment (identify induced land use change assessment; if >5% of removals, deduct)
Uncertainty	Identify/quantify uncertainty Discounts apply if uncertainty high	Quantify uncertainty Discounting (depending on qualitative level of uncertainty)	Method dependent	No specific information found	Conservative assumptions and uncertainty discount buffer account (equal to 30% of removals) to cover later recalculations	20% buffer withheld, then retired
Permanence management	Pooled buffer account (retired at end of project), range 10-60% Project contribution determined by Non-Permanence Risk Tool, considering project risks (management, op. cost), external risks (natural disaster, politics, ...)	Buffer Required to inform subsequent landowner	Long project duration (25/100 years) Participant liability (during project duration) if reversals >5%	ETS: Participant liable for reversals through ETS (for perpetuity) PFSI: Long project duration (99 years)	Discounting (30% buffer) Conservative estimates Long project duration (30-100 years) - credit max. 50 years of avoided emissions	20% buffer, retired at end of project. Participants liable during project Other forestry legislation limits post-project reversals
Sustainability	Identify/manage externalities Stakeholder consulting	Identify co-benefits, recorded on removal certificates Simple (co-benefit matrix) and complex (farm audit tool) tools	Negative lists (e.g. no tree planting in drought stressed locations)	No specific information found	Quantification of non-climate benefits (incl. Biodiversity, flooding, etc.). Recorded on MoorFutures certificates. Other ecosystem-services are not	Ex ante validation assesses co-benefits, managed negative externalities

Certification scheme	Verified Carbon Standard (Verra)	Label Bas Carbone	Australian Emissions Reduction Fund	New Zealand ETS/ NZ Permanent Forest Sink Initiative	MoorFutures	Woodland Carbon Code
					negatively impacted by rewetting	
Crediting periods	Agriculture, forestry, land use: 20 to 100 years Agricultural Land (re. CH_4 and N_2O emissions reduction):10 year (fixed) or 7 years (2x renewable)	Method dependent e.g. Forestry: 30 years Agriculture: 5 years	25 years or 100 years	Annual payment	50 years max	Around 40 years (min: length of clear fell cycle - max 100 years)
Validation	Ex ante project evaluation (internal and 3rd party)	Ex ante project/participant evaluation (internal or 3rd party)	Basic ex ante assessment (internal)	No ex ante validation	Ex ante project evaluation (by experts)	Ex ante validation (external)
Verification	Ex post verification (by 3rd party), incl. site visit; timing: see crediting period	Ex post verification (3rd party) incl. site visit; timing method dependent (CarbonAgri 5 years)	External verification (3rd party, site visit); minimum 3 audits per project duration	Self-verification + random auditing	External verification; site visit (5 years, then every 10 years)	Ex post verification (3rd party; site visit); after 5 years then every 10 years
Payment timing	Ex post (on verification)	Forestry: ex ante award for 30 years Ag: ex post (after 5 years)	Ex post (annually)	Annual payment	Ex ante payment	Ex ante payment (Pending issuance units) Converted into ex post credits on verification

Certification scheme	Nori Carbon Removal	Gold Standard	Clean Development Mechanism (CDM)	Joint Implementation	California's Compliance Offset Programme
Short scheme description	The Nori Carbon Removal Marketplace was established in 2017 in the USA and is currently in a pilot phase. It exclusively focuses on removing CO2 from the atmosphere. For now, only agricultural projects that focus on storing carbon dioxide in soils can apply. Nori uses blockchain technology to replace an offset market registry.	Gold Standard was established in 2003 by WWF and other international NGOs to certify and provide a mechanism for voluntary offsetting. Gold Standard is active globally and is the second largest independent offset mechanism by emissions reductions/removals. Gold Standard credits are predominantly used voluntarily but some are also accepted in some regulatory regimes.	CDM, running since 2004, is one of the three flexibility mechanisms that were established under the Kyoto Protocol (KP). CDM is project-based. It promotes carbon removal projects that assist developing countries in realising social, environmental, economic, and sustainable development while generating certified emission reductions (CERs) for investments from industrialised countries.	The JI was one of three international flexible project-based market-mechanisms estab-lished under the Kyoto Protocol (KP), that were in place between 2000 and 2012. Industrialized countries could earn emission reduction units (ERU) from emission reduction or removal units (RMU) from removal projects in another industrialized country and use them to meet part of their emission reduction targets and KP commitments	The California Compliance Offset Scheme (CCOP) is a crediting mechanism which began in 2013 and is complementary to the California Cap-and-Trade program that aims to re-duce emissions by 40% and 80% below 1990 levels by 2030 and 2050, respectively
Baselines	Scenario, participant-specific, scenario, dynamic (adjusted each year due to weather)	Differ per methodology. Generally project-specific scenario All land use/forestry must have baselines reset every five years	Scenario, project-specific and methodology-specific, conservative baseline	Scenario (BAU baseline), project-specific	Scenario (BAU baseline), project-specific and standardised (differ by methodology)
Additionality	Relative to baseline +Adoption of new management/production/technology test	Relative to baseline +Financial additionality (i.e. narrative evidence that offset credits necessary)	Relative to baseline + barrier test, investment and common practice analyses	Relative to baseline + CDM Additionality tool (depending on Track)	Sector-specific +Regulatory additionality

Certification scheme	Nori Carbon Removal	Gold Standard	Clean Development Mechanism (CDM)	Joint Implementation	California's Compliance Offset Programme
Leakage	Assume no leakage	Quantitative leakage calculation, deducted from gross removals	Quantitative leakage calculation necessary, methodology-specific, Project Design Document elaborates on procedure	Qualitative leakage identification	No specific method, i.e. no transparent and project-specific quantification of leakage effects
Uncertainty	20% buffer	Quantitative calculation (standard deviation at 90% level of confidence), based on monitoring, sampling, data. Discounts apply if uncertainty >20% Buffer: 20% for land-use/forestry projects, retired	Conservative assumptions, quantitative calculation (standard deviation at 90%/95% level of confidence), no overall data certainty requirements	Project developers must explain quality and undertake control procedures for data and variable monitoring and error sampling.	Conservative BAU assumptions
Permanence management	Participant liable for project duration plus ten years	Project developers liability	Temporary credits: periodically expire, re-issuance upon verification, expire after 5 years Long-term credits: expire after either 30 or 60 years	Project developers liable	Long project duration (storage for 100 years following credit issuance), compensation for reversals, Forest Buffer Account (10.5% to 21.2%)
Sustainability	Monitored at mechanism level but not managed	Must contribute to 2 additional SDGs. Qualitative identification/management of externalities Stakeholder involvement	Sustainable development criteria mandatory, managed negative externalities (impact assessment, mitigation action plan)	Sustainable development criteria not mandatory, anticipation of environmental impacts for LULUCF projects, management of externalities	Promote co-benefits: Revenues in Greenhouse Gas Reduction Fund: 60% towards sustainable communities, housing, public transport; 35% to disadvantaged communities

Certification scheme	Nori Carbon Removal	Gold Standard	Clean Development Mechanism (CDM)	Joint Implementation	California's Compliance Offset Programme
Crediting periods	10 years; renewable (with new baseline)	Method dependent: Either fixed 10 years or 3 x renewable 7 year (total 21 years).	Method-dependent: Standard period: 10 years or 7 years and extended 2x Sink projects: 30 years or 20 years + 2x review and extension	5 and 8 years in accordance with KP period (extension possible)	Sequestration: 10 to 30 years (forestry: 25-year average); Non-sequestration: 7 to 10 years
Validation	Ex ante validation (internal)	Ex ante validation (3rd party and internal)	Ex ante validation (approved 3rd party)	Ex ante validation (approved 3rd party)	Ex ante validation (approved 3rd party)
Verification	Ex post validation every 3 years: internal; at project end i.e. 10 years: 3rd party, site visit)	Ex post verification (external, site visit, after 2 years, then every 3 years (agriculture) or 5 years (forestry))	Ex post periodic, independent verification	Ex post verification (quality differs according to track)	Ex-post (internal, 3rd party), restriction per verifier up to 6 years
Payment timing	Ex post (upon internal verification)	Ex ante (max 20%) Ex post (upon verification)	Ex post	Ex post	Information not found. Offsetting via a private market exchange between emitters and offset project owners.

Table 4: Short list of certification methodologies reviewed.

Type of mechanism	**Category**	**Name**	**Coverage of carbon removal solutions**	**MRV Sophistication**	**Implementation stage**	**Market size**
Carbon farming methodologies	Global	VCS Jurisdictional Nested REDD+ method	sustainable forest management	high	mature	large
	Regulatory	New Zealand Emission Trading Scheme – Forestry methodology (New Zealand, regulatory afforestation)	afforestation	high	mature	large
	Regulatory	New Zealand Permanent Forest Sink Initiative methodology (New Zealand, regulatory afforestation)	afforestation	high	mature	medium
	Regulatory	Label bas Carbone methodology e.g. CarbonAgri methodology on voluntary agro-forestry	agroforestry	high	new	small
	Voluntary	MoorFutures (Germany, voluntary peatlands)	peat	high	mature	small
	Voluntary	Woodland Carbon Code (UK, voluntary afforestation)	afforestation	high	mature	medium
	Voluntary	Nori Carbon Removal Marketplace (USA, soil)	soil	high	nascent	large

Type of mechanism	Category	Name	Coverage of carbon removal solutions	MRV Sophistication	Implementation stage	Market size
	Voluntary	Indigo Ag – VCS Methodology for improved agricultural land management (Global, soil/grass)	soil/grass	high/medium	new	medium
Industrial removals methodologies	Global	Clean Development Mechanism (CDM) – specific modalities and procedures (i.e. rules) for carbon capture and geological storage project activities	Geological storage	high	mature	large
	Global	Voluntary Carbon Standard (VCS) - Methodology for Greenhouse Gas Capture and Utilization in Plastic Materials (v1.0), and Methodology for CO2 Utilization in Concrete Production (in development)	CCU Plastics, concrete	medium	new	large
	Global	Puro Earth – Methodologies for biochar, carbonated building elements, and wooden building elements	Biochar in buildings	medium	new	large

Type of mechanism	Category	Name	Coverage of carbon removal solutions	MRV Sophistication	Implementation stage	Market size
	National	Alberta Emission Offset System – Methodology for CO2 Capture and Permanent Storage in Deep Saline Aquifers	Geological burial, Saline aquifers	high/medium	medium	small
	National	Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard	Direct air capture, Geological burial	high/medium	new	medium
	National	US 45Q tax credit system – MRV guidance on the tax credit requirements (covers the capture and disposal, injection (Enhanced Oil Recovery), or utilization of CO2, captured from the atmosphere or from industrial installation and which would have otherwise be released to the atmosphere)	Direct air capture, Geological burial	high/medium	new	medium

ANNEX 5: BACKGROUND ON CARBON REMOVALS

1 IMPORTANCE OF CARBON REMOVALS FOR 2050 CLIMATE NEUTRALITY

Reaching climate neutrality in the EU by 2050 has been an aspiration for the Commission since the publication of 'A Clean Planet for all[32]' in late 2018. Reducing the Union emissions to net zero by mid-century is now a formal commitment under the European Green Deal, and the European Climate Law adopted in 2021 sets the EU objective of climate-neutrality by requiring the reduction of Union-wide greenhouse gas emissions to net zero by 2050 and the aim of achieving net removals (negative emissions) thereafter. The analysis carried out by the European Commission[33,34] shows how this objective of climate neutrality can be achieved. Any pathway towards climate neutrality entails a drastic reduction of Greenhouse Gases (GHG) emissions in all sectors, with an EU economy-wide emission reduction ranging from 85% to 95% compared to 1990[35]. Carbon dioxide removals will close the gap to reaching net zero GHG emissions through, in the mid-term, the enhancement of the natural sink and, in the longer term, the deployment of industrial solutions able to capture and store CO_2 permanently. The quantity of CO_2 to be removed from the atmosphere and the respective role of ecosystems and industrial solutions for carbon removals vary following assumptions on technological uptakes and consumption patterns for transport, food diet and other goods or services.

Globally, while latest findings by the IPCC[36] point towards a decreasing likeliness of limiting global warming to 1.5°C unless rapid GHG emission reductions occur, the importance of carbon removal is only increasing. In order to still reach the goal of limiting global warming to 1.5°C, 20-660 Gt CO2 net negative emissions need to be generated in the timeframe 2020-2100.[37]

The scenario analysis on the need for carbon removals in a 2050 climate neutral EU carried out in the context of the Communication on Sustainable Carbon Cycles and presented in more details in Staff Working Document "Sustainable carbon cycles for a 2050 climate-neutral EU - Technical Assessment" shows variation depending on future societal choices, all options require a substantial enhancement of the carbon sink function of our ecosystems and a large development of industrial solutions to capture, use and store carbon.

The scenario ECOSYS assumes priority is given to the enhancement of the carbon removals through the restoration of ecosystems. This is also a scenario where changes in lifestyle and consumer choices are beneficial for the climate. It includes less carbon intensive diets that free land for the regeneration of natural ecosystems. The scenario INDUS relies more heavily on large scale deployments of industrial solutions to capture, recycle and store CO2.

The achievement of the EU climate-neutrality objective will require the industrial carbon capture of at least 300 $MtCO_2$ for ECOSYS and more than 500 $MtCO_2$ for INDUS from various sources (power generation, industrial processes or directly from the air) for storage or to supply innovative routes to produce materials and fuels. By 2050, the uptake of renewable energies such

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[32] COM (2018) 773, A Clean Planet for all (link).
[33] In depth analysis accompanying the Communication "A Clean Planet for All" (link).
[34] SWD (2020) 176, Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people (link).
[35] These figures are focusing on emission reductions and excludes CO2 emissions captured and stored in CCS facilities as well as carbon removals from the land sector.
[36] IPCC WG III (2022), Technical Summary. In: Climate Change 2022: Mitigation of Climate Change. AR6 (link).
[37] IPCC (2018), IPCC Special Report on the impacts of global warming of 1.5°C (link).

as wind and solar in the power sector as well as innovation in industry will strongly reduce the use of fossil fuel and limit the CO_2 emitted from point source installation. Even though some process emissions will remain, an EU economy aiming at restoring sustainable carbon cycles will need to source most of its carbon directly from the air and from biogenic sources as long as it stays within acceptable boundaries without negative impact on biodiversity and other environmental assets.

The CO2 captured can also be stored either permanently in geological sites or in new long-lasting products to eventually provide industrial carbon removals when it is directly or indirectly captured from the atmosphere. They play a more important role in INDUS that is requiring more than 300 MtCO2 to be stored each year in geological storage sites or products to neutralise the relatively high residual emissions in sectors such as agriculture and aviation. The reliance on industrial carbon removal is lower in ECOSYS but the scenario still requires to store each year more than 100 MtCO2 (Figure 7).

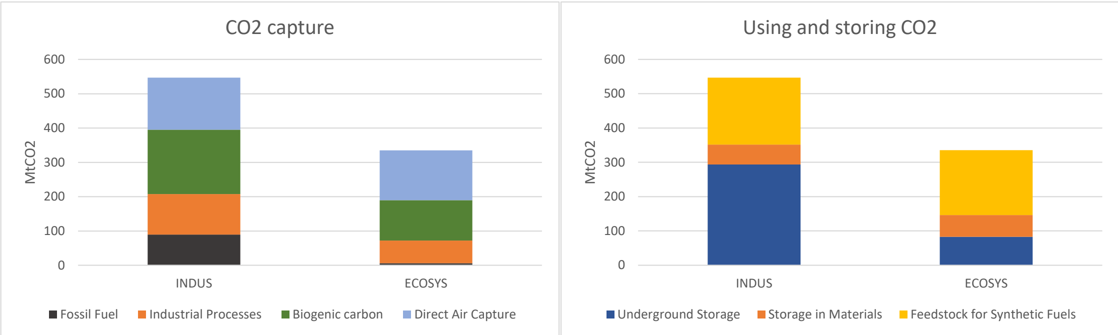

Figure 7: Industrial capture, use and storage CO_2 by 2050 in EU carbon neutral scenarios

Figure 8 presents the LULUCF sink projected for the scenarios INDUS and ECOSYS at various carbon prices aiming to incentivise action in the sector. The potential at “No carbon price” corresponds to the level of net removals with no specific measures deployed to support the enhancement of carbon removals in ecosystems.

The “No carbon price” level of LULUCF sink for the scenario INDUS is lower than the removals projected in the EU Reference scenario 2020 due to the greater use of bioenergy. On the contrary, in ECOSYS the LULUCF sink benefits from a lower demand in bioenergy and from the release to natural vegetation of agriculture land driven by changes in the food consumption pattern of this demand driven scenario.

If appropriate supporting action is taken, the land-use modelling suggests a potential to increase the net removals of the LULUCF sector by about 185 Mt of additional CO2 sequestration towards 2050 at a maximum marginal cost of EUR 150/tCO2e. But the starting point matters, and removal potential can be higher or lower depending on lifestyle changes and bio-energy requirements impacting land use requirements.

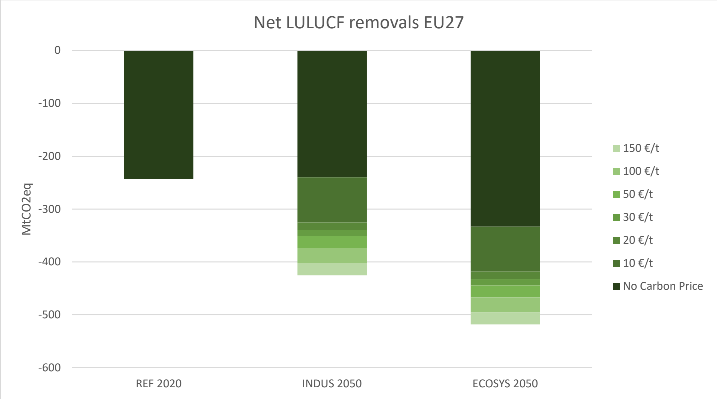

Figure 8: Potential for EU LULUCF sink enhancement at various carbon prices in INDUS and ECOSYS scenarios

2 TYPES OF CARBON REMOVAL SOLUTIONS

Carbon removal solutions remove carbon from the atmosphere through biological, chemical or geochemical processes to store it either in biomass, soils, products, minerals, geological reservoirs or marine sediments.[38] Different storage media lead to different timescales of carbon storage and different risks of releasing CO2 back to the atmosphere. The storage of carbon in geological reservoirs, sediments or in a mineral form can last several millennia and be considered permanent. Storage of carbon in products or in soil and vegetation is by nature more dynamic and can last from years to decades or centuries. This section presents the characteristics of various carbon removal solutions as well as an assessment of their cost and potential. Unless specified differently, the information presented is referring to the following sources:

- Technology Readiness Level (TRL), Cost (EUR/tCO2) and Global Potential (MtCO2/yr): Sixth Assessment Report of IPCCC Working Group III on Mitigation of Climate Change[38]
- EU potential (MtCO2/yr): Economic potentials as assessed in the modelling work of the European Commission and reported in various documents such as the in-depth analysis accompanying the Communication "A Clean Planet for All"[33], the Impact assessment prepared for the revision of the LULUCF Regulation[39] and the Technical Assessment accompanying the Communication "Sustainable Carbon Cycles"[40] as well as Synoptic review of carbon removal solutions prepared by Environment Agency Austria.**Error! Bookmark not defined.**

The large ranges reported, in particular for costs and potentials, reflect the high level of uncertainties attached to the estimates. The numbers reported are long-term potentials and costs, often from 2050 modelling. Short-term potentials are lower for most of the carbon removal solutions presented, in particular for industrial removals but also for some carbon farming practices such as afforestation.

[38] IPCC WG III (2022), Climate Change 2022: Mitigation of Climate Change. AR6 (link).
[39] SWD (2021) 609, Better regulation agenda (link).
[40] SWD (2021) 451. Sustainable carbon cycles for a 2050 climate-neutral EU - Technical Assessment (link).

2.1 Permanent Geological storage of carbon

Bioenergy with carbon capture and storage (BECCS)

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Biological	Geological	5-6	15-400	500-11,000	5-276

BECCS (Bio-energy carbon capture and storage) is the combination of generating energy from biomass with carbon capture and storage. A relatively pure stream of CO2 from industrial and energy-related sources at bioenergy facilities is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere. Feedstocks include dedicated bioenergy crops, residual products and forest biomass, municipal waste and algae. The CO2 for BECCS can stem from biological processes such as fermentation (e.g. for the production of biofuels) but also from the combustion of biomass for the generation of heat and power.

Whether BECCS can actually yield negative emissions across its lifecycle depends on the biomass feedstock but also on other factors such as biomass yield, fertiliser application, and biomass drying (for high moisture biomass). Other elements to consider are the transport and processing of the biomass. Even though plants take up CO_2 while they are growing, the process steps of planting, growing, harvesting and transporting biomass requires energy which in turn causes emissions. Besides the impact of harvesting the biomass on the land carbon stocks, another important factor to consider is indirect land use change (ILUC), which has been widely discussed in the context of first generation biofuels: where pasture or agricultural land previously destined for food and feed markets is diverted to biofuel production, the non-fuel demand will still need to be satisfied either through intensification of current production or by bringing non-agricultural land into production elsewhere. The latter case constitutes indirect land-use change and when it involves the conversion of land with high carbon stock it can lead to significant GHG emissions. The IPCC special report on Climate Change and Land[41] found that negative impacts on biodiversity and food security through land competition might arise if BECCS is deployed globally at large-scale. The availability of sustainable biomass is one of the major limiting factors for the deployment of BECCS that contributes to removing carbon from the atmosphere.

Project sizes for BECCS installations range from 0.1 to 4 Mt CO2 per year.[42]

Examples of solutions already operational or in planning

Currently, there are more than 10 facilities, most involve the capture of fermentation derived CO_2 from ethanol plants, and only one is large-scale.

- Stockholm Exergi BECCS plant (SE): expected to start operations in 2026, the plant combines CO2 capture with heat recovery, reducing GHG emissions by 7.83 Mt of CO2eq during its first ten years of operation.

[41] IPCC (2019). Climate Change and Land. An IPCC special report (link).
[42] Bey N. et al (2021) Certification of Carbon Removals - Part 1: Synoptic review of carbon removal solutions (link).

- Klemetsrud WtE plant (NO): expected to be operational in 2023/2024 (if approved for investment), planned CO_2 capture capacity: 0.4 $MtCO_2$/year (from both fossil and biological materials).
- Twence WtE plant (NL): uses Aker's Just Catch modular carbon capture plant to capture CO_2. CO_2 will be captured from flue gas, commissioning expected in 2021, CO_2 capture capacity: 0.1 $MtCO_2$/year.
- Drax BECCS plant (UK), operational since 2019, pilot project. Drax power station converted from coal-fired to biomass. Plan to capture 4 $MtCO_2$/year at one of the power station units with storage in a North Sea oil field, with a start date in 2027. Plan to operate CCS units on all four bioenergy power units by mid-2030s.
- Illinois Industrial Carbon Capture and Storage, implemented by Archer Daniels Midland and funded by the Department of Energy (US): operational since 2017, capture capacity: 1Mt CO_2/year, CO_2 captured from ethanol production and stored into the Mount Simon Sandstone saline aquifer in the Illinois Basin.

Existing certification schemes

- In an EU context, the Innovation Fund methodology for carbon capture and storage assesses projects characterised by the capture of CO2 in industrial processes or power generation, or directly from ambient air. Storage sites are permitted under the CCS Directive 2009/31/EC and can be different types of geological formations: saline aquifers, depleted oil and gas reservoirs, un-mineable coal beds, or mafic rocks (e.g. basalts).
- Puro.earth has developed a methodology for carbon removal solutions with geologically stored carbon

Direct air carbon capture and storage (DACCS)

Capture	Storage	TRL	Cost (€/tCO_2)	Potential ($MtCO_2$/yr) Global	EU
Chemical	Geological	6	84-386	5,000-40,000	83-264

DACCS uses engineering processes relying on chemical capture to remove CO_2 directly from the atmosphere using a separating agent that is regenerated with heat, water, or both. The CO_2 is subsequently desorbed from the agent and released as a high purity stream. There are two main methods to capture CO_2 from the air:

- Liquid systems: the air passes through chemical solutions (e.g. a hydroxide solution), which removes the CO_2 and returns the rest of the air to the environment.

- Solid system: the air passes through filters composed of solid sorbents which chemically bind with CO_2.

The process to separate CO_2 from the other components of ambient air is either done through absorption or adsorption. The main disadvantage of these adsorption and absorption processes is that the regeneration of the sorbents requires large amounts of energy and thereby leads to high costs of direct air capture technologies. Further practical barriers include the need for an abundant supply of renewable energy. Even though DACCS installations per se do not require a lot of space, the supply of required renewable energy translates to around 2,000 km^2 of non-arable land that could be needed to remove 1 Gt of CO_2 net from the atmosphere.[43] Furthermore, the water input to different DACCS technologies needs to be considered. Capture technologies that use electrochemical processes to regenerate the sorbent are promising to reduce energy requirements for DACCS and thereby cost. However, these processes are still nascent and not deployed at industrial scale.

Current DACCS facilities in various locations around the world capture between 3-4,000 t CO2/yr. Targeted installation capacities for 2030 are about 1-2 Mt CO2/yr.

Examples of solutions already operational or in planning

Existing DAC plants are small. The global capture capacity lies below 10,000 tCO_2/year. CO_2 is either utilised in industrial processes (e.g. carbonating drinks, Power-to-X, greenhouse fertilisation) or permanently stored. Example of important projects are:

- The Orca project is a collaboration between Climeworks and the Carbfix project (Iceland): It has been operational since September 2021 with a carbon removal capacity of 4000t CO_2/year, running on renewable geothermal energy with CO_2 storage via mineralization.
- Carbon Engineering, in partnership with 1PointFive, plans to begin the construction of their first large-scale commercial DACCS plant. It is under development and will be located in the Permian Basin, U.S. with an expected capacity to capture one million tons of carbon dioxide from the air annually when completed.

Existing certification schemes

- In an EU context, the Innovation Fund methodology for carbon capture and storage assesses projects characterised by the capture of CO2 in industrial processes or power generation, or directly from ambient air. Storage sites are permitted under the CCS Directive 2009/31/EC and can be different types of geological formations: saline aquifers, depleted oil and gas reservoirs, un-mineable coal beds, or mafic rocks (e.g. basalts).
- Puro.earth has developed a methodology for carbon removal solutions for geologically stored carbon
- California Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard
- US 45Q tax credit system

2.2 Other permanent storage

Enhanced Rock weathering

Capture	Storage	TRL	Cost (€/tCO_2)	Potential ($MtCO_2$/yr)	
				Global	EU
Geochemical	Mineral	3-4	24-578	1,000-95,000	n.a.

[43] Beuttler C. et al. (2019). The Role of Direct Air Capture in Mitigation of Anthropogenic Greenhouse Gas Emissions 1 (link).

Enhanced Rock weathering (ERW) refers to carbon removal solutions targeting the enhancement of geochemical processes that naturally absorb CO2 from the atmosphere. ERW spreads fine-grained silicate rocks containing calcium or magnesium on land (e.g. cropland) which react with CO2 by forming carbonate minerals and hence remove CO2 from the atmosphere. Similar methods can be applied to the open ocean (see Ocean alkalinisation).

Upscaling these carbon removal solutions may require additional mining of new rocks, which requires significant energy for mining, grinding and transportation steps and creates additional CO2 emissions and environmental impacts. In order to better assess the overall potential and effects of ERW, further research needs to be conducted. Two of the potential impacts, which need to be better understood, are:

- Impacts on human health in case of particles of respirable size and potential impacts on groundwater when particles are washed away.
- Potential release of heavy metals, changes in soil hydraulic properties, soil contamination and disturbed ecosystems

Examples of solutions already operational or in planning

- GreenSand (Netherlands): Offers carbon credits to customers from applying crushed olivine as replacement for sand and gravel in construction or landscaping projects (credits sold 42 EUR/tCO2). The company has since 2007 scattered 45,452 tonnes of greenSand Olivine and claims to have removed 3,284 tonnes CO2 from the atmosphere.
- Working Lands Innovation Center: ERW demonstration experiment in coastal California, the Central Valley, and Imperial Valley. The project is in partnership with farmers, ranchers, government, mining industry, and Native American tribes. It tests the GHG removal effect of rock dust and compost amendments from soil, including other aspects such as crop yields, and plant and microbial health. The project supports the commercialization of soil amendment technologies.
- University of Sheffield - Leverhulme Centre for Climate Change Mitigation, 10-year programme established in 2016: Large-scale field trials to measure rates of rock weathering in agricultural soils under natural conditions and how nutrient release and pH change may increase crop productivity. The project utilises basalt rock dust generated as a by-product, meaning there are no additional CO2 emissions from mining and grinding. The project aims to estimate carbon removals based on field studies.

Existing certification schemes

GreenSand sells credits in the form of 'Cleanup Certificates', but limited information is available. They are affiliated with NL Greenlabel, an organisation which develops a form of ecolabelling.

Ocean alkalinisation

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Geochemical	Mineral	1-2	40-260	1,000-100,000	n.a

Ocean alkalinization is the deposition of alkaline minerals or their dissociation products at the ocean surface. This increases total surface alkalinity, and may thus increase ocean CO2 uptake and ameliorate surface ocean acidification as co-benefit. The residence time of dissolved inorganic carbon in the deep ocean lies at around 100,000 years. Ecological and biogeochemical consequences of ocean alkalinisation largely depend on the minerals used. When natural minerals such as olivine are used, the release of additional silicon and iron could have fertilising effects. In addition to perturbations to marine ecosystems via reorganisation of community structure, potentially adverse effects of ocean alkalinisation that should be studied include the release of toxic trace metals from some deposited minerals. However, as also expressed by the relatively low TRL, the understanding of effects and risks of ERW at large scales is still poorly understood. Further difficulties for large-scale application under certification arise from limitations in marine law and questions of how to conduct MRV for ERW.

Examples of solutions already operational or in planning

None.

Existing certification schemes

None.

Ocean Fertilisation

Capture	Storage	TRL	Cost (€/tCO_2)	Potential ($MtCO_2$/yr)	
				Global	EU
Biological	Sediments	1-2	50-500	1,000-3,000	n.a

Ocean fertilisation is a carbon removal method that depends on the intentional addition of nutrients to the near-surface ocean with the goal of sequestering further CO2 from the atmosphere through biological production.[44] Macro-nutrients or micronutrients may be directly added to the near-surface ocean. In order to ensure the successful long-term removal of carbon from the atmosphere, the additionally sequestered carbon must reach the deep ocean. There, it may be stored on climatically relevant time-scales. Ocean fertilisation however also has several anticipated side-effects: toxic species of diatoms may appear more commonly, with knowledge gaps on the effects on food webs and marine biology, as well as the potential for creating anoxic ocean regions and disruption of marine ecosystems. As ocean alkalinization, the application of ocean fertilisation is furthermore limited by practical barriers such as international marine law.

Examples of solutions already operational or in planning

None.

Existing certification schemes

None.

Other

Carbon removal research community is looking at few other solutions to remove carbon from the atmosphere, in particular ocean based solutions. However the understanding on their

[44] IPCC WG III (2022). Climate Change 2022: Mitigation of Climate Change. AR6 (link).

feasibility, mitigation potential, risk or impacts is rather low and this solutions are currently not relevant in the context of an EU framework for the certification of carbon removals.

Artificial upwelling

Artificial upwelling uses pipes to transport water from the deep ocean, which is rich in nutrients, to surface waters, where it acts as a fertiliser.[44] In order for this solution to deliver carbon removals on a Gt scale, it would need to be applied extensively, as previous calculations suggested that in the best-case scenario, more than half of the ocean would be needed to deliver carbon removals of 10 Gt CO2/yr. Artificial upwelling may furthermore significantly affect precipitation and atmospheric circulation.

Terrestrial biomass dumping

Another carbon removal solution is the sinking of terrestrial biomass, such as logs, crop residues or biochar, into the deep ocean.[44] Cold water temperatures, as well as the lack of oxygen and relevant decomposing bacteria, halt the decomposition of the biomass, leading to projected storage timescales of hundreds or even thousands of years. Many aspects of this carbon removal solution, such as effects on land nutrient availability as well as on marine chemistry, ecosystems and circulation, require further research.

Marine biomass

For this solution, marine algae could be utilized in several ways: either by sinking cultured macroalgae to great ocean depths, by cultivating macroalgae, or by utilizing algae as biochar feedstock. These algae could also be fertilized or dumped at great ocean depths.[44] The potential of carbon removal by marine biomass could reach up to 19 GtCO2, using 9% of the oceans for macroalgal aquaculture.[45] Currently, further research is being conducted on the potential of this carbon removal solution.

Extraction of CO2 from seawater

CO2 can be removed from seawater using a vacuum or gas with low CO2 contents, mineral acid or via electrolysis or electrodialysis.[44] Due to the reduction of CO2 in ocean surface waters, atmospheric CO2 enters the ocean to restore the equilibrium, thereby decreasing atmospheric CO2 concentrations.

Methane removals

Methane (CH4) is the second most dominant GHG after CO2.[46] It can be removed from the atmosphere as CH4 or be oxidized, e.g. to CO2. If a total of 3.2 Gt CH4 were removed from the atmosphere, pre-industrial levels would be re-established and total global radiative forcing would decrease by one sixth, despite adding 8.2 Gt CO2 to the atmosphere in the case of oxidation to CO2. Industrial methane removal is however more complicated than CO2 removal as capture is

[45] N'Yeurt, A.d.R., et al. (2012). Negative carbon via Ocean Afforestation. Process Safety and Environmental Protection, 90, 6 (link).

[46] Jackson, R.B., *et al.* (2019). Methane removal and atmospheric restoration. *Nat Sustain* **2,** 436–438, (link).

complicated by differing chemical properties of CH4 and its overall lower concentration in the atmosphere.

2.3 Carbon Farming

Afforestation and reforestation

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Biological	Vegetation	8-9	0-240	500-10,000	18-36

Afforestation and Reforestation describe the planting trees/establishing forests in areas where there previously were no trees (afforestation) or conversion of land to forest that previously contained forest but has been converted to other use (reforestation), to capture CO2. The two are among the most prominent land mitigation actions and imply a long-term land use change. In Europe, afforestation takes place mainly on marginal land or land that may not be used for crop production anymore. Care should be taken when choosing locations, species and methodology for afforestation projects to avoid negative and unintended impact: Afforestation may reduce valuable agricultural area if afforestation occurs on fertile arable land, may negatively affect biodiversity, e.g. on former biodiverse grasslands or peatlands, or lead to net positive GHG emissions, if afforestation takes place on organic soils.

Total mitigation potential of afforestation is also limited by the availability of land. Most of afforestation in the EU takes place through natural or spontaneous forest growth. This however requires that land managers allow trees to spread and grow, hence require a land management strategy of no action. Once a dense low story forest has developed, land managers may intervene to optimize the management of the nascent forest (see improved forest management).

Assisted afforestation by tree planting is currently rather limited in the EU but it ensures higher survival rates per seedlings and is therefore a useful means to complement natural forest growth. Afforestation by tree planting requires comparatively high initial investments.

Examples of solutions already operational or in planning

Afforestation and reforestation are widespread across Europe.

Existing certification mechanisms

Afforestation and reforestation are already part of many existing certification mechanisms, including Label Bas Carbone, the Woodland Carbon Code, New Zealand Emissions Trading Scheme, and the Australian Reduction Fund.

- Label bas Carbone focuses on the certification of carbon offset projects in afforestation, reforestation of destroyed or impacted forests, or conversion of coppice to high stands in forests. To date, 173 individual forestry projects are certified, representing a potential of 320 302 tCO2.[47]
- Woodland Carbon Code (WCC) incentivises UK land-owners for woodland planting for carbon removal through a voluntary standard. Since its 2011 launch, 187 projects

[47] Label Bas Carbone (link).

covering 8,261ha have been validated, with expected carbon sequestration of 3.4million tCO_2.

- New Zealand Emissions Trading Scheme: afforestation is included in New Zealand's ETS as a carbon removal option (sequestration is rewarded with credits). Since 2008, this has resulted in 18.3 Mt CO_2-eq removals.
- Gold Standard and VCS mechanisms include methodologies for afforestation and reforestation.

Improved forest management

Capture	Storage	TRL	Cost (€/tCO_2)	Potential ($MtCO_2$/yr) Global	EU
Biological	Vegetation	8-9	n.a.	100-2,100	20-80

Carbon friendly changes to management practices of existing forests are a powerful means to achieve additional mitigation. They do not result in any visual changes of the landscape (no land use change) but can have significant consequences for biodiversity, the environment and the socio-economy either positive or negative, depending on the measures applied. Changes in the land management may imply additional actions, and hence operational costs that would commonly be attributed to forest maintenance budgets – or no actions with cost-savings; both resulting in possibly significant long-term consequences. Forest thinning is the main management practice influencing tree growth[48] and health of the forest, affecting the prevalence of species and impacting wood production and wood value. Further key actions include better harvesting practices (e.g. actions to decrease emissions per unit of timber), lowering harvest intensity (longer forest rotations, selective cutting), reducing disturbances (e.g. fire/pest management), and increasing biomass growth (e.g. thinning, drainage, replanting with new species).

Protection of forests, especially of those of particular ecological value, is another strategy of increasing long-term carbon storage in forest ecosystems. Even though the sink function of old unmanaged forests tends towards zero as they mature and reach an equilibrium[49], forest protection offers short- to medium-term carbon sink benefits until the saturation point is reached, while providing high biodiversity value and increased forest resilience as the forest develops old-growth attributes[50,51].

Changes in forest management have rather small mitigation benefits per hectare. On the other hand, a significant roll out can be expected due to the overall low cost for action, the need to adapt to changing climatic conditions, and long-term revenues and co-benefits with the environment. This combination results in the highest total land mitigation benefit for forest

[48] Ker G; et al. (2011), Thinning Practice A Silvicultural Guide (link).
[49] Grassi G. et al. (2021), Brief on the role of the forest-based bioeconomy in mitigating climate change through carbon storage and material substitution (link).
[50] O'Brien L. et al. (2021), Protecting old-growth forests in Europe. A review of scientific evidence to inform policy implementation (link).
[51] Albrich K. et al. (2021), The long way back: Development of Central European mountain forests towards old-growth conditions after cessation of management (link).

management from changes in the practices in Europe, compared to all other actions on land use as modelled in the LULUCF Impact Assessment[52].

Examples of solutions already operational or in planning

Forest management is widespread across Europe.

Existing certification mechanisms

- Label Bas Carbone has a methodology for converting coppice forests into uneven-aged high stands.
- The Woodland Carbon Code also covers some forest management improvements.
- International methods include e.g. VCS, which has a general methodology for improved forest management, as well as a number of specific methods including reduced impact logging, fire management, forest conversion, avoided forest degradation, extension of rotation age and other.

Agroforestry

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Biological	Vegetation and Soil	8-9	n.a	300-9,400	7.8-235

Agroforestry describes a form of land use intentionally combining the growth of woody perennials with crop production or animal husbandry on the same land area.[53] It is a prime example of integrated land management and likely the mitigation action with benefits in several policy fields. At the same parcel and time agroforestry can deliver on:

- climate mitigation and adaptation by increased carbon removals, better potentials to retain the stored carbon, nitrogen fixation, and lower risks for disturbances
- biodiversity and wider environmental improvement agenda by increasing species richness, better water retention, reduced erosion and natural nutrient management
- bioeconomy by providing biomass and fiber which may be converted into long-lasting biobased products
- food sector by providing crops from arable land, ground for grazing or animal feed from grasslands, and high value marketable products from fruit and nut trees, but lower intensity
- energy by providing feedstock from low value biomass

There is a multitude of forms of agroforestry and a wide variety of its implementation across the world. Of relevance in the EU and at scale are silvo-arable systems, i.e. the mix between trees and crops (frequently planted in alleys), and silvo-pasture systems, which are a mix between trees and permanent pasture that may be grazed or mowed for hay or silage. Other forms such as forest gardening, forest farming tree rows or hedges for property separation, or windbreaks or

[52] SWD (2021) 609, Impact Assessment revision LULUCF regulation (link).
[53] FAO (2015), Agroforestry definition (link).

riparian buffer strips, are of smaller importance for carbon but of high value for biodiversity and the environment. Maintenance of agroforestry systems does in most cases not require substantial management actions, hence operating costs are low.

Beyond cost-effectiveness, land transformation to agroforestry systems could be restrained by biophysical barriers. For instance, agricultural land on organic soils should not be converted into agroforestry systems, which require machinery or foraging animals to some extent that could lead to soil disturbance and erosion.

Examples of solutions already operational or in planning

Agroforestry is widely implemented across Europe.

Existing certification mechanisms

- The CarboCage project in France is a publicly-funded project (2016-2020) developing and implementing a method for carbon storage through sustainable hedge management, where carbon removals will be sold in local voluntary carbon markets.

- Other projects include: Coop project (Switzerland), where the coop retailer has been supporting farmers within their supply chain to plant trees on their land to deliver GHG emission reductions, and crediting the removals against coop emissions. Other ongoing research projects include one focussed on the Montado (by University of Evora) and CarboHedge (by Thunen Institut).

Organic soils, peatlands and wetlands

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU[54]
Biological	Soil	8-9	n.a.	500-2,100	52-54

The rewetting of peatlands and wetlands predominantly avoids emissions, rather than removing carbon from the atmosphere. As peatlands and wetlands are drained (e.g. for agriculture, urban expansion) or degrade, they release stored carbon (and nitrous oxide). Rewetting or restoring drained peatlands swiftly stops the release of this carbon into the atmosphere (i.e. avoided emissions). Rewetting also leads to sequestration through plant growth and increases in carbon stock, although these are small and variable and only occur over longer timescales. The build of the carbon stock in the period immediately after restoration takes 20-50 years and is initially hardly measurable.[55]

These mitigation strategies predominantly focus on carbon emission reductions from decaying organic material, in most cases due to drainage and intensive land use. Therefore, the most efficient mitigation practices such as fallowing of organic soils under cropland and grassland aim at avoiding drainage. Rewetting will accelerate the process of rising water tables, but in

[54] In the specific case of peatlands, this EU potential is predominantly achieved through the reduction of emissions from carbon already sequestred in soils rather than from removing carbon from the atmosphere removals.
[55] COWI, Ecologic Institute and IEEP (2021), Technical Guidance Handbook - setting up and implementing result-based carbon farming mechanisms in the EU Report to the European Commission (link).

some cases requires technical deployment of measures, which may be costly and invasive to the ecosystem. A decision on the most appropriate mitigation action and intensity thereof needs to be made on a case-by-case basis.

Carbon benefits should not be assessed in isolation; instead, an assessment of the overall greenhouse gas balance, also taking into account emissions of CH_4 and N_2O, is required. Increasing the water table will gradually lower emissions and eventually sequester carbon. This net reduction in CO_2 emissions to the atmosphere, however, is countered by emissions of CH_4 and N_2O due to the anaerobic conditions in the soil, though on balance peatland rewetting is expected to deliver large net mitigation results and higher carbon stocks in soils. Increasing the water table will gradually lower emissions. An optimal total net greenhouse gas balance can be reached through careful control of the optimal water table, which can be achieved by various technical controls.

Besides carbon benefits and the greenhouse gas balance, action on organic soils needs a holistic view on co-benefits with the biodiversity and environment and potential economic implications. Most mitigation actions will require an extensification or stop of today's land use practices. In many cases this will be beneficial for biodiversity, although some species from today's land uses will not be able to cope with the new, generally wetter conditions. There are also co-benefits for water filtration and retention capacity and air quality. Economic losses of income foregone may be at least partially mitigated by opportunities for paludiculture or very extensive seasonal grazing land.

Examples of solutions already operational or in planning

Peatland rewetting is widespread across Europe.

Existing certification mechanisms

- MoorFutures in Germany, a voluntary offset standard which since establishment in 2010 has certified projects with lifetime mitigation impact of 68,889tCO2-eq.
- Peatland Code in the UK, aims to have 2 million ha of UK peatlands under restoration management by 2040.
- MaxMoor in Switzerland focuses on restoring degraded peatlands that are no longer in agricultural use, with estimated potential of avoiding up to 19,000t CO2-eq per year.
- Verra's Verified Carbon Standard has five methods for peatland/wetland rewetting and coastal restoration. Most relevant for the EU is VM0036 Methodology for Rewetting Drained Temperate Peatlands v1.014 (published in 2017); as of time of writing, there were no registered projects for this methodology in the Verra registry.

Mineral soil carbon sequestration

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Biological	Soil	8-9	45-100	600-9,300	9-116

There is a variety of potential practices to increase soil organic carbon in mineral soils under agricultural use, including the conversion to permanent grassland, the rotation between cropland and grassland, crop residue management, planting cover crops to reduce erosion and fix nitrogen, crop rotations, reduced or no tillage, etc. While the conversion of cropland to grassland or forests holds the highest mitigation potential (excluding for intensive grasing purposes), it also implies a permanent conversion of the land use and implicitly a loss of its value for the land manager. Other changes in the practices maintain cropland land use and can be applied in parallel or rotation. Yet, they generally require some extensification by reducing the soil disturbance or by temporally planting other crops.

In most Member States grassland systems sequester more CO_2 in mineral soils than they emit. Often, such systems also require significant management action with implications on carbon storage. Mowing and removals of biomass for hay making or silage, soil compaction by the use of heavy machinery or shallow tillage may reduce storage capacities. On the other hand, these practices are needed to maintain grassland landscapes and allow for limited economic benefits from this land. In many cases grazing animals may be preferred, but inadequate management can cause damages e.g. by soil compaction, overgrazing or erosion when roaming on steeper slopes.

A change in the land management practices requires a holistic view. Specific land use practices such as nitrogen fixing catch crops may bring about significant short-term benefits for CO_2 removals while, if not properly controlled, N_2O emissions could also increase, resulting in net greenhouse gas emissions after a few decades[56]. While soils hold a significant carbon stock which can be increased, sequestration capacities will reach limits after a few decades, with the long-term challenge of ensuring permanence. Yet, today's main challenge is the considerable roll out of actions that would be needed to achieve significant additional removals from mineral soils.

Examples of solutions already operational or in planning

Many practices to increase soil carbon stocks are already implemented across the EU, e.g. cover cropping. Some CAP funding supports soil-health/soil carbon stock enhancements e.g. organic farming, cropping rotations, fertiliser management etc..

Existing certification mechanisms

- Indigo Ag
- Soil capital
- Label Bas Carbon
- Gold Standard

Box 1 – EU support to R&I for carbon farming

Research and innovation on carbon farming and related nature-based solutions for carbon removals has been supported for some time under the EU's **framework programmes** for R&I. Relevant activities funded under Horizon 2020 (2014–2020) include, for example, a project on land-based negative emission solutions.[57] Horizon Europe will fund the creation of a demonstration network on climate-smart farming, with calls for proposals so far covering pilot

[56] Lugato, E. et al. (2018). Mitigation potential of soil carbon management overestimated by neglecting N_2O emissions (link).
[57] LAND-use based MitigAtion for Resilient Climate pathways (LANDMARC), EU contribution of € 7M – link

farms and advisory services. The Horizon Europe Mission "A Soil Deal for Europe" in 2022 has allocated funding to the creation of a network on carbon farming for agricultural and forest soils and to projects on the monitoring, reporting and verification of soil carbon and greenhouse gases balance.[58] Calls for proposals dedicated to carbon farming are to be included also in the work programmes for the next years.

In the next two years, projects supported by the European Joint Programme on Agricultural Soil Management (EJP SOIL, co-funded by the Commission with 40m EUR and by the Member States with the same amount[59]) will deliver: a report on the state of the art of the use of proximal/remote sensing techniques to estimate Soil Organic Carbon; an accuracy/cost analysis of the use of proximal/remote sensing techniques to estimate soil properties in field (ProbeField); a study on the cost-effectiveness of carbon farming schemes in the presence of MRV costs (Road4Scheme); national scale estimates of the technical and feasible SOC sequestering potential (CarboSeq); studies on potential trade-offs of carbon storage in soils such as additional N2O emissions and N-leaching (Sommit, TRACE-soil and INSURE).

Further support measures on cooperation for innovation are programmed in the context of the Common Agricultural Policy. The European Innovation Partnership **EIP-AGRI** facilitates the piloting and testing on the ground of practices for carbon sequestration and protection, with the direct involvement of farmers supported by advisors, local researchers and solution providers.[60] Several thematic focus groups have been launched and are producing factsheets and reports, which constitute a good basis for knowledge transfer within the farming community.[61]

Biochar

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Biological	Vegetation	7-9	10-345	300-6,600	79[62]

The pyrolysis of organic matter can result in biochar, a stable solid form of carbon (like charcoal) that is relatively resistant to decomposition and which can stabilise organic matter when added to soil as amendment. While further research is needed to increase the understanding of biochar, biochar can improve the physico-chemical properties of soils and potentially combine many advantages with the long-term storage of carbon from biogenic origin in a product that improves the carbon sequestration capacity of soils as well as their water-holding capacities and their resilience to drought. However, the effect of biochar depends on the feedstock used for its production and on the soil and crop to which it is applied. The potential for biochar depends on availability of feedstock biomass and the competition with other uses of biogenic residues.

[58] HORIZON-MISS-2022-SOIL-01-05 and HORIZON-MISS-2022-SOIL-01-06
[59] EJP SOIL (link)
[60] EIP AGRI projects (link)
[61] EIP AGRI focus groups (link)
[62] Roe et al. (2021). Land-based measures to mitigate climate change: Potential and feasibility by country (link).

Biochar production can produce electricity and/or heat as by-product of the pyrolysis process. Biochar can also be a by-product of the gasification of biomass to produce bio-methane.

Examples of solutions already operational or in planning

In 2020 in Europe, there were 72 biochar production plants in operation, capable of producing 20,000t of biochar annually. Currently, 69% of European production (including Switzerland) occurs in four countries: Germany, Sweden, Switzerland, Austria.

Existing certification mechanisms

- Puro.earth: Has seven different sellers of biochar credits, with prices ranging from €96-150/tCO2-eq. Total amount of removals is unclear.

- Other: Verra is creating a biochar methodology for VCS, to be ready for public review in Q4 2021.

- The European Biochar Certificate (EBC) sets minimum standards for biochar production and composition, while the EBC 'C-Sink' quantifies the magnitude and duration of carbon storage through biochar use.

Blue carbon farming

Capture	Storage	TRL	Cost (€/tCO_2)	Potential ($MtCO_2$/yr)	
				Global	EU
Biological	Vegetation and sediments	2-3	n.a	<1,000	n.a

Blue carbon refers to carbon dioxide removed from the atmosphere by the world's ocean ecosystems, mostly phytoplankton, algae, macroalgae, mangroves, seagrasses meadows, and tidal marshes, through plant growth and the accumulation and burial of organic matter in the soil and sediment. In the oceans, carbon could be sequestered in the natural environments[63], as a result of micro- and macroalgae aquaculture, or in marine permaculture[64].

Of particular importance are coastal biogenic habitats, or blue carbon habitats (seagrass, mangrove, tidal marshes) with high intensity biogenic carbon sequestration. It should be noted that other biogenic species are storing carbon not only organically but also through biomineralisation in shells and skeletons (coral, oysters reef, Honeycomb worm reefs).

Development of blue carbon strategies, initiatives, and projects has the potential to lead to multiple co-benefits, like carbon fixing and storage, ocean health improvement (removal of excess nutrients causing eutrophication, generating oxygen), improvement of ecosystem services (bringing back marine life), development of environmental services creating new, green local

[63] Globally macroalgae can sequester 0,17 Gt C yr^{-1} (2% of global emissions), 90% of which is transported to the deep ocean (link).
[64] Marine Permaculture is a form of mariculture that reflects the principles of permaculture by recreating seaweed forest habitat and other ecosystems in nearshore and offshore ocean environments.

jobs etc. Development of regenerative seaweed aquaculture in addition to the above, will bring to the market healthy food alternatives and low-carbon feed and other algae-derived products.

A significant challenge for the potential of blue carbon is the degradation of blue carbon ecosystems leading to release of stored carbon back into the atmosphere and to reduced carbon fixation and storage capacity. For instance, decline in seagrass meadow area has been widespread and substantial over the last century with 19% of globally surveyed meadows lost since 1880. Whilst natural events, including outbreaks of disease and eruptions of grazing urchins enhanced by pollution and overfishing, can result in significant local seagrass decline, the major drivers of seagrass loss are anthropogenic: eutrophication, coastal development, land erosion (leading to enhanced sedimentation), and mechanical damage due to dredging, seining, boat mooring, and anchoring.

Examples of solutions already operational or in planning

- The seaweed company: Carbon sequestration in seaweed[65]

Existing certification mechanisms

None.

2.4 Carbon storage products

Biobased products

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Biological	Products	4-9	n.a	70-1100[66]	n.a.

Increasing carbon stocks in (long-lasting) biobased products is a way of storing carbon. The carbon pool of biobased products can act as a temporary reservoir that delays emissions of the renewable biogenic carbon to the atmosphere. The size of the biobased products' carbon pool depends on the quantity of carbon stored in newly-produced products entering the pool, the duration of storage and their end of life options (landfilling, energy recovery, recycling, re-use).

Biobased products also bring climate benefits through avoided emissions by replacing GHG-intensive materials with biobased materials. The substitution effect of biobased products can be uncertain and depends on several variables such as the type of product being substituted, the energy-mix used in the production of the substituted product, and the life cycle emissions of the biobased material.

The biomass for biobased products must come from a combination of sustainable sources from agriculture, animal farming, aquaculture and forestry while ensuring the maintenance and the enhancement of natural sinks and preserving healthy ecosystems. Applications that can both reduce greenhouse gas emissions in the short term while not damaging, or even improving, the

[65] The seaweed compagny (link)

condition of forest ecosystems include for example collecting fine wood debris within the limits of locally recommended thresholds, afforesting former agricultural land with mixed species plantations or with naturally regenerating forests. Solutions based on circular economy principles applied to biobased products such as the cascading principle are also beneficial.

The building sector is one of the most promising sectors to foster the use of carbon removal products and materials. While wood is one of the most popular construction materials which removes carbon during its growth, many other materials, traditional or innovative, can also contribute at various storage durations, e.g. cellulose fibre, cardboard and construction paper, bamboo, hemp, cork, straw, sheep wool, seaweed, herbaceous plants, composites from agriculture residues or from mycelium.

Examples of solutions already operational or in planning

There are limited examples of biomass in building projects with carbon removal claims (estimated using different methods) but this is a fast-growing sector. Some examples of recent wooden construction projects are:

- Brock Commons Tallwood House, construction management by Urban One Builders (Canada): 18-story mass timber hybrid residence at University of British Columbia, completed in 2017, wooden inputs (Cross Laminated Timber (CLT) and Glulam): 2,233 m3, avoided and sequestered CO_2 estimated using the Wood Carbon Calculator for Buildings: 679 tCO_2 avoided and 1,753 tCO_2 sequestered over the life cycle
- Oakwood Tower in London, Cambridge University's Department of Architecture, PLP Architecture, Smith and Wallwork (UK) - proposal: 80-story wooden building, wooden inputs: 65,000 m3 of structural timber (softwood), estimated sequestration of 50,000 tCO_2 (no indication on the method)
- Dalston Works, Waugh Thistleton Architects, Ramboll, B&K Structures (UK): 10-story wooden building, largest CLT project globally, material inputs (CLT): approx. 3,850 m3, sequestered CO_2 estimated: 2,866 tCO_2 (no indication on the method).
- Mjøstårnet, Brumunddal (Norway): 18-story wooden building, wooden inputs (CLT, Glulam, Trä8), Moelven subcontractor for structural timber components: Follows the Puro.earth methodology requirements, audited for carbon removals of 541 kg/m3 with a 10% safety buffer and permanence of 50 years.
- The French Plan "Immeubles de Grande Hauteur en bois" (High-rise Timber Building Plan) plan aims to demonstrate the feasibility of high-rise timber buildings, in a very concrete way. It also aims to showcase the most appropriate technical solutions. The plan was implemented by the ADIVbois Association (Association for the Development of Wooden Buildings), a dedicated organisation created in 2016 in the context of the governmental initiative, "New Industrial France".

Existing certification mechanisms

- Puro Earth – methodology for wooden building elements
- Past experience from CARBOMARK project 2009-2011. Emission credits trading platform (voluntary carbon market). Italy (regional: Veneto, Friuli Venezia Giulia). At the end of the project, 21 private companies and 27 public forest owners had joined the

CARBOMARK market, and three buying contracts had been signed. According to these contracts, 350 tonnes of carbon have been stocked.

CCU products

Capture	Storage	TRL	Cost (€/tCO_2)	Potential (MtCO_2/yr) Global	EU
Chemical	Products	4-8	n.a.	100-1400[66]	n.a

Set of technologies involving the utilisation of CO2 from air or biogenic sources in diverse production processes. Temporary carbon removal can be achieved when applications use CO2 as a feedstock to convert it into value-added products which then retain CO2 for decades or centuries.

CO2 can be used as an alternative to fossil fuels in the production of chemicals that require carbon to provide their structure and properties, e.g. primary chemicals such as ethylene and methanol, which are building blocks to produce a range of longlived end-use products such as plastics.

CO2 can also be used in the production of building materials as feedstock in its constituents (i.e. cement and construction aggregates) via reaction between CO2 and minerals or waste streams (e.g. concrete waste) to form carbonates. Another way that CO2 can be used in building materials consists in adding CO2 to concrete during curing, This technique also reduces the quantity of cement needed to reach similar product strength requirements.

Examples of solutions already operational or in planning

- 9 operational pilot/commercial projects referenced as operational/ongoing on Smart CO2 Transformation platform

- **Error! Bookmark not defined.**Covestro facility in Dormagen (Germany)**Error! Bookmark not defined.**: operational since 2016, produces around 5,000 t/year of polyether polycarbonate polyol (cardyon®) where CO_2 substitutes up to 20% of fossil feedstock normally used in the process (TRL = 6-7). The polyol can be converted into flexible polyurethane foam.

Existing certification mechanisms

- The Innovation Fund has developed a methodology for the quantification of climate benefits from CCU projects for products whose conventional production is covered by the EU ETS Directive.

- Puro Earth methodology on carbonated building elements

[66] Hepburn et al. (2019). The technological and economic prospects for CO2 utilization and removal (link).

- VCS methodology for CO_2 Utilization in Concrete Production (in development) and for Greenhouse Gas Capture and Utilization in Plastic Materials

ANNEX 6: QUALITY CRITERIA – QUANTIFICATION

1 INTRODUCTION

Quantifying, monitoring and reporting the climate benefits of a carbon-removing project are the most essential tasks of the certification process. Therefore, it will be necessary to implement accurate, cost-efficient quantification and monitoring of the climate benefits to generate the necessary trust in carbon removals and to increase their uptake.

Quantification is a multi-step process: The first key element is to assess (ex-ante) the potential total climate impact of the carbon removal activity over the period of the project.

Second, during the execution of the project, the carbon removal activity should monitor and report removals and emissions taking place within the scope of the activity with a sufficient level of timeliness, resolution and accuracy. It can build on established or innovative monitoring systems and should remain affordable for smaller projects as well. Independent verification is essential to create the necessary trust in the quantification of the climate impacts (see Annex on Transparency).

Quantification, monitoring and reporting methodologies for an EU certification framework should require reporting modalities avoiding double counting and compatible with national GHG inventories. In this way, the widespread application of the EU certification framework will improve the quality of national inventories by providing high-quality monitoring information on carbon removal activities. This improvement will allow Member States to better target their climate policy implementation and to see the contribution of carbon removal activities in the achievement of their domestic or EU climate targets.

The two main normative references for the quantification, monitoring and reporting of GHG emission reductions and removal enhancements are the Greenhouse Gas Protocol established by the World Resources Institute (WRI) and the Business Council for Sustainable Development (WBCSD) and the international standard ISO 14064-2 [67]. The two documents are consistent and complementing each other.

The Greenhouse Gas Protocol Initiative is a multi-stakeholder partnership of businesses, nongovernmental organisations (NGOs), governments, academics, and others convened by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). Launched in 1998, the Initiative's mission is to develop internationally accepted greenhouse gas (GHG) accounting and reporting standards and/or protocols, and to promote their broad adoption[68]. The GHG Protocol for Project Accounting[69] is a comprehensive, policy-neutral accounting tool for quantifying the greenhouse gas benefits of climate change mitigation projects. It provides specific principles, concepts, and methods for quantifying and reporting

[67] ISO 14064-2:2019 (link).
[68] GHG Protocol (link).
[69] GHG Protocol for Project Accounting (link).

GHG emission reductions or increases in removals from climate change mitigation projects. Complementary to the GHG Protocol for Project Accounting, the Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting[70] provides more specific guidance and uses more appropriate terminology and concepts to quantify and report GHG reductions from LULUCF project activities.

The ISO 14064-2 specifies principles and requirements and provides guidance at the project level for the quantification, monitoring and reporting of activities intended to cause greenhouse gas (GHG) emission reductions or removal enhancements. It includes requirements for planning a GHG project, identifying and selecting GHG sources, sinks and reservoirs (SSRs) relevant to the project and baseline scenario, monitoring, quantifying, documenting and reporting GHG project performance and managing data quality. This standard is designed to be neutral and compatible among a range of programmes by avoiding programme-specific definitions and requirements.

Both standards build on six principles underpinning all aspects of the accounting, quantification, and reporting of project based GHG reductions:

- Relevance: Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information
- Completeness: Consider all relevant information that may affect the accounting and quantification of GHG reductions, and complete all requirements
- Consistency: Use data, methods, criteria, and assumptions that allow meaningful and valid comparisons
- Transparency: Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims
- Accuracy: Reduce uncertainties as much as is practical
- Conservativeness: Use conservative assumptions, values, and procedures when uncertainty is high

2 CERTIFICATION CHALLENGES

The quantification of a project's benefits follows a common approach across the WRI Greenhouse Gas Protocol and ISO 14064-2, summarized in response to three key challenges:

- **Set the boundaries of the system by selecting the GHG sources and sinks to be accounted in the estimate of the GHG effect**. Carbon removal is often the outcome of the aggregation of carbon removals from sinks with GHG emissions from various sources. These fluxes, moreover, may present potentially different dynamics and timescales, and may even have varying impacts in geographical extent. The system boundaries should be chosen to ensure the best comparison and identification of the climate benefits.

[70] GHG Protocol LULUCF Guidance (link).

- **Define a baseline against which the climate performance of the carbon removal project is assessed**. A key element is to quantify emissions and removals in the baseline. Baseline setting is a complex exercise which must balance an appropriate level of ambition with the desire to stimulate broad participation. More on the concept of baselines can be found in the next Annex (Annex 7).
- **Monitor and report the emissions and removals of the project**. Robust monitoring and reporting of carbon removals activities is necessary to ensure the quality of carbon removals. Assessing and managing the uncertainty in data and methods, including on-site measurement, modelling, and default emission or removal factors, is an important challenge that the certification should address. However, the costs of the monitoring, reporting, and verification of carbon removals, need to be kept manageable, in particular to enable smaller projects. The use of state-of-the-art digital solutions should allow for a cost-efficient implementation, in particular for carbon farming.[71]

3 EXISTING CERTIFICATION APPROACHES

3.1 Setting project boundaries

The GHG Protocol distinguishes two types of GHG effects:

- A primary effect is the intended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink. Primary effects considered by the GHG Project protocol focus on reduction on energy and process emissions, fugitive and waste emissions as well as CO2 removal by biological processes. In the specific context of LULUCF projects all carbon pools (including living biomass, dead organic matter, and soils) should be included unless the project developer can demonstrate that a pool will not become a source as a result of the project activity.

- A secondary effect is an unintended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink. Secondary effects are typically small relative to a project activity's primary effect. In some cases, however, they may undermine or negate the primary effect. Secondary effects often correspond to leakage effects and are classified into two categories:

    - One-time effects, i.e. changes in GHG emissions associated with the construction, installation, and establishment or the decommissioning and termination of the project activity.
    - Upstream and downstream effects, i.e. recurring changes in GHG emissions associated with inputs to the project activity (upstream) or products from the project activity (downstream), relative to baseline emissions.

[71] Smith et al. (2020). How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal (link).

For LULUCF projects, secondary effects are primarily from fertiliser application, fuel combustion in machineries but also potential indirect land use change effects from market responses.

For the GHG protocol the project system boundary encompasses all primary effects and significant secondary effects associated with the GHG project. A project activity's total GHG effects are quantified as the sum of its associated primary and secondary effects, across the project's scope of activities.

The ISO 14064-2 standard does not use the term project boundaries but refers to relevant Sources, Sink and Reservoirs (SSR). While the terminology is different, the approach is similar to the GHG protocol with an identification of the SSRs controlled by the project, those related to energy and material flows and those affected by the project.

3.2 Defining baseline emissions and removals

The GHG Protocol describes two methods, also known as procedures, to estimate baseline emissions and removals: the performance standard method and the project-specific method.

The performance standard method produces an estimate of baseline emissions and removals from a numerical analysis of the GHG flux rates of "baseline candidates". A performance standard is sometimes referred to as a multi-project baseline or benchmark because it can be used to estimate baseline emissions for multiple project activities of the same type. It serves the same function as a baseline scenario but avoids the need to identify an explicit baseline scenario for each project activity.

By contrast, the project-specific method produces an estimate of baseline emissions and removals through the identification of a baseline scenario specific to the proposed project activity. The baseline scenario is identified through a structured analysis of the project activity and its alternatives. Baseline emissions are derived from the baseline scenario and are valid only for the project activity being examined.

The guidance of the GHG Protocol indicates that a performance standard method may be preferable when a number of similar project activities are being implemented, when obtaining verifiable data on project activity alternatives is difficult, or when confidentiality concerns arise with respect to the project activity. Project-specific procedure may be preferred when the type of project is very specific with a number of baseline candidates limited or GHG emission rate data for baseline candidates are difficult to obtain. Strengths and weaknesses of these two approaches are discussed further in the annex on Baselines and Additionality [Annex 7].

The ISO 14064-2 guidance to define baseline emissions and removals are rather general. They state the need to consider all feasible baseline scenarios and select the most plausible one through a process respecting the principles of conservativeness, completeness, consistency, accuracy transparency and relevance. The ISO 14604-2 refers to customized (i.e. project specific) and standardized baselines and differentiates static and dynamic baselines. It mentions the relevance of historical conditions, market conditions and best available technologies for the development of baseline methodologies.

3.3 Monitoring and Reporting

Both the GHG protocol and the ISO standard underline the importance of establishing a comprehensive monitoring plan describing in detail the procedures used for the measurement or the estimates of all GHG data and other information relevant to the project and the baseline. The ISO 14062-2 guidance indicates which elements should be included (e.g. parameters, data, assumptions, methodologies, modelling, roles and responsibilities, frequency of the monitoring, etc..) and insist on the importance of documenting and recording these elements.

The GHG protocol follows the same line and brings more details on the different steps for the implementation of a robust monitoring system. For this standard, a monitoring plan should contain provisions for:

- Monitoring project activity emissions and removals: For each GHG source or sink related to a primary or significant secondary effect, the monitoring plan shall describe all data to be monitored, how it will be monitored, the level of uncertainty, potential assumptions used for the measurement, further relevant technical information, the frequency of the monitoring and all sources of data and information

- Monitor baseline parameters: All baseline parameters shall be described in the monitoring plan in a similar way, when applicable, as for project activities.

- Describe quality assurance and control (QA/QC) measures. How the GHG project data will be maintained and how QA/QC measures will be implemented shall be described in the monitoring plan and include information on role and responsibilities, data management, QA/QC procedures.

In terms of reporting, the GHG protocol guidance for project accounting presents a list of the information that must be compiled and reported to ensure transparency and enable third-party reviewers to evaluate the quantification of GHG reductions for a GHG project. Project developers should retain all data, assumptions, criteria, assessments, and explanations used to support reported information and should follow the principles of transparency and completeness in reporting GHG reductions.

Neither of the two standards provides specific guidance on the management of uncertainty and the verification of the reported data because they are considered as elements dependant of GHG programmes or certification schemes. However, the ISO 14064-2 requires adherence to ISO 14064-3 on guidance for the verification and validation of GHG statements, if the project proponent requests verification and/or validation of the GHG project.

Experience from existing certification schemes show that they typically identify the sources of uncertainty and estimate its size based on sampling techniques, expert opinion, data distribution, simulations, or literature sources. They then propose various approaches to managing this uncertainty, sometimes in combination, such as:

- Discounting the estimated removals when these are uncertain, possibly proportional to the level of uncertainty
- Storing a percentage of the total estimated removals in a buffer account, which can be drawn down at later date; the credits in the buffer account are sometimes released to the participant at the end of the project duration, or are retired (equivalent to discounting)[72];
- Using conservative assumptions when quantifying removals.

In addition, a promising avenue for simplification of monitoring is the use of remote sensing data (especially in the case of carbon farming) that can provide information on soil types, above-ground biomass, and geographic location of the project in an accurate, automated and non-expensive way.

4 QUANTIFICATION CRITERIA FOR AN EU FRAMEWORK

4.1 General criteria

The existing standards provide the general criteria that all carbon removal projects to be certified under an EU framework should follow:

- The quantification, monitoring and reporting of carbon removals should apply the six principles underpinning international standards and best practices for the quantification, and reporting of project based GHG emission reductions and removal enhancement: Relevance, Completeness, Consistency, Transparency, Accuracy and Conservativeness. The quantification, monitoring and reporting of carbon removals should also take in consideration the specificities of the EU climate policies.

- The project boundaries should be set in a way that it accounts for all removals and emissions attributable to the carbon removal activity. This would include primary emissions and removals directly associated to the carbon removal activity and any secondary emissions, also called leakages, that would impact negatively the overall climate benefit of the carbon removal activity.

- The climate benefit assessment of a carbon removal project should be conducted by comparing the net removals expected from the project activities to a representative baseline. The baseline setting should be relevant, transparent, conservative and credible. It should encourage ambition over time – in line with the Paris agreement – and a broad participation. It should be adapted to the type of carbon removal activities and the context in which the carbon removal project is developed (see Annex 7).

[72] This approach is also used to address the uncertainty on duration of the sequestration and mitigate the risk of CO2 reversal, see Annex XXX

- The carbon removal project should provide a comprehensive monitoring plan describing in detail the procedures used for the measurement or the estimates of all GHG data and other information relevant to the project and the baseline, including a detailed breakdown of the emissions and removals attributable to the project.

When assessing the different carbon removal solutions, very different quantification approaches emerge. For some industrial solutions such as BECCS and DACCS, carbon removals and emissions can be directly measured with a high level of accuracy; instead, for some carbon farming solutions, these can only be modelled or inferred (which entails more uncertainty), and there is a trade-off between quantification accuracy and costs.

4.2 Quantification of permanent storage solutions

The storage of CO2 in geological formations is covered by several jurisdictions: the CCS directive at the EU level but also other frameworks from UK government oil & gas authorities, the US Environmental Protection Agency, the California Air Resources Board, the Alberta Emission Offset Programme or the Australian Government Offshore Petroleum and GHG act. The primary objective of these frameworks has been the capture and stockage of fossil CO2 emissions, they do not address specifically the quantification of carbon removals resulting from the storage of non-fossil CO2.

In an EU context, DACCS and BECCS methodologies can build on methodologies developed for projects under the Innovation Fund[73], i.e. a life-cycle assessment accounting for the direct emissions of the carbon removal activities but also upstream and downstream emissions attributable to the carbon removal project. The Innovation Fund methodology for carbon capture and storage assesses projects characterised by the capture of CO2 in industrial processes or power generation, or directly from ambient air, with a separation and compression of the CO2, which will then be transported by road tankers, ships, rail and/or pipelines to a suitable storage site where it will be injected and permanently stored. Storage sites are permitted under the CCS Directive 2009/31/EC and can be different geological formations: saline aquifers, depleted oil and gas reservoirs, un-mineable coal beds, mafic rocks (e.g. basalts).

Some methodologies for the permanent storage of CO2 are also emerging on the voluntary market. Puro.earth marketplace proposes methodologies for the certification of geologically stored carbon[74]. Puro.earth is also considering biochar, also refered as Pyrogenic Carbon Capture and Storage (PyCCS), as a permanent form of carbon storage when the carbon is stored in appropriate soils, depth and climatic conditions.

Boundaries

The quantification of the net climate benefit for industrial solutions to capture and store permanently carbon in geological sites should include the emissions from capture, transportation

[73] Innovation Fund website (link)
[74] Puro.earth standards (link).

and injection as well as emissions from chemicals, membranes and purpose-built equipment including the construction and materials for the equipment. Energy consumption can be substantial in carbon capture activities, in particular for DACCS projects, and therefore all the emissions from energy use, including displacement effects, should be accounted for when quantifying the net climate benefit of CO2 removals. Increasing demand for bioenergy has the potential to drive land use change (LUC) effects, which should be considered for BECCS projects. Existing EU policy frameworks exist for controlling the risk of LUC from bioenergy, primarily the biomass sustainability criteria and certification standards developed under the Renewable Energy Directive framework. These same standards should be used as a precondition for BECCS projects. See also Annex 9 on Sustainability.

Baseline

See Annex 7 on Baselines and Additionality.

Monitoring and reporting

The certification of carbon removals with permanent storage will focus firstly on BECCS and DACCS activities. Even though DACCS and BECCS installations are not covered by the EU ETS, these solutions can draw from the current framework applied to fossil CCS, including the Monitoring Reporting Regulation[75] (MRR) and the Directive on Geological Storage of Carbon Dioxide (CCS Directive)[76]. The monitoring and reporting requirements would build on the EU ETS since the capture, transport and geological storage of fossil CO2 is already covered by the EU ETS. The detailed requirements from the MRR are aligned with principles and requirements from ISO 14064, therefore by building on these existing EU legislations the certification framework can also be consistent with international standards. The reporting of carbon removals should moreover provide useful information for the compilation of national inventories.

Other types of carbon removal projects such as for instance enhanced rock weathering or ocean alkalinisation have the potential to play a very important role in the future to remove carbon from the atmosphere, but their characteristics and potential impacts still need to be better understood before being addressed in a certification context. Specific methodologies could be developed in the future once enough certainty on the climate benefit and environmental sustainability of these activities is established.

4.3 Quantification of carbon farming practices

The complexity of the quantification process for carbon farming varies from practice to practice. Table 5 presents an overview of the main challenges related to quantification for different types of carbon farming practices.

[75] Regulation (EU) No 2018/2066, Monitoring and Reporting Regulation (link).
[76] Directive 2009/31/EC on the geological storage of carbon dioxide (link).

Table 5 - Quantification across carbon farming solutions

	Quantification challenges
Afforestation / Reforestation	Well-established and tested methodologies suggest robust monitoring can be achieved at affordable costs for the biomass part. Some uncertainties remain around impacts on soil carbon.
Improved Forest Management	Many forest management methodologies that have low monitoring and reporting costs rely on forest growth and yield modelling to estimate change in carbon storage. More recent methodologies (e.g. VCS methodology for Improved Forest Management) apply field measurements of biomass carbon stocks and dead wood, as well as monitoring of other factors (such as fertiliser application).
Agroforestry	High diversity of agroforestry practices means that quantification must be adapted to the local context. Existing examples of quantification approaches are limited. While above-ground biomass can be relatively easily monitored, soil carbon is sometime considered more challenging but innovative solutions making use of Earth Observation data with artificial intelligence are very promising[77].
Soil carbon sequestration in cropland and grassland	Monitoring of the soil organic carbon can be either predicted via soil sampling and empirical or process models. High variability of soil carbon stocks across locations make quantification very challenging using current technologies, implying that solutions need to be developed to address statistical uncertainty at field level.
Peatland and wetland restoration	Quantification relies on established correlations with easily measurable parameters, such as the height of the water table, to develop emissions factors for local context, and to classify land categories, potentially limiting short-term upscaling. Real time onsite measurement is not cost-effective. There are well-developed examples of quantification methods (e.g. MoorFutures), but they are dependent on local scientific evidence (to calibrate methodology to local conditions), which can nonetheless be collected using for example remote sensing.
Biochar	It is relatively straightforward to quantify emissions and removals related to biochar feedstocks and to the production of biochar. The European Biochar Certificate[78] guidance has identified a positive list of biomass feed-stock sources. The quantification of biochar application is more uncertain, but European climate is favourable to the stability of biochar. There are still some remaining knowledge gaps regarding impacts on soil carbon, methane and nitrous oxide emissions.

<u>Boundaries</u>

[77] Smith et al. (2020). How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal (link).
[78] European Biochar Certificates (link).

Following IPCC guidelines and common recommendations from international standards, the quantification of carbon farming project should cover the emissions and removals from the LULUCF sector[79] and carbon pools primarily impacted by carbon farming practices, e.g. aboveground and belowground biomass as well as soil organic carbon, should be reported and accounted for the baseline and the project where relevant. Dead wood and litter are rarely subject to significant changes due to carbon farming practices but are significant with respect to verifying that environmental conditions are respected.

Secondary emissions attributable to the project activities (e.g. fertiliser emissions or fuel combustion for machinery) need to be considered to properly assess the overall climate benefit.

Baseline

See Annex 7 on Baselines and Additionality

Monitoring and reporting

The monitoring and reporting of the direct emissions and removals from carbon farming solutions can build on the IPCC guidelines for compiling the national GHG inventories for the Agriculture, Forestry and Other Land Use sector, and on the methodologies required under the LULUCF Regulation, which would allow consistency and better integration with national inventories. Where applicable, tier 3 approaches of IPCC[80] guidelines should be favoured to enhance alignment.

IPCC puts forward a clear argument to rely on a combination of sampling surveys, remote sensing, and machine learning to minimise monitoring and reporting costs. Accuracy and comparability are optimised by attributing to each parcel of land an estimate of emissions and removals based on remote sensing data (provided for instance by airborne LIDAR, or alternatively sensors and products through the Copernicus programme). This reduces the need to perform frequent on-site sampling for every certified project, especially when it comes to establishing the baseline level of emissions and removal of a project (see also Annex 7).

The Communication on Sustainable Carbon Cycles proposes the aspirational goal that, by 2028, every land manager should have access to verified emission and removal data, an objective that can be enabled by widespread certification activities. The European Commission and the Member States should, in the next years and based on existing and evolving technologies, create a database of high-resolution information on the emissions and removals of all managed land parcels in the EU. Ideally, this could leverage existing datasets held by Member States for agricultural and environmental policy implementation. Such a system would obviously enable a dramatic improvement in the quality of land-based GHG inventories and policymaking, in coherence with the objectives of the Commission's proposal to upgrade the LULUCF Regulation. It would, moreover, encourage a wider uptake of carbon farming approaches by

[79] GHG emissions and removals from land use, land use change and forestry as defined by the UNFCCC (link)
[80] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (link)

significantly reducing quantification costs for economic operators and certification schemes alike.

4.4 Quantification of carbon storage products

Carbon removal projects storing carbon in long-lasting products can provide climate benefit. By removing carbon from the atmosphere for several decades or centuries, they can contribute in limiting the peak of global warming and therefore the worst climate impacts. Two sub-categories of product storage can be distinguished: storage in bio-based material and storage in long-lasting Carbon Capture and Utilisation (CCU) products.

There are only few examples of certification schemes covering the sequestration of carbon in products, and quantification protocols for product storage are still at an early stage of development. IPCC only recognises three broad categories, with complex computational methods to determine how, when sawn-wood, panels or paper are created from harvested timber, emissions associated with the harvesting are deferred to the future. These methods apply very broadly at national (macro) level and entail a series of assumptions that impact project level implementation. Nevertheless, the Commission's proposal in 2021 for the LULUCF sector introduces "a more explicit pathway towards new products (construction materials, fibres/polymers)"[81].

Reviews of existing schemes for the certification of carbon removals such as McDonald et al. (2021)[82] and Arcusa et al (2021)[83] report that the voluntary market Puro.earth has developed a limited number of carbon removal methodologies for the sequestration of carbon in wooden products, carbonated material and biobased insulation material, while Verra has established a methodology for the long-lasting plastics. There is an overall understanding that the quantification should follow an LCA approach, but inherent difficulties exist in accounting for the end of life of the product, as well as in recognising the temporary storage of carbon in the product.

Bio-based products

There is currently no consensus on quantification rules for embodied carbon emissions and biogenic carbon storage in wood products, aside from, at national level, the IPCC guidelines on Harvested Wood Products included in the LULUCF Regulation. Large statistical uncertainties persist in existing Life-Cycle Assessments with regard to biogenic carbon emissions, sequestration in the production and end-of-life stages of wood building products.

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[81] European Commission, 2021, COM (2021) 554 final (link).

[82] McDonald et al. (2021). Certification of carbon removals - Part 2: A review of carbon removal certification mechanisms and methodologies (link).

[83] Arcusa et al (2021). Snapshot of the Carbon Sequestration Certification Market Ecosystem (link).

A study contracted by the European Commission on the evaluation of the climate benefits of the use of harvested wood products in the construction sector[84] concluded that current LCA standards fall short in considering the temporary carbon storage effect of wood products.

This study recommends using innovative methods and in particular a simplified dynamic LCA approach that explicitly takes into account the timing of GHG fluxes. This recommendation is in line with those of other authors such as Hoxha et al. (2020)[85] who found the same limitations for LCA standards. They also identified the simplified dynamic LCA approach as the most pertinent and transparent approach to be applied in the assessment of the climate change impact of construction bio-based products and materials.

In this context, 2022 annual EU work programme for European standardisation propose to develop a new "Dynamic life-cycle assessment for estimating carbon removals in construction products"[86]. The main objective is to reflect the progress made in dynamic life-cycle assessment better to acknowledge carbon storage in standards for construction products, mainly when using time-dependent characterization factors applied to a dynamic life cycle inventory.

The IPCC approach for Harvested Wood Products (HWP) is based upon a deferred progressive release of carbon following the conversion to a product but progressively over years or decades. GHG inventories report that carbon stock in the HWP declines over time according to a first-order decay (FOD) model, and therein explicitly acknowledges the impermanence of carbon storage in HWP. However, it may seriously underestimate the re-use or recycling of timber products, especially if these undergo rapid innovation under an impulse of the bioeconomy. Under the current LULUCF Regulation, Member States may use country-specific methodologies and half-life values to account for HWP in their national GHG inventory, provided that such methodologies and values are determined on the basis of transparent and verifiable data. Under the Fit-for-55 package, proposed revisions to the LULUCF Regulation envisage the introduction of new categories of carbon storage products not just timber based – allowing for improved granularity over pathways for wood use and the application of more specific assumptions regarding the durability of carbon storage in HWP. Applying similar methodologies in the context of project certification could be considered.

Long-lived CCU products

The quantification of CCU products is complex due to the wide range of products operating in different markets and the risk of double counting or leakage. Like bio-based products, the quantification of CCU products should consider how long the carbon is stored in the product and the end of life of the product. Most of the standard life-cycle assessment methods are not

[84] Bolscher et al. (2021). Evaluation of the climate benefits of the use of harvested wood products in the construction sector and assessment of remuneration schemes (link).
[85] Hoxha et al. (2020). Biogenic carbon in buildings: a critical overview of LCA methods (link).
[86] The 2022 annual EU work programme for European standardisation (link).

designed to distinguish between various temporary carbon retention times. Several methodologies have been proposed, nevertheless, to solve this issue:

- The Innovation Fund has developed a methodology for the quantification of climate benefits from CCU projects for products whose conventional production is covered by the EU ETS Directive. However, the end-of-life considerations are based on very simple assumptions and an adjustment and improvement of this methodology would be required to apply it for the certification of carbon removals.
- The Global CO2 Initiative[87] has developed guidelines for the life-cycle analysis and technico-economic assessment for CCU products providing recommendations for the selection of the specific elements needed and the boundaries, as well as considerations on uncertainties.
- A simplified dynamic life-cycle assessment, relying on the use of a dynamic life-cycle inventory and time-dependent characterization factors, already tested for wooden construction products, could in theory be applied to all type of products, assuming that the information required for the assessment is available.

From a monitoring and reporting perspective, the CO2 inputs and product outputs from CCU activities e.g. in the production of plastics or building materials can in general be measured with high level of accuracy. Activities covered by the ETS should follow the requirements of the Monitoring and Reporting Regulation.

[87] Global CO2 Initiative – The Technico-Economic Assessment and Life Cycle Assessment toolkit (link
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ANNEX 7: QUALITY CRITERIA – BASELINES AND ADDITIONALITY

1. INTRODUCTION

Baselines and additionality are two important concepts that are related in the sense that they both aim to establish that an activity has a positive climate benefit. The baseline, as mentioned in the previous Annex, is an essential element in the quantification of the climate effect of a carbon removal activity compared to the standard practice: it determines a minimum level beyond which carbon removals are additional. To ensure that also the activity generating the removals is additional in given regulatory and market circumstances, two further tests are proposed:

1. **Regulatory additionality** requires that the activity goes beyond what is already required by legislation. This type of additionality therefore depends on the regulatory context applicable to the jurisdiction where the activity takes place.
2. **Financial additionality** requires that the financial support linked to certification should have an incentive effect: this is present when the beneficiary would not engage in the additional activity without such financial support. This type of additionality therefore depends on the profitability and the funding possibilities inherent to the project. A similar approach is used under State Aid rules: in this context, the presence of the incentive effect is assumed when work on the relevant project or activity has not started before the application, but simpler approaches exist for aid schemes where the financial incentive effect is assumed to be fulfilled through the application itself.

2. CERTIFICATION CHALLENGES

Different challenges have to be balanced when setting the baseline and demonstrating additionality.

First, it is important to consider how the choice of the baseline and additionality requirements will affect the total number of economic operators that want to undertake carbon removal projects. Setting a very ambitious baseline, which is e.g. oriented towards best-in-class levels, may discourage uptake and lead to a very low uptake and small amounts of delivered carbon removals. Setting a baseline based on individual past performance has two drawbacks: (i) it can lead to unambitious results, as such a baseline will favour those economic operators that start from a very low business-as-usual performance; (ii) it will discriminate against early movers that piloted innovative projects in the past; as project developers fear that their past efforts may not be rewarded in the future, there is a risk that these rules may lead to inaction of economic operators while they wait for the certification framework to be in place[88]. The baseline should be defined to balance those opposing incentives.

Second, it is paramount to minimise the administrative burden on economic operators. Establishing the baseline requires to quantify the baseline emissions and removals, and establishing regulatory and financial additionality can require a lot of information, such as an

[88] This concern was raised by the participants to the Thematic Group on Carbon Farming organised by the European Network of Rural Development (ENRD) which met twice in Spring 2022. Report: (link to be added when published)

overview of the existing regulatory requirements, information on the business-as-usual land management, data about the profitability of a project, and/or an overview of the existing public subsidies available to carry out the same project with a justification that these incentives are not enough to trigger action. Baseline determination and additionality demonstration can represent up to 50% of costs associated to drafting projects documents when an "individualized" demonstration is required[89]. Most economic operators, especially in the carbon farming field, are small- or medium-sized enterprises (SMEs) that could be reluctant to take up carbon removal activities if certification is too complex.

Finally, the certification methodology should minimise the risk that baselines or additionality tests are manipulated with a view to arbitrarily increase the volume of "additional" carbon removals. Experience with voluntary carbon markets have demonstrated significant risks of over-issuance of certificates. For instance, the climate performance in a historic or projected baseline may be arbitrarily underestimated to increase the volume of certificates generated (so called "hot air" certificates), or activities already planned for non-climate reasons may be presented as additional activities to receive more money from the sale of certificates ('wind-fall profits'). Another challenge is represented by the risk of adverse selection: in the presence of a baseline computed as the average across a large sample with very heterogeneous circumstances, only the sites with a potential for producing more carbon removals than in the baseline may opt-in the programme, with no guarantee that the removals were not going to happen anyway because of the biophysical characteristics of these sites.

3. EXISTING APPROACHES

These challenges, which are common to the design of any incentive contract or scheme, have been discussed extensively in the voluntary carbon markets – from the Clean Development Mechanism under the Kyoto Protocol to the voluntary cooperation under Article 6 of the Paris Agreement.

The implementation rules for Article 6.4 of the Paris Agreement, which were agreed at the Glasgow COP in 2021, provide the latest guidance on baseline setting and additionality.[90] Particularly important features are that baselines should encourage ambition over time and broad participation; be real, transparent, conservative, credible and below [i.e. more ambitious than] 'business as usual'; and align with the long-term temperature goal of the Paris Agreement and the relevant Nationally Determined Contribution.

The implementation rules for Article 6.4 promote a performance-based approach to setting baseline, taking into account:

a. Best available technologies that represent an economically feasible and environmentally sound course of action, where appropriate;

[89] Grimault et al.(2018). Éléments clés du suivi, de la certification et du financement des projets carbone forestiers ().
[90] Glasgow Climate Pact, in particular paragraphs 33 to 39, (link).

b. An ambitious benchmark approach where the baseline is set at least at the average emission level of the best performing comparable activities providing similar outputs and services in a defined scope in similar social, economic, environmental and technological circumstances;

c. An approach based on existing actual or historical emissions, adjusted downwards to ensure alignment with the principles outlined in the previous paragraph.

These standardised baselines shall be established at the highest possible level of aggregation in the relevant sector.

As regards regulatory and financial additionality, the Glasgow Climate Pact says that "Additionality shall be demonstrated using a robust assessment that shows the activity would not have occurred in the absence of the incentives from the mechanism, taking into account all relevant national policies, including legislation, and representing mitigation that exceeds any mitigation that is required by law or regulation, and taking a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices".

As explained in annex 6, other important reference documents for the quantification of climate activities (the GHG Protocol and the ISO 14064-2 standard) describe two methods to establish the baseline: performance standards methods (the average performance of a group of projects) or project-specific methods (the past or projected performance of an individual project). Compared to the Glasgow guidance, the GHG Protocol and ISO standards still include the more generous method of a baseline based on the business-as-usual historic performance of an individual project, without reference to any external benchmark. Still, most certification schemes in the EU rely on project-specific baselines, based on an assumption that standardised baselines based on national averages may not be representative of the individual project's circumstances:

	Woodland Carbon CO_2de	PEATLAND CODE	Moor Futures	LABEL BAS CARBONE	2014 2	Green Deal	CARBOMARK	Ökoregion Kaindorf	CLIMATEAUSTRIA
Individualized methods	×	×	×	×	-	×	×	×	-
Standardized methods	-	-	-	×	×	-	-	-	×

Source: I4CE

1. Label Bas Carbone to use both: if a standardized additionality is used a discount rate is applied (see section 3.1).

The French Label Bas Carbone allows the project developer to choose between an individual and standardised baseline. In case of a standardised baseline based on a national average, a discount is applied (i.e. a more ambitious baseline below the national average is demanded).

In particular for carbon farming, the representativeness of standardised baselines will be significantly improved by recent advances in monitoring technologies, which can also largely simplify MRV procedures and lower costs. The representativeness of standardised baselines in carbon farming will be ensured by aggregating large amounts of observations from parcels in the same specific soil/crop/forest type and climatic context. Information on these parameters can gathered via remote sensing technologies (e.g. Copernicus programme) or existing databases (e.g. the Land Parcel Identification System of the Common Agricultural Policy, LUCAS). Thanks to machine learning and artificial intelligence applications, it is possible to classify each parcel according to these parameters and to assign to it a baseline which reflects the average emissions and removals in a very large number of comparable parcels.

In addition, the Commission is working on the inclusion of environmental data surveyed in the context of the Farm Accountancy Data Network. This database is already used to define benchmark for economic performance of farmers in several Member States, grouped and clustered by using different criteria. The inclusion of environmental variables, including climate-related ones, will also give the possibility to build references related to carbon removals. Data inserted by farmers in on-farm carbon calculators, once largely deployed, will also represent an important source of data. Several commercial tools are already available; the Commission as well worked on the integration in the Farm Sustainability Tool for Nutrient (FaST) of a module for the calculation of GHG emissions, including carbon stock and changes, with a first version available to be tested and improved by operators[91].

Therefore, in the context of this Impact Assessment, we will consider three types of baselines based on a mix of the two categorisations proposed:

- a highly representative standardised benchmark, as just described, which would correspond to the best available technologies or best performing activities (first or second approaches described in the Glasgow rules) defined as the "economically feasible and environmentally sound course of action", and present a high level of aggregation (i.e. based on a large number of observations) and of representativeness (activities in similar social, economic, environmental and technological circumstances);
- a generic standardised baseline based on historic national or regional averages, which would correspond to the third approach described in the Glasgow rules, and be less representative as based on a broader range of circumstances;
- a project-specific baseline based on the historical emissions of an individual project, which would correspond to the project-specific methods contemplated in the GHG protocol and the ISO standard and be based on information provided by the individual economic operator on its business-as-usual climate performance under current regulatory and financial constraints.

	Highly representative standardised baseline	**Generic standardised baseline**	**Project-specific baseline**

[91] Study for the development of a common framework for the quantitative advice of crop nutrient requirements and greenhouse gas emissions and removal assessment at farm level (FaST navigator study) (link).

Robustness	✓ Baseline can be validated through large datasets, remote sensing and modelling, and based on standard practices (e.g. Good Agricultural and Environmental Conditions (GAECs) from the CAP) to accurately reflect the circumstances of the carbon removal activities and standard practices.	✓✗ Baseline is more difficult to establish because of potentially different circumstances in regional or national averages. May be difficult to avoid adverse selection, e.g. if an economic operator is above the baseline by virtue of their specific circumstances (e.g. soil type which is more carbon rich than the average soil in a country) and not because of any particular effort to go beyond standard practice. Needs to be adjusted downward to reflect standard practices and data uncertainties.	✗ Baseline can be validated through direct observations or modelling, and accurately reflects the current circumstances of the individual project. However, it relies on counter-factual arguments provided by the economic operator, which may be difficult to substantiate, and prone to arbitrary manipulation, especially in the case of forecasted baselines (high risk of 'hot air'). Needs to be adjusted downward to avoid rewarding small improvements compared to Business-as-Usual, which would not be aligned with the goals of the Paris Agreement.
Incentives to uptake	✓ Incentivizes action beyond current practices and avoids continuation of inefficient business-as-usual practices. Rewards 'first-movers' by acknowledging their additional effort compared to the standard practice under similar circumstances[92]; may	✓✗ A non-representative baseline could favour first-movers or late-comers depending on the composition of the sample.	✓✗ Rewards 'late-comers' (economic operators whose initial business-as-usual climate performance is very low) and discourages first movers

[92] For instance, a parcel on organic soils with high CO2 emissions that maintains a rewetting project to preserve the carbon stock would deliver more removals with respect to a representative baseline corresponding to the average

	discourage uptake among "late-comers" (with very low climate performance) if too ambitious.		
Administrative burden	✓ Low administrative burden because baseline is established independently from economic operator.	✓ Low administrative burden because baseline is established independently from economic operator.	× Requires a large number of inputs from economic operator.

A highly representative baseline, which already reflects well the market and regulatory conditions, will reduce the need for complex tests on financial and regulatory additionality.

4. BASELINES AND ADDITIONALITY CRITERIA FOR AN EU FRAMEWORK

4.1. General criteria

Based on the assessment in the previous section, the certification methodology should ensure that:

- the baseline incentivizes the broad uptake of carbon removal activities that go beyond standard practices;
- the carbon removal activity is additional from a regulatory and financial perspective;
- the administrative costs for establishing baselines and for testing additionality are minimised.

Depending on the type of carbon removal, the setting of the baseline and the establishment of additionality will be straightforward (permanent storage) or more complex (carbon farming, carbon storage projects).

4.2. Additionality and baselines for permanent storage solutions

Most industrial solutions that permanently store carbon in geological reservoirs are fairly nascent technologies that are often being started with the main purpose of sequestering carbon. In these cases, no emissions or removals would usually take place in the absence of a project to permanently store carbon, and a pragmatic approach to reduce certification costs could be to assume a standard baseline equal to zero removals (i.e. all carbon removals stemming from industrial solutions would not occur in the baseline). These technologies are also extremely

emissions of comparable parcels (i.e. parcels on organic soil), whereas it would not deliver more removals compared to a generic baseline corresponding to the national average in a country where most soils are mineral soils with small GHG fluxes, nor if compared to its own level of emissions under a project-specific baseline since the project has already started before the certification application.

costly and would not be profitable without a mix of public support and private financing through certification. If these assumptions can be justified (depending on the type of activity), then all removals can also then be considered additional, without the need to run any complicated test.

4.3. Additionality and baselines for Carbon Farming

Based on the analysis carried out in the previous section, a highly-representative standardised baseline is considered the most pragmatic approach to ensure the recognition of the net climate benefits of activities compared to current practices on comparable parcels, while decreasing the burden on economic operators, where economic operators are usually SMEs with little time or skills to provide the extensive documentation and calculations needed to establish a project-specific baseline. A standardised baseline for carbon farming has also the advantage of recognising the effort of carbon farming practices that started before the establishment of the certification framework, thus rewarding first-movers.

While such highly-representative performance standards would be the preferred approach, their effectiveness rests on the assumption that sufficient data and adequate technologies are available to construct such a baseline. Otherwise, other approaches could be available to certification schemes and economic operators, provided that the carbon removals resulting from the application of such baselines are discounted or adjusted to account for uncertainty and possible biases:

- A performance standard based on less representative national or regional statistics;
- A project-specific baseline based on historic data (only for a limited period to allow late-comers to ramp up their climate effort and catch up with the more progressive land managers who already put carbon farming solutions into practice);

Irrespective of which baseline is eventually applied, economic operators should be free to choose a more ambitious benchmark level.

Carbon farming activities in the EU take place in a regulatory context that already includes statutory requirements; these can be used to establish regulatory additionality for carbon farming activities. Examples of relevant regulatory standards stem from the Nitrate Directive[93], the Water Framework Directive[94] and the National Emissions Ceilings (NEC) Directive. Within the CAP framework as well, certain conditions linked to the receipt of area-based CAP payments such as the standards of Good Agricultural and Environmental Condition (GAEC) described in the national CAP strategic plans, or any other relevant mandatory requirements established by national or regional legislation, whichever is the more ambitious and can be extrapolated to apply also to areas not subject to claims under the CAP.

[93] Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (link).
[94] Directive 2000/60/EC establishing a framework for Community action in the field of water policy (link).

These standard practices can be used to validate the highly representative baselines for the different carbon farming activities, possibly grouped at the level of the appropriate jurisdiction (regional or national) through a standard baseline based upon these.

When establishing financial additionality, it will be important to clarify upfront which combination of public and private support will or will not lead to double financing. In particular for carbon farming, the rules for support by the Common Agricultural Policy (CAP) and State aid need to be taken into account.

Carbon farming projects often require financial support in their initial phase, for instance through financing of upfront investment costs via the CAP. While carbon farming practices may show reduced input costs (e.g. use of less fertilisers, less machinery etc.) or increased soil quality and thus soil fertility, which results in more resilient production in the long-term, they may result in an initial and temporary decrease of profitability, either because of an initial decrease of yields (extensification, reduced tillage), or due to necessary investments related to a change of management strategy (e.g. new sowing machine for sowing on residues).

Box 2 - Combining private financing of carbon removals with public support by the Common Agricultural Policy (CAP) and State aid

It is essential to avoid double funding, i.e. help ensuring that beneficiaries do not receive a double payment for the same action. This is particularly relevant in the EU as most European land managers receive payments for voluntary schemes under the Common Agricultural Policy (CAP), such as eco-schemes and rural development (RD) interventions.

Eco-schemes and RD interventions for environmental, climate and other management commitments are generally schemes that design payments for land managers to undertake certain practices, i.e. the actual carbon sequestration inherent to those practices does not constitute the basis for the payment. Those practices, even if they are beneficial for carbon removals, are part of the whole farming management of the holding and the production of food and other ecosystem services so the relevant payments are intended to finance such practices and not directly aimed at rewarding carbon removals so that double funding is excluded. The same reasoning would apply to other CAP financing for voluntary measures covering costs which support the adoption of carbon removing practices: investments, advisory services, training, research possibilities, collective approaches etc. do not finance the achievement of carbon removals so that a combination of CAP funding and revenues from private markets would not constitute double funding.

Similar considerations apply mutatis mutandis to support through State aid: the risk of double funding could occur only where State aid is granted in favour of a carbon sequestration scheme that would pay the beneficiary based on the actual carbon removals generated, whereas national financing of other aid measures could be combined with financial revenues from the selling of certified carbon removals on the markets, without creating such a risk.

4.4. Additionality for carbon storage products

As the experience with certification schemes for product storage is still limited, no best practice can be yet identified. As one of the few examples, the CarboMark methodology for wooden products proposes e.g. that carbon credits could be generated if the ratio of wood in construction was higher than the national average.

ANNEX 8: QUALITY CRITERIA – LONG-TERM STORAGE

1 INTRODUCTION

A peculiar characteristics of carbon removals, which distinguishes them from emission reductions, is the risk that the stored CO2 is re-emitted to the atmosphere (i.e. risk of reversal). It is important that any certification methodology includes elements to address this risk and to guarantee the long-term sequestration of carbon, providing carbon removal projects with the appropriate incentives to store carbon over the long term and policymakers, financers and stakeholders with more clarity on the exact duration of the sequestration.

2 CERTIFICATION CHALLENGES

The average duration of carbon sequestration varies enormously across the spectrum of carbon removal activities. Activities sequestering carbon in soil and vegetation can store carbon for decades to centuries while those sequestering carbon in geological formation can store carbon for ten thousand years or more[95].

Early release of carbon can occur due to intentional or unintentional reversal. These risks varies significantly between different types of mitigation activities and the likelihood, scale, and timing of an early carbon reversal is difficult to predict ex ante. It is important to establish appropriate regimes to allocate liability for redressing carbon reversals, intentional or unintentional, over the lifespan of a removal activity.

A framework ensuring the long-term storage of carbon needs to consider the expected duration of carbon sequestration of carbon removal activity under normal circumstances, as well as the risk of an early release of carbon into the atmosphere, the measures put in place to mitigate this risk and account for potential release and the arrangements to share the related economic risks.

3 EXISTING APPROACHES

3.1 Accounting for the diversity of expected storage durations

The GHG effect of a ton of CO2 emitted in the atmosphere last for centuries. Neutralising emissions with carbon removals requires addressing this long term GHG effect by ensuring that enough carbon has been removed from the atmosphere for long enough. Three strategies can achieve a compensation of CO2 emissions with carbon removals:

- The first option is to compensate one tonne of CO2 emitted with one tonne of permanent carbon removal, i.e. one tonne of CO2 stored for several centuries out of the atmosphere.

- The second option is to compensate one tonne of CO2 emitted with over time a succession of one tonne of temporary carbon removal to ensure that when the first tonne of carbon removal is released back to the atmosphere, another tonne of carbon is removed from the atmosphere.

[95] IPCC WGIII (2022). Climate Change 2022: Mitigation of Climate Change. Summary for Policy Makers, (link).

- The third option is to compensate one tonne of CO2 emitted with up front multiple tonnes of temporary carbon removal. For a given time horizon, an equivalence could be defined between a long term carbon removal and multiple short term carbon removals.

3.1.1 Very long term carbon sequestration

The simplest way to address the issue of long-term storage is to focus on "permanent" carbon removals or carbon removal solutions that, under normal circumstances, and appropriate management practices, store carbon for a predefined number of years, for instance 100, 500, 1000 years or more. However, this approach can exclude most of carbon farming approaches, CO2-derived products, and other temporary storage solutions that can provide value to avoid the worst short-term impacts of climate change while potentially providing co-benefits on other environmental aspects.

An example of voluntary scheme focusing on the certification of very long term carbon removals is Puro.earth[96]. It includes methodologies with assumed long-term storage periods such as biochar, carbonated building elements or geological stored carbon. However this marketplace defines long-term storage as more than 50 years, does not require any specific procedures to monitor and account for potential CO2 reversal and does not establish liability regimes.[97] Moreover, the "proof of permanent sequestration" required in the methodology are very relative: Biochar is considered permanent by proving it is not used for energy purposes; carbonated building elements are considered a priori permanent regardless of the use of the carbonated building elements and the end of life emissions are not considered; for geological stored carbon the legislation of the jurisdiction of the storage site applies.

More stringent requirements are set by regulatory frameworks. The EU requires that any geological site in the EU storing more than 100 kt CO2 of total storage from any source (fossil, biomass, and atmosphere) must be permitted in accordance with the CCS Directive. The primary aim of the Directive is to ensure safe and environmentally sound practice, including effective site selection and management to reduce the risk of site leaks. The CCS Directive also establishes a structured liability framework governing the stewardship of the stored CO2 over the long-term. CO2 pipelines and geological storage sites falling within the scope of the CCS Directive are also subject to an environmental impact assessment (under the EIA Directive). In the event of leaks from the geological storage site (carbon reversal), the conditions of the GHG permit under the ETS require the site operator to monitor, report and surrender EU Allowances equivalent to the mass of CO2 estimated to have leaked. Following liability transfer, the host Member State is obliged to monitor and report emissions in accordance with the 2006 IPCC Guidelines.

3.1.2 Temporary carbon removals

The vast majority of carbon removal projects deployed today are sequestering carbon through nature-based solutions that cannot guarantee a very long term storage of carbon. An analysis conducted in Arcusa et al. (2021)[98] across twenty carbon removal standards developing organisations has shown that most of the proposed carbon removal standards stipulate duration

[96] Puro.earth (link).
[97] However, Puro.earth uses a buffer to correct the volume of issued removals and account for uncertainties such as metering inaccuracies and product life-time emissions. The buffer is set by default at 10% for all removal methodologies but can be adjusted for specific carbon removal solutions.
[98] Arcusa et al (2022). Snapshot of the Carbon Sequestration Certification Market Ecosystem (link).

of sequestration management between 10 and 100 years, often without specific consideration for the physical characteristics of the storage and without consistency across standards (different standards can require different durations for the same type of removals). In fact, the standard stipulations on duration refer often to the active monitoring period of the project under which the project developer is liable but without any constraint on liability or on the validity of the certificate once the monitoring period ends. This means that in most cases there is no guarantee of carbon sequestration beyond the monitoring period when an afforestation offset programme certifies 1 tonne of carbon removal to compensate for 1 tonne of GHG emitted.

Only very few certification schemes have introduced expiry date on certificates to account for the temporary nature of carbon farming removals. A time-limited certification has been introduced in the Clean Development Mechanism through temporary and long-term certified emission reductions (tCERs and lCERs). These certificates for afforestation and reforestation activities were designed to periodically expire and re-issuance could be done only upon verification. The tCERs were based on sequestration levels at a given verification date and expired after 5 years. The lCERs expired after either 30 or 60 years. A major barrier explaining the poor uptake of these certificates was the reluctance of potential investors to engage due to the higher administrative burden of reapplications and the fact that tCERs and lCERs were not allowed to be traded under EU ETS due to the risk that a replacement with permanent credits would not be feasible. Given the large oversupply of carbon credits under the CDM, the temporary credits were not successful on the voluntary market because buyers could already buy permanent credits at extremely low prices.

More recently, the US marketplace Nori[99], specialised in soil carbon sequestration, has chosen to issue temporary carbon removal certificates valid for 10 years, with robust monitoring obligations. After this period, the farmer can re-enrol and re-register projects. Nori believes that long-term permanence for nature-based solutions is more likely to be achieved through recurring carbon retention payments, as opposed to large up-front payments and land-use restrictions imposed by covenants.[100]

3.1.3 Carbon removal equivalence

One of the main barriers with temporary removal is the process to renew the certificate once it expires, which requires to set up a mechanism where the buyer commit to replace the expired certificate with a permanent certificate or another temporary certificate. Some certification mechanisms get around this issue by setting equivalence factors to compare short term temporary removal to longer term removals. The central idea is that the climate impacts of CO_2 can be characterized by the quantity of CO_2 involved and the time it resides in the atmosphere. A larger quantity of CO_2 stored for a shorter period of time and a smaller quantity of CO_2 stored for a longer period of time can claim equivalent climate outcomes.

Following this approach, the constraint of acquiring several temporary carbon removal certificates over time is replaced by the acquisition of multiple temporary carbon certificates upfront. The tonne-year approach referred in the 2000 IPCC special report on Land Use, Land-

[99] Nori (link).
[100] See document "How Nori works" (link).

Use Change and Forestry[101] is building on this principle. An equivalence could be for instance that a temporary carbon removal of 50 year provides 25% of the climate benefit from a 1000 year storage and therefore 1 tCO2 could be neutralised by investing upfront in 4 temporary certificates instead of single permanent one.[102]

The tonne-year methods simplify the management of temporary carbon removal from an investor perspective by quantifying the benefit of carbon sequestration on an annual basis; this is the main reason why programmes such the Natural Capital Exchange (NCX)[103] and more recently the Canadian national carbon offset system[104] propose such methods for certifying carbon removals.[105] Tonne-year methods can be applied to any type of temporary carbon storage, to carbon farming activities but also to solutions storing carbon in products.

However, they also come with challenges, the main one being the fact that the resulting equivalence depends very much on the time horizon selected and the specific methods used. An analysis conducted by Carbon Plan[106] reports equivalence ratio from offsetting programmes can vary greatly with some requiring 100 year of 1 tCO2 stored to compensate for 1 tCO2 emitted while others requiring only 17 year. The choice of the equivalence ratio is a difficult exercise and partly arbitrary, with potential impacts in terms of environmental integrity when it is set too low or on cost for investors when it is set too high.Other drawbacks of these methods include: 1) There is no assurance that the carbon removal project has the right incentives to carry out its activities for the long term. 2) The diversity of carbon storage products from their production to their end of life is not well captured with such simple methodologies and more complex dynamic life-cycle assessments have been proposed for a consistent consideration of non-fossil carbon storage and timing of GHG emissions in a products. A dynamic LCA approach uses a dynamic inventory, which details each emission through time (i.e., the amount of GHG released at every given time-step), and dynamic characterization factors to determine the impact of emissions for every time-step.[107]

3.2 Managing the risk of early release of carbon

To cover the risk of an early release of carbon, robust certification schemes should put in place measures to decrease this risk and allocate liabilities adequately. Reducing the risk of reversal goes thorough assessment of carbon removal projects accounting for local conditions and technological factors. Three broad approaches offer means to address the risk of early reversal and allocates liabilities; these approaches can be combined to a certain extent.

3.2.1 Liability set on the economic operator: Monitoring and compensating for reversals

The economic operator (i.e. carbon removal supplier) maintains liability for the issued certificates in the event of carbon reversal. If a reversal is recorded as activity emissions during the monitoring period, these can generally be deducted from the overall level of removal

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[101] IPCC, Special report on Land Use, Land-Use Change and Forestry (link).
[102] Carbon direct, Accounting for Short-Term Durability in Carbon Offsetting (link).
[103] NCX (link).
[104] Federal government launches greenhouse gas offset credit system system (link).
[105] Verra also proposed a methodology based on tonne-year accounting (link). However, the proposal was not adopted following three month of public-consultation.
[106] Carbon Plan, unpacking ton-year accounting (link).
[107] Levasseur et al. (2012). Biogenic Carbon and Temporary Storage Addressed with Dynamic Life Cycle Assessment (link).

certificates to be issued. However, if the level of emissions exceed the level of removals achieved in the monitoring period, conditions for certification can include a mandate for economic operators to acquire and retire certificates from other suppliers or other sources. Concerns about the costs in such events may inhibit uptake of certification for some type of carbon removal solutions. However, private insurance products may be available to limit the risks for economic operators. This approach does not directly address the risk of CO2 reversals beyond the monitoring period. The duration of the monitoring is therefore an essential element to assess the robustness of certification under this approach, and monitoring periods vary considerably among certification schemes, between 1 and 100 years from the start of the crediting period.[108]

3.2.2 Liability at the level of a financial intermediary: Pooling the risk

In some cases, a financial intermediary puts in place measures to manage liability for carbon reversals on behalf of economic operators. This usually involves applying discount factors to the quantity of net carbon removals certified, possibly proportional to the risk of early reversal of a given carbon removal activity. The part of carbon removal that is discounted can be withheld and allocated to a buffer account in a registry that is operated by the certification scheme. This common buffer reserve can be drawn upon to cover reversals from any economic operator participating in the buffer.

This approach absolves the economic operator of direct liability, thus reducing the disincentive to participate. It is widely adopted[109] among certification schemes and offsetting programmes. A key element is setting the discount rate and dimensioning the size of the buffer reserves to cover reversal risks over time during the active period of the project and also, preferably, after the end of the monitoring period of carbon removal activities. It is therefore important to establish which fraction of carbon credits is put into the reserve and how the reserve is replenished in case a reversal needs to be compensated for.

3.2.3 Liability at the level of the user

The liability for carbon reversal risk is attached to the certificate and therefore passed on to its buyer. In case of a reversal, the certificate loses its validity and the buyer needs to acquire a new certificate to preserve the benefit of the associated carbon removals. This approach is rarely used by certification schemes and its pertinence would depend on the context in which the certificate is used. It can inhibit the uptake of certification for some types of use, for instance in an offsetting context.

4 LONG-TERM STORAGE CRITERIA FOR AN EU FRAMEWORK

4.1 General criteria

The following best practices can be identified to better distinguish the different capacities of carbon removal solutions to sequester carbon over the long term:

- For technology-based removal solutions that offer the possibility for very long-term storage (e.g. BECCS and DACCS), the liability rules of the CCS Directive provide the

[108] EDF & Oeko-Insitut (2021). Methodology for assessing the quality of carbon credits (link).
[109] McDonalad et al. (2021). Certification of carbon removals - Part 2: A review of carbon removal certification mechanisms and methodologies (link).

most robust standard for permanent storage, i.e. the carbon removal project remains responsible for monitoring and reporting and liable to compensate for any re-emission with a transfer of liability foreseen at the cessation of the activities.

- Carbon removal projects that cannot offer permanent storage (e.g. carbon farming, carbon storage products) should be able to commit for shorter time periods:
  - During the commitment period, the carbon removal project takes the full liability for any re-emission.
  - The carbon removal project needs to commit to at least a minimum duration that is appropriate in view of the technological, regulatory and business conditions.
  - It should be possible to renew those short-term commitments or to commit upfront for a longer time period.

  With a view to transparency, clear rules should be established that the certificate becomes void after the expiration of the commitment period, e.g. no claim can be made that the carbon which was removed from the atmosphere during the project is still sequestered after the expiry date of the certificate.

These principles allow to design methods tailored to the different types of carbon removals. The strengths and weaknesses of the approaches just described are compared in Table 6.

Table 6: Comparison approaches for long-term storage criteria

	Policy baseline	Temporary storage	Permanent storage
Short description	The risk of reversal is addressed through a combination of two approaches: a buffer setting aside a % of certificates and/or a liability for the economic operator during the monitoring period of the project. The release of sequestered carbon after the end of the project, including the monitoring period, is not directly addressed.	The certification is valid until an expiry date set in accordance with the expected duration of the carbon removal under normal circumstances. Monitoring obligations and liability are set only until the expiry date of the certificate.	The economic operator must monitor potential reversal and is liable during the operational phase of the project and after closure up until transfer of responsibility to a private or public entity.
Transparency on the	× The risk of reversal after the end of the	✓✓ Temporary sequestration and expected duration is	✓✓ The very long-term storage of the carbon is recognised

duration of the storage	activity/monitoring period is rarely addressed. Even though the amount of certificates set aside in a buffer could be adjusted to the likelihood of reversal of various types of carbon removals, a common percentage of certificates is usually set aside often irrespectively of the expected risk. There is not clear distinction between carbon removals with very different durations. .	acknowledged by the expiry date of the certificate. Monitoring obligations and liability regimes are set during the validity period of the certification. The certificate can be renewed if the activity or monitoring is continued. If not, the carbon is assumed to be released after the expiration of the certification.	with a permanent validity of the certification. Clear rules establish liability and monitoring obligations during the project and after the end of the project (as set out in the Carbon Capture and Storage (CCS) Directive for geological storage).
Incentivising long-term storage	✓✗ Incentive is given to mitigate the risk of reversal before the end of the project, which can take place over several decades. No specific incentives to maintain the sequestration of carbon beyond the duration of the project.	✓ Incentive is given to mitigate the risk of reversal before the end of the project, which can take place over several decades. A renewal of the temporary certificate will maintain the sequestration for a longer period than the initial validity period.	✓✓ Only permanent carbon removal solutions can be certified under this approach.
Administrative burden	✓✓ Simple to implement with limited costs and low economic uncertainty for projects. Adapted to small scale projects.	✓ Simple to implement with limited costs and low economic uncertainty for projects. Adapted to small scale projects. The obligation for the renewal of the certificates after the expiration can be seen as an administrative constraint, in particular for use such as offsetting.	✓✗ Stringent long-term liability can be source of economic uncertainty or entry barrier for small-scale projects. Financial insurance mechanisms or risk pooling arrangements can be set. Transfer of liability after the closure of the project requires the commitment of a new private entity or public authorities.

		Well adapted to financial contributions without offsetting claims. Fair and transparent sharing of reversal risk between economic operator and financer.	
Application		This approach would apply to carbon farming and carbon storage products	This approach would apply to all permanent storage solutions (geological storage and others),

4.2 Long-term storage for Permanent Storage solutions

Geological storage is often considered as a virtually permanent solution for the sequestration of carbon. Appropriately selected and managed geological reservoirs are very likely to retain over 99% of the sequester CO2 for longer than 100 years and likely to retain 99% of the sequestered CO_2 for longer than 1000 years.[110] The injection of gases with high CO2 concentration in subsurface formations for rapid carbon mineralization is a trapping technique that can permanently store CO2 in reactive rocks such as basalt and mafic or ultramafic rocks in general.

Carbon removal relying on geological storage present a high level of confidence regarding their long-term storage with already an existing framework covering the risk of reversal and attribute liabilities. From a certification perspective, these solutions can be considered as permanent without the necessity to put new measure to complement the existing regulatory framework in the CCS Directive. Any geological site in the EU storing more than 100 kt CO2 of total storage from any source (fossil, biomass, and atmosphere) must be permitted in accordance with the CCS Directive.

Other permanent solutions to remove carbon such as enhanced rock weathering or ocean alkalinisation have also the potential to store carbon for more than 10.000 years[111] with limited risk of reversal but further research is required for these solutions.

4.3 Long-term storage for Carbon Farming

Overall, biological processes can sequester carbon for decades to centuries and face a higher risk of reversal due to the necessity to maintain practices that prevent the release of CO2 to the atmosphere, including the potential impact of climate change on natural ecosystems.

All biological carbon sinks are prone to depletion through natural or anthropogenic events. Changes in ownership of the land and tenure arrangements can also lead to land use change impacting carbon stocks. Based on the carbon removal solutions identified in the IPCC AR6 WGI report[112], Table summarises the risk of reversal for selected carbon farming solutions.

Table 7: Risk for reversal with carbon farming projects

	Risk of reversal in an EU context
Afforestation, Reforestation, Improved Forest management, Agroforestry	Natural disturbances (e.g. fires, pests, droughts), extreme weather. Climate change can increase the risk in the future. Change in management practices.
Soil carbon sequestration in cropland and grassland	Soil and crop management. The soil carbon stocks are sensitive to management practices. Not maintaining carbon farming practices could quickly lead to the release of carbon back to the atmosphere. The progression of climate change is increasing reversal risks.
Peatland and wetland restoration	Peatland drainage, fire, drought, land use change.

110 IPCC (2005). Special Report on carbon capture and storage (link).
111 IPCC WGI (2021). The Physical Science Basis, chapter 5: Global Carbon and Other Biogeochemical Cycles and Feedbacks, AR6 (link).
112 Ibidem.

Biochar	Biochar remaining in the soil are at lower risk of reversal. Fire could potentially release carbon from it. Lower residence times occur under tropical and sub-tropical regions and not in Europe, higher residence times in dry soils.

Establishing a long-term liability at the level of the economic operator – comparable to the rules of the CCS Directive – would imply economic risks difficult to take on for a land manager. Nevertheless, it is important that land managers engage to climate-friendly practices on a long-term basis, and contractual agreements can prevent the voluntary early withdrawal of carbon-farming projects. A pre-defined period of commitment where the land manager is liable for adopting carbon farming practices could be set and continuously renewed (building on existing practices with private buyer contracts or subsidy schemes under the Common Agricultural Policy). Such arrangements can secure a continuous income stream for the land managers and limit their risk exposure, which is particularly important for the promotion of carbon farming with land managers who have smaller holdings.

The issuance of temporary certificates with an expiry date would provide a very transparent information on the temporary nature of carbon removal solutions while preventing the use of the certificates beyond their validity. A minimum duration of validity would be set according to existing regulatory or business practices (e.g. programming period of the Common Agricultural Policy for soil management). However, carbon removal projects should be able to go beyond and be able to commit up to the expected duration of the specific carbon farming solution or to renew their commitment period.

To manage the risk of early release of carbon, additional risk measures – such as buffers, risk pooling, or tonne-year accounting – can be applied.

4.4 Long-term storage for Carbon Storage Products

The potential for carbon sequestration in products depends very much on the type of product and its end-use. Bio-based and CCU products encompass a very large range of storage duration and risk of reversal, the assessment should be carried out on a case by case basis, for instance construction products are often considered as low risk of reversal over the first 50 to 100 years.

Certification of removals through bio-based products should align with models used for Harvested Wood Products (HWP) in the national GHG inventory compilation. In this context,the criterion of long-term storage should be implemented either through:

- Issuance of temporary certificates that expire at rates aligned with the HWP half-life under the first-order decay (FOD) calculation approach according to 2006 IPCC Guidelines, or
- Use of a variant of tonne-year methods to calculate the amount of certificates to be issued based on the time equivalency of the mitigation aligned to the assumed HWP half-life.

There is no fundamental reason to treat CCU products differently than bio-based products. A FOD approach coupled with temporary certificates or tonne-year accounting would also fit CCU products with different life expectancy and risk of reversal. A FOD set to zero would represent a permanent storage but imposing requirements similar to the CCS Directive on the monitoring of carbon reversal from CCU products could turn out to be hardly implementable given the likely more complex value chains of CCU products over their lifetime and changing ownership.

ANNEX 9: QUALITY CRITERIA – SUSTAINABILITY

1 INTRODUCTION

Carbon removal actions have the potential to affect sustainability objectives beyond climate targets, as highlighted by the most recent reports by the IPCC[113] and can therefore contribute positively to sustainable development goals, including adaptation to climate change, food and water security, and biodiversity.

As highlighted in the EU Biodiversity Strategy[114], nature is a vital ally in the fight against climate change and nature-based solutions[115], such as protecting, restoring and managing sustainably ecosystems, are essential for climate action. Carbon removals activities should minimize trade-offs and instead encourage synergies with other environmental impact categories.

There is growing scientific evidence[116] that the healthier and more biodiverse an ecosystem, the higher its productivity and multi-functionality, the more carbon it stores and the more resilient it is to the impacts of climate change. It is therefore important that ecosystems on all types of land, including forests, grasslands, croplands and wetlands, are in good condition to be able to capture and store carbon efficiently.

Dimensions of sustainability other than biodiversity, such as land tenure and food security, also need to be addressed. It is necessary to ensure that carbon removals do not exclude sustainable models of agriculture or land management, for instance through increased uncontrolled competition for land. If monocultures were to replace natural forests and subsistence farmlands, some carbon removals activities, such as afforestation and bioenergy with carbon capture and sequestration (BECCS), would raise various issues with adverse side-effects for adaptation, biodiversity, and other sustainability objectives. As such activities involve land use change that can affect food and water security as well as local livelihoods, they can cause conflict around land tenure and access. Several cases of increased land competition due to the implementation of voluntary climate scheme have been documented, including large-scale land acquisition for afforestation and peatland restoration in the United Kingdom[117] or the conversion of farmland to forestry induced by carbon offsetting in New Zealand[118]. To prevent these adverse impacts, appropriate sustainability requirements are necessary to ensure the right choice of species and

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[113] IPCC WG III (2022), Climate Change 2022: Mitigation of Climate Change. AR6 (link).
[114] COM (2020) 380. EU Biodiversity Strategy for 2030 Bringing nature back into our lives (link).
[115] EC. Nature-based Solutions (link).
[116] Lewis, S. L., et al. (2019). Restoring natural forests is the best way to remove atmospheric carbon. Nature, 568(7750), 25–28, (link).
Liang, J., et al. (2016). Positive biodiversity-productivity relationship predominant in global forests. Science, 354(6309), aaf8957, (link).
van der Plas, F., et al. (2016). Jack-of-all-trades effects drive biodiversity–ecosystem multifunctionality relationships in European forests. Nature Communications, 7(1), 11109, (link).
[117] McMorran, R., et al. (2022). Large-scale land acquisition for carbon: opportunities and risks: A SEFARI Special Advisory Group Final Report. Scotland's Rural College (SRUC), (link).
[118] Orme, S., et al. (2021). Independent validation of land-use change from pastoral farming to large-scale forestry. Beef + Lamb New Zealand, (link).

management practices, the implementation of these measures at appropriate scales and on relevant locations, and the suitable integration into territories.

However, carbon farming practices can improve the soil fertility and land resilience to climate change, and thus contribute to better food security and sustainability. These win-win synergies should be encouraged in order for carbon farming to remain truly a new business model for farmers, foresters and land managers, as set out in the Farm to Fork Strategy[119]. Practices increasing carbon sequestration in trees and soils can help to conserve and restore biodiversity and to maintain and enhance multiple ecosystem services[120].

Sustainability issues are not specific to carbon farming but apply to all types of carbon removals. For example, industrial carbon removals can be resource, land or energy intensive and affect localised pollution. Conversely, carbon storage products often have advantages in terms of energy efficiency, user comfort and circular economy. The successful implementation of carbon removal activities depends on consideration of local environmental and socio-economic conditions. Certification methodologies that capture negative and positive impacts, as well as the engagement of civil society organisations, can help in deploying carbon removal projects with high acceptability, equitability and sustainability.

2 CERTIFICATION CHALLENGES

The assessment of sustainability impacts can cover a wide range of climate (e.g. adaptation), environmental (e.g., air, water and soil quality, protection of natural resources, biodiversity conservation), social (e.g. public health, energy access, food and water security) and economic goals (e.g. energy independence, income stability, green job creation, technology transfer).

- Safeguards can be defined as a set of principles, rules and procedures put in place to prevent adverse side-effect[121] and to reduce trade-offs[122]: activities carried out for a purpose of climate change mitigation should not have trade-offs that would lead to significant negative impacts on other environmental and socio-economic objectives. In this sense, the concept is similar to the environmental impact assessment required for many projects in national and European regulations. At the international level, forest carbon standards were equipped early-on with particularly elaborate systems of safeguards, with social, environmental and procedural criteria[123].

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[119] COM (2020) 381. A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system, (link).

[120] Common International Classification of Ecosystem Services (CICES version 5.1 updated in 2018), (link).

[121] Defined by IPCC as follows: "A negative effect that a policy or measure aimed at one objective has on another objective, thereby potentially reducing the net benefit to society or the environment."

[122] Defined by IPCC as follows: "A competition between different objectives within a decision situation, where pursuing one objective will diminish achievement of other objective(s). A trade-off exists when a policy or measure aimed at one objective (e.g., reducing greenhouse gas emissions) reduces outcomes for other objective(s) (e.g., biodiversity conservation, energy security) due to adverse side effects, thereby potentially reducing the net benefit to society or the environment."

[123] Roe, S., Streck, C., Pritchard, L., & Costenbader, J. (2013). Safeguards in REDD+ and forest carbon standards: a review of social, environmental and procedural concepts and application. ClimateFocus, (link).

- While safeguard clauses are aimed to prevent negative impacts on other sustainability dimensions, the notion of co-benefits[124] aims to demonstrate the positive impacts that mitigation activities can have on other environmental and socio-economic objectives. Although various definitions of co-benefits can be considered[125], they imply effectively a 'win–win' strategy to address two or more goals with a single activity.

A robust monitoring of sustainability impacts requires a solid framework of indicators and statistical data to monitor progress, inform policy and ensure accountability of all stakeholders. At UN level, a global indicator framework was adopted to measure and monitor progresses the along the 17 SDGs of the 2030 Agenda for Sustainable Development[126]. Eurostat used a similar structure in its monitoring report on sustainable development[127]. Sustainable development objectives have been at the heart of European policymaking for a long time, firmly anchored in the European Treaties[128] and mainstreamed in key projects, sectoral policies and initiatives, including under the European Green Deal[129]. As many of the SDG concerns are already being integrated in regulatory obligations, the challenge to include sustainability criteria in carbon removal certification could be simplified in the Union.

If SDGs are highly relevant to frame sustainability impact assessment, associated indicators are however only partially applicable at the project level and can overburden project developers. Besides, the ambiguity of the notion of sustainable development has led to different definitions and interpretations, resulting in a large number of indicators and ratios. Based on an analysis of 217 project-level indicators from different existing schemes, Day et al. (2020)[130] identified five potential issues when using indicators to assess sustainable development impacts:

1. Indicators may be vague and may not refer to specific results, making it difficult to understand the impact and magnitude of the impact;
2. Even in the case of a specific result or impact, the link with the project level may be only indirect, making it difficult to understand cause and effect relationships;
3. Some indicators do not lend themselves to the use of quantitative measures, reducing accuracy and transparency;
4. Some indicators are very complex and require large data collection and processing efforts;
5. Indicators may also raise politically sensitive issues, hindering their implementation.

Pragmatic solutions can improve sustainable development impact assessment without increasing complexity: indicator definitions should be specific enough to ensure that there cannot be

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[124] Defined by IPCC as follows: "A positive effect that a policy or measure aimed at one objective has on another objective, thereby increasing the total benefit to society or the environment."

[125] Mayrhofer, J. P., et al. (2016). The science and politics of co-benefits in climate policy. Environmental Science & Policy, 57, 22–30, (link).

[126] Resolution A/RES/71/313 adopted by the General Assembly on 6 July 2017. Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development, (link).

[127] European Commission. Statistical Office of the European Union. (2021). Sustainable development in the European Union: monitoring report on progress towards the SDGs in an EU context: 2021 edition. Publications Office, (link).

[128] Articles 3 (5) and 21 (2) of the Treaty on European Union (TEU)

[129] COM (2019) 640 final, (link).

[130] Day, T., et al. (2020). Indicators for the promotion of sustainable development in carbon market mechanisms. Final report (No. UBA-FB--000345/1, ENG). Umweltbundesamt (UBA), (link).

multiple interpretations; one-dimensional indicators should be used when possible, to ensure comparability and reduce costs; indicators should be expressed in absolute terms to increase the comparability and ease the verification.

Another certification challenge for assessing the sustainability impacts of carbon removals relies in the site-specific dependency of side-effects and co-benefits, which vary according to topography, bioclimatic conditions and other conditions of the place where removals activities are taking place, the past and current practices, and more generally the socio-economic conditions of the populations present on or near the site.

The following table summarises some co-benefits and trade-offs identified by the IPCC AR6 WG3 report[131] for selected carbon removal solutions.

Table 8 – Co-benefits and trade-offs of carbon removal solutions

	Co-benefits	**Trade-offs**
Afforestation and reforestation	Focusing on e.g. degraded lands or biodiversity friendly afforestation has significant co-benefits, including for biodiversity and adaptation.	Afforestation that results in monodominance could reduce biodiversity. Inappropriate deployment at large scale can lead to competition for land with biodiversity conservation and food production. Reduced catchment water yield and lower groundwater level if species and biome are inappropriate. Potential leakage due to afforestation of productive land, with commercial activities shifting. Afforestation can alter albedo changes and other local biophysical variables.
Improved Forest Management	Sustainable forest management can lead to enhanced biodiversity and productivity, water quantity and quality. High co-benefits, including ecosystem and biodiversity preservation, as well as water quality and water quantity benefits.	If it involves increased fertiliser use and introduced species it could reduce biodiversity and increase eutrophication and upstream GHG emissions. In some cases, improved forest management for mitigation can lead to mal-adaptation, e.g. increasing biomass in fire-prone forests. Leakage effects are low, as forest management occurs on existing forest land and has only small impacts on timber production. If it involves short rotations, clear-cutting and even-aged management to benefit from high storage rates in young forests, it can have negative effects on biodiversity and soil health/storage capacity

[131] IPCC WG III (2022), Climate Change 2022: Mitigation of Climate Change. AR6 (link).

Agroforestry	Enhanced biodiversity (e.g., on pollinators, insects, and provision of habitats), improved soil quality, more resilient ecosystems. Protection against flooding, nitrate leaching, and soil erosion Significant positive impact on biodiversity (including habitat provision, pollinators and insects), reduced soil erosion and improved soil health, flooding protection and reduced nitrate leaching.	Modest trade-off with agricultural crop production. Low risk of leakage since agroforestry does not fully replace existing arable/animal production (although small impact on output).
Soil carbon sequestration in cropland and grassland	High co-benefits. Improves soil structure and soil fertility, increases water retention capacity of soils and increases resilience to climate change, reduces soil erosion and reduces soil compaction risk.	Potential negative impacts on production in the transition period. There are concerns about possible unintended impacts on soil health (due to pollutants) if the SOC levels are increased by applying off-farm organic inputs. There may be trade-offs with N2O emissions. Clear estimates for risk of leakage are not available in literature.
Peatland and wetland restoration	Improved biodiversity, soil carbon and nutrient cycling, water and soil quality, protection from floods and coastal storms. Many co-benefits, such as biodiversity conservation, flood protection, improved soil and water quality, protection from coastal storms, as well as cultural ecosystem services.	Competition for land on some peatlands used for food production. Small-medium leak-age risk due to activity displacement (though relatively small peatland area, so limited risk). Peatland restoration in-creases methane emissions (though in most contexts in medium and long term net GHG effect is negative)
Biochar	Increased crop yields and increased resilience to drought. Stabilization of toxins and heavy metals, the decrease of soil nutrient losses, improved soil structures and water holding capacities. Expected co-benefits are uncertain but expected to be relatively small; improved soil structure, water holding capacity, reduction in nutrient losses from soils, stabilisation of heavy metals and other toxins.	Environmental impacts associated with particulate matter (soil black carbon emissions); competition for biomass resource, potential GHG leakage due to biomass production, decrease in albedo, potentially negative effects on biodiversity Unclear impacts on worms and soil fauna, or broader impacts on biodiversity. Precautionary approach should be applied until better scientific understanding of side-effects and long-term impacts. Leakage can occur if biochar biomass production competes with other land uses. Biochar application poses no leakage risks as biochar can be applied to existing crop/grasslands.
BECCS	Fuel security, use of residues, generation of energy, energy independence, bioenergy pathways	Relatively large land requirements compared to other carbon removal options. Competition for water to grow

		biomass feedstock. Biodiversity and carbon stock loss if from unsustainable biomass harvest. Increased competition for land, potential land use change and deforestation. Competition for biomass & land, forests managed with weak MRV, and pressure on bio-diversity and water resources.
DACCS	DAC installation have a low land area footprint.	Energy requirement and emissions associated when fossil sources of energy are used. Land area footprint for the production of energy when wind or solar energy is used. Water requirement
Bio-based products	Substitution of fossil carbon products. Production with long-term circularity potential. For some products, end-of-life use as an agricultural amendment.	Competition for water and land to grow biomass feedstock. Biodiversity and carbon stock loss if from unsustainable biomass harvest. Increased competition for biomass & & land use.
Carbon capture and utilisation	Substitution of GHG intensive products. Foster circular use of carbon.	End of life of the product conditions the real environmental benefit, large energy requirements High energy demand

3 EXISTING APPROACHES

3.1 Sustainability assessment and requirements in EU policies

3.1.1 Existing legislative frameworks

The European ambition for sustainability is long-standing and many assessment frameworks have been built over the years to verify the sustainability of activities and projects, especially on environmental aspects. Two important general frameworks are:

- The Environmental Liability Directive[132] establishes a framework based on the polluter pays principle to prevent and remedy environmental damage. The Directive defines "environmental damage" as damage to protected species and natural habitats, damage to water and damage to land. Guidelines[133] were adopted that clarify the scope of the term 'environmental damage' in the Directive. These guidelines help Member States to better assess whether damage to water, land and protected species and natural habitats must be prevented or restored by explaining the scope of each of these categories in detail.

[132] Directive 2004/35/CE, (link).

[133] Commission Notice Guidelines providing a common understanding of the term ‘environmental damage’ as defined in Article 2 of Directive 2004/35/EC (link)

- The Environmental Impact Assessment Directive[134], whose first version was adopted in 1985, is one of the oldest pieces of EU environmental legislation. It ensures that environmental considerations are properly considered when project decisions are made, with a view to reducing their environmental impact and making the projects more sustainable, thus contributing to sustainable development.
- The Environmental Footprint method[135] defines the recommended modelling requirements, data quality requirements[136], and life cycle impact assessment[137] to be followed when assessing the environmental performance of products and organization. Such methods allows to identify co-benefits and trade-off between climate change and the other 15 impact categories.

3.1.2 Sustainable finance taxonomy

More advanced frameworks for assessing environmental sustainability at activity level have emerged under the EU sustainable finance policies, relying on long-established policies related to environmental liability and environmental impact assessment. In the EU's policy context, sustainable finance is understood as finance to support economic growth while reducing pressures on the environment and taking into account social and governance aspects. The financial sector has a key role to play in delivering on climate objectives. Following the sustainable finance action plan[138] and the strategy for financing the transition to a sustainable economy[139], the Commission has implemented a sustainable finance toolbox. One of these tools is the EU taxonomy, a classification system, establishing a list of environmentally sustainable economic activities, and providing companies, investors and policymakers with appropriate definitions of which economic activities can be considered environmentally sustainable. The Taxonomy Regulation[140] establishes six environmental objectives:

- Climate change mitigation,
- Climate change adaptation,
- The sustainable use and protection of water and marine resources,
- The transition to a circular economy,
- Pollution prevention and control,
- The protection and restoration of biodiversity and ecosystems.

The regulation establishes the basis for the EU taxonomy by setting out 4 overarching conditions that an economic activity has to meet in order to qualify as environmentally sustainable:

i. it contributes substantially to one or more of the six environmental objectives;

[134] Directive 2011/92/EU (link)
[135] EC (2021) https://environment.ec.europa.eu/publications/recommendation-use-environmental-footprint-methods_en
[136] JRC Technical Report "Guide for EF compliant data sets. Version 2.0" (2020) https://eplca.jrc.ec.europa.eu/permalink/Guide_EF_DATA.pdf
[137] The Environmental Footprint reference package includes the flow list, the life cycle impact assessment methods and other related xml files https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml
[138] COM/2018/97. Action Plan: Financing Sustainable Growth, (link).
[139] COM/2021/390. Strategy for Financing the Transition to a Sustainable Economy, (link).
[140] Regulation (EU) 2020/852 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, (link).

ii. it does not significantly harm any of the other environmental objectives;
iii. it is carried out in compliance with minimum safeguards that target human rights; and
iv. it complies with the "technical screening criteria" that are established by the European Commission through delegated acts. The technical screening criteria specify the conditions under which an economic activity meets criteria (i) and (ii).

Minimal safeguards in the area of human rights refer to procedures carried out to ensure the alignment with the OECD Guidelines for Multinational Enterprises[141] and the UN Guiding Principles on Business and Human Rights[142].

In order to receive input from experts from across the economy and civil society, the Platform on sustainable finance[143] is tasked with advising the European Commission. Advice can deal with the further developing the EU taxonomy, improving its usability and exploring its expansion to social objectives[144]. It is also working on the environmental transition taxonomy[145], with extension options including activities that significantly harm the environment or activities that are neutral towards the environment.

A first delegated act[146] has been published on sustainable activities for climate change adaptation and mitigation objectives. A second delegated act for the remaining objectives will be published in 2022, analysing the platform's recommendations on technical screening criteria for the four remaining environmental objectives[147].

The Climate Delegated Act of the Taxonomy includes technical screening criteria for the following activities, particularly relevant for carbon removals:

- Forestry: afforestation; rehabilitation and restoration of forests, including reforestation and natural forest regeneration after an extreme event; enhance sustainable forest management; Conservation forestry;
- Environmental protection and restoration activities: restoration of wetlands;
- Water supply, sewage, waste management and remediation: material recovery from non-hazardous waste; underground permanent geological storage of CO2.

What does not qualify as a green economic activity under the EU Taxonomy is not necessarily unsustainable given the need to make a 'substantial contribution'. The taxonomy is a living document, with the possibility to add screening criteria for new activities that make a substantial contribution to one of the six environmental objectives in the taxonomy and don't harm any of them; the existing criteria will also be regularly reviewed. In particular, there is not yet technical

[141] OECD (2011), OECD Guidelines for Multinational Enterprises, OECD Publishing, (link).
[142] UN Human Rights – Office of the High Commissioner (2011), Guiding Principles for Business and Human Rights: Implementing the United Nations "Protect, Respect and Remedy" Framework, (link).
[143] EC, Platform on Sustainable Finance – Platform publications and news, (link).
[144] Platform on Sustainable Finance (2022) *Final Report on Social Taxonomy*, (link).
[145] Platform on Sustainable Finance (2022) *The Extended Environmental Taxonomy: Final Report on Taxonomy extension options supporting a sustainable transition*, (link).
[146] Commission Delegated Regulation (EU) 2021/2139, (link).
[147] Platform on Sustainable Finance (2022). *Technical Working Group. Part A: Methodological report*, (link). Platform on Sustainable Finance (2022). *Technical Working Group. Part B: Annex: Technical Screening Criteria*, (link).

screening criteria for agriculture. The technical screening criteria for substantial contribution to climate change mitigation of the activity "Manufacture of other low carbon technologies" relies on life-cycle GHG emission savings calculated using PEF or static life-cycle analysis, which does not allow a proper acknowledgement of carbon removals.

3.2 Sustainability requirements in existing climate certification schemes

Several studies[148] have attempted to compare how existing climate certification schemes cover sustainability issues, while scoring tools are beginning to emerge to provide investors and project developers with more transparency on existing standards[149]. The majority requires methodology developers or project managers to identify and to clarify how likely sustainability impacts are managed, and include more or less stringent prescriptions and tools.

At UN level, the Clean Development Mechanism provides a voluntary tool for sustainable development impact assessment, based on a 3-pillars classification along environmental (natural resources, soil quality and/or soil pollution, water quality, air quality), social (education, job creation, welfare, health and safety) and economic aspects (energy transfer, technology transfer, economic growth, balance of payment). If any negative impacts are identified, the projects are required to provide a socioeconomic and environmental impact assessment of the proposed activity as well as a mitigation action plan. However, only a very small share of CDM activities has actually used this tool[150].

The Glasgow decisions for sustainable development under article 6 Paris Agreement represent a step forward compared to the CDM, including in terms of international harmonization and reporting[151]. While the main focus is on reducing greenhouse gas emissions, addressing other sustainability aspects has been enshrined as a principle which applies when Parties intend to use cooperation mechanisms under article 6 Paris Agreement. Under Article 6.2, comprehensive reporting and accounting requirements have been introduced, which also aims to ensure sustainable development benefits and to avoid negative impacts. Under Article 6.4, the successor of the CDM, the rules also include requirements for reporting on the sustainable development impacts of the host country. As regards non-market approaches under article 6.8, one of the initial priority areas of the work programme includes "mitigation actions to address climate change and contribute to sustainable development". Sustainable development issues are well identified in the

[148] Cevallos, G., Grimault, J., & Bellassen, V. (2019). *Domestic carbon standards in Europe.* Institute for Climate Economics (I4CE), (link).
McDonald, H. et al. (2021). *Certification of Carbon Removals. Part 2: A review of carbon removal certification mechanisms and methodologies*. Vienna: Environment Agency Austria, (link).
Wissner, N. et al. (2022). Sustainable development impacts of selected project types in the voluntary carbon market. Foundation Development and Climate Alliance. Öko-Institut, (link).
ICARE. Étude comparée des standards de compensation existants. Évaluation des critères pertinents de sélection des standards et projets pour la mise en œuvre de l'article 147 de la loi Climat et Résilience. Direction Générale de l'Énergie et du Climat, (link).
[149] See for example, the Standards Map (link) and the Carbon Credit Quality Initiative (link).
[150] Michaelowa, A., Espelage, A., & Hoch, S. (2020). Co-benefits Under the Market Mechanisms of the Paris Agreement. In W. Buchholz, A. Markandya, D. Rübbelke, & S. Vögele (Eds.), Ancillary Benefits of Climate Policy (pp. 51–67). Springer International Publishing, (link).
[151] Olsten, K.H. and Arens, C. (2021). Promoting sustainable development in Article 6 pilot activities. Sustainable Development Initiative and Wuppertal Institut, (link).

first agreements under Article 6.2, signed notably between Switzerland and several developing countries[152]. However, there is hardly any concrete implementation experience yet available.

While existing climate certification schemes carry out in most cases only qualitative assessments, some of them include quantification tools on multiple sustainable development goals. Some schemes condition certification on the disclosure of additional co-benefits, as long as they can be monitored and verified. Co-benefits can be attached to certificates, giving them additional value.

Beyond the disclosure aspects, some schemes condition the eligibility of methodologies and projects on applicability or exclusion criteria with regard to impacts on sustainable development. These criteria can limit eligibility to methodologies or projects that generate significant co-benefits on multiple sustainable development goals beyond climate change mitigation, or alternatively can exclude projects that, despite their climate benefits, are likely to generate adverse side-effects.

Regarding stakeholder consultation, many schemes require that methodology and project developers involve stakeholders and that new methods/projects are subject to public consultation.

At the international level, based on the 17 Sustainable Development Goals (SDGs) of the UN 2030 Agenda for Sustainable Development[153], the majority of certification schemes propose to measure the contribution to the SDGs in a general way, without proposing any specific tool or method. The approaches deployed by the schemes vary greatly. While some schemes do not include any specification, others include the facultative but recommended reporting of impacts or an assessment framed along several SDGs. In some rare cases, the assessment follows the entire framework of the 17 SDGs with a suitable tool made available. In most cases, the main sustainability issues addressed are the conservation of biodiversity and other environmental objectives, socio-economic benefits, and the protection of human rights.

Regarding biodiversity, while some schemes do not provide any specification, the majority of standards propose at least an optional or method-specific consideration, particularly for methods involving land management. Some schemes include general principles or specific criteria that must be respected by all methodologies. A few schemes rely on a mandatory assessment of the negative and positive impacts of projects on biodiversity.

For other environmental criteria, the degree of consideration covers a wide range of possibilities, including the absence of specification; an assessment of environmental impacts complementary to biodiversity, without a precise purpose, method or indicators to be used; and an assessment of an established list of co-benefits on the quality on soils, water and air, and other environmental topics.

Regarding socio-economic benefits, best practice is to require an assessment of the socio-economic co-benefits generated by the project. While some schemes define their own requirements, others refer to requirements under national law which may lead to uneven

[152] Switzerland has recently formed bilateral agreement under article 6 with Peru, Ghana, Senegal, Georgia, Vanuatu, Dominica, Thailand, Morocco and Chile, (link).

[153] Resolution A/RES/71/313. Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development, (link).

outcomes in different countries. Schemes can be more or less stringent, with a large range of possibilities, including the absence of specification, optional socio-economic impact analysis, a mandatory analysis of negative and positive socio-economic impacts, either without specific methodology or by listing several specific criteria to be respected.

Regarding respect for human rights and rights of local populations, international best practice is to require projects to demonstrate that they are not in breach of a list of fundamental human rights or rules, through regular auditing. More specifically, the degree of consideration ranges from the absence of any specification, to mandatory consideration of the views of local people and communities or the presence of safeguards or mandatory conditions. For several schemes whose projects are carried out only in industrialised countries, respect for human rights is not considered a concern and schemes do not contain any specific provision.

For several climate schemes, it should be noted that complementary schemes can be added for more in-depth consideration of environmental objectives, socio-economic benefits, human rights and consultation with local populations and communities. For example, Gold Standard include social safeguards principles, which can be complemented by Fairtrade Climate International standard, particularly on the issue of working conditions. Similarly, the Climate, Community and Biodiversity (CCB) Standards is a complementary standard to Verra which proposes, in addition to the no net harm criterion and the criteria specific to land sector methodologies, to apply more specific criteria to the species and ecosystems concerned by the project.

4 SUSTAINABILITY CRITERIA FOR AN EU FRAMEWORK

4.1 General criteria

Three approaches can be envisaged to implement the sustainability criteria:

1. **Policy baseline**: rely on existing legislation which puts direct obligations on carbon removal providers regarding a range of sustainability aspects.
2. **Disclosure of sustainability co-benefits**: certification methodologies can include specific indicators that show the most important co-benefits and allow comparing the sustainability performance of the carbon removal projects. Projects with co-benefits would be more attractive than projects without co-benefits.
3. **Minimum sustainability requirements**: the activity should meet some minimum requirements that ensure that only activities that do not generate adverse side-effects and on the contrary that generate co-benefits for sustainability objectives are certified.

The following table**Error! Reference source not found.** summarises the strengths and weaknesses of these approaches in terms of incentivising sustainability and in terms of the administrative burden that they impose on economic operators:

Table 9 - Comparison of approaches for sustainability criteria

	Policy baseline	Disclosure of co-benefits	Minimum requirements

Incentives for sustainability co-benefits	✗ Legislative framework already applicable to specific carbon removal activity does not incentivise additional co-benefits. ✓✗ Safeguards against negative impacts depend on type of solution and of legal approach.	✓ Carbon removal activities can demonstrate their co-benefits and attract more finance ✗ No safeguard against projects with negative sustainability impacts	✓ Goes beyond mandatory legal standards ✓ Additional incentives because only carbon removal activities that provide a minimum level of co-benefits are eligible.
Administrative burden	✓ No additional burden	✓✗ To keep administrative costs low, the indicators for disclosure should build on indicators used in other existing legislation but not yet mandatory for the economic operator (such as Taxonomy or Nature Restoration Law) or best practices from private certification. The development and testing of new indicators could lead to high administrative burden.	✓✗ Should build on existing legislation, but adjustments may be needed to operationalise criteria, and flexibility should be ensured to update with evolving policy developments.

4.2 Sustainability criteria for permanent storage

Permanent storage solutions such as BECCS and DACCS have very strong potentials to deliver carbon removals but are not likely to provide co-benefits to sustainability objectives, except, for BECCS, for some inherent socio-economic benefits related to energy security (Table 8). On the other hand, these solutions may cause harm to environmental objectives. Therefore, the most pragmatic approach for this type of solution is to focus on criteria that prevent any adverse effect on sustainability, while not including minimum requirements for sustainability co-benefits.

The policy baseline already includes EU legislation that is directly applicable to the economic operators of BECCS and DACCS carbon removal activities and that can provide appropriate safeguards against any negative sustainability impacts:

- The **CCS Directive**[154], which lays down extensive requirements for selecting sites for CO2 storage and contains several provisions related to the management of health, safety and environmental risks, thereby providing appropriate safeguards for avoiding environmental harm from geological storage (i.e. the CCS part of BECCS and DACCS). The Directive states that the geological storage of CO2 has to be done in such a way to prevent, and where this is not possible, eliminate as far as possible negative effects and any risk to the environment and human health (e.g. gas-phase CO2 concentrations in the atmosphere in the surroundings of the complex, water contamination and pollution and other environmental risks, displacement and leakage of other formation fluids, including oil or gas, ground displacement and induced seismicity). Yearly inspections examine the full range of relevant effects from the storage complex on the environment and on human health. Liability for local damage to the environment is dealt with by using the Directive on Environmental Liability.

- The **Renewable Energy Directive**[155] puts sustainability criteria on the biomass used to produce bioenergy, and therefore these criteria are relevant to establish the sustainability of the bioenergy component in BECCS plants. To count towards the renewables targets, or to be eligible for subsidies by EU countries, renewable energy sourced from biomass needs to fulfil criteria that cover agricultural and forest biomass and include threshold for GHG emission savings and efficiency; in addition, evidence is required to ensure that agricultural biomass does not come from primary or highly biodiverse forests, protected areas, highly biodiversity grasslands, or land with high carbon stocks such as wetland, peatland and continuously forested areas. For forest biomass, evidence is needed to verify the legality of the biomass, to avoid the risk of unsustainable harvesting and to ensure that emissions from forest harvesting are properly accounted for. The proposal a revision of the Renewable Energy Directive[156]includes the extension of no-go areas for forest biomass to protect in particular primary and old-grown forests, as well as wetland and peatland. It also requires to avoid the use of roots and stumps and to minimise large clear-cuts. The proposed rules introduce an obligation on EU countries to design their national support schemes in accordance with the biomass cascading principle whereby woody biomass is used according to its highest economic and environmental added value. These provisions can be seen as minimal requirements to ensure that there is no significant harm on several sustainability objectives, including on biodiversity protection and the transition to circular economy.

- The **Taxonomy Climate Delegated Act** includes technical screening criteria for underground permanent geological storage of CO2. In this context, the Do No Significant Harm criteria for water pollution and biodiversity build on existing legislation (the Water Framework Directive[157] and the Environmental Impact Assessment Directive), and in addition require that on the basis of the Environmental Impact Assessment the identified

[154] Directive 2009/31/EC on the geological storage of carbon dioxide (link).
[155] Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, (link).
[156] COM/2021/557 (link).
[157] Directive 2000/60/EC (link)

risks are addressed and that the necessary mitigation or compensation measures are implemented.

4.3 Sustainability criteria for Carbon Farming

The proposed Nature Restoration Law[158] highlights that ecosystems restoration can make an important contribution to maintaining, managing and enhancing natural sinks, thus generating sustainable carbon removals, and to increasing biodiversity while fighting climate change. It is also in this perspective that the proposed revision of the LULUCF Regulation[159] emphasises the need to protect and enhance nature-based carbon removals, to foster the resilience of ecosystems to climate change, to restore degraded land and ecosystems, and to rewet peatlands. As announced in the Farm to Fork Strategy, carbon farming has been designed from the outset to provide strong evidence of no significant negative impacts on environmental objectives, and even to show a positive contribution to these objectives, including biodiversity. The technical handbook[160] on how to set up and implement carbon farming in the EU highlights that assessing the potential to deliver climate impacts has also to cover the co-benefits. The handbook insists that response to climate change needs to be fully integrated with the other pressing environmental and social issues, including biodiversity.

Therefore, in the case of carbon farming, going beyond already applicable legislation safeguards in the policy baseline or the disclosure of sustainability impacts should be encouraged to fully exploit the potential synergies between carbon farming and sustainability objectives, and minimum requirements for sustainability should also be included in the certification methodologies. The best practice is therefore to aggregate all the relevant elements from the three general approaches:

- **Policy baseline**

Elements of the Common Agricultural Policy (Statutory Management Requirements, standards for good agricultural and environmental condition (GAECs)) can constitute relevant environmental safeguards that are directly applicable to farmers.

The proposed transformation of the Sustainable Use of Pesticides Directive[161] into a new Regulation on the Sustainable Use of Plant Protection Products[162] introduces new provisions for a drastic reduction of chemical pesticides and fertilizers in all types of farms and the development of sustainable agriculture, including the respect for nature and the workers. The proposal includes strict rules on environmentally friendly pest control and a ban on all pesticides in sensitive areas, including Natura 2000 areas.

The CAP directly contributes to socio-economic objectives such as food security and support to rural communities through the provision of direct income support and includes social safeguards

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[158] COM (2022) 304 final (link)
[159] COM (2021) 554 final (link)
[160] Setting up and implementing result-based carbon farming mechanisms in the EU - Technical guidance handbook (link)
[161] Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides. https://eur-lex.europa.eu/eli/dir/2009/128/2009-11-25
[162] COM (2022) 305 final

such as provisions to simplify access to CAP support for small farmers or to improve the position of farmers in the value chain.

- **Disclosure of co-benefits**

The Nature Restoration Law proposal includes biodiversity indicators for various ecosystems to track progress in restoration efforts at national level. These indicators include monitoring indexes for various categories of animals (e.g. butterfly and birds), carbon stocks in various carbon pools (e.g. soil organic carbon, deadwood) and other spatial indicators (e.g. the share of agricultural land with high-diversity landscape features, forest connectivity). When designing the individual methodologies, it should be considered to which extent these indicators can be used at the farm level, in order to maximize synergies between carbon removals and ecosystem restoration efforts. It should be avoided to develop indicators just for the purpose of the carbon removal certification in view of the risks of high administrative burden and inconsistencies with other EU legislation. It will therefore be important to follow closely the development in the relevant EU policy areas and take over the indicators developed there.

In addition, the EU Forest Strategy[163] announced that the Commission, together with the Member States and in close cooperation with different forest stakeholders, will identify additional indicators as well as thresholds or ranges for sustainable forest management concerning forest ecosystem conditions, such as health, biodiversity and climate objectives, in order to enhance the sustainable forest management framework. The Commission has also published a handbook for practitioners for evaluating the impact of nature-based solutions[164]. The Commission will also develop a "close-to-nature" voluntary certification scheme, so that the most biodiversity friendly management practices could benefit from an EU quality label. Guidance and indicators used for Natura 2000, green infrastructure and areas under restoration can be entry points for assessing the sustainability impacts of land-based carbon removals activities. Once ready, these indicators, new certification criteria, and guidance documents could be taken up for measuring co-benefits under the relevant certification methodologies for carbon removals.

The new CAP promotes the use of new instruments which provide EU farmers and land managers with tools and datasets, including remote sensing, on agriculture, environment and sustainability, such as the Farm Sustainability Tool (FAST)[165]. As this tool is intended to gather a lot of information related to the sustainability of agriculture, it can be a useful tool to assess the sustainability impacts of carbon farming options, starting with fertiliser management.

The long-term vision for the EU's rural areas[166] has identified areas of action to improve rural livelihoods in the EU: i) deploying innovative solutions for the provisions of services; ii) maintaining and improving public transport services and connections; iii) promoting sustainable bioeconomy and circular economy, as well as resilience to climate change, natural hazards and economic crises; and iv) diversifying economic activities and improving the value added of rural

[163] COM/2021/572 final. New EU Forest Strategy for 2030. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0572
[164] EC., DG RTD (2021). Evaluating the impact of nature-based solutions: A handbook for practitioners, (link).
[165] https://fastplatform.eu/
[166] COM (2021) 345 final A long-term Vision for the EU's Rural Areas - Towards stronger, connected, resilient and prosperous rural areas by 2040. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0345

activities. These areas of action could be a source of inspiration for developing indicators to inform the socio-economic co-benefits of carbon farming-based removal activities.

Box 3 – Experience drawn from LIFE projects on carbon farming

As part of its work to identify and accelerate the development and adoption of carbon farming in Europe, the **LIFE Carbon Farming Scheme** project has assessed the environmental impacts of carbon farming[167]. This work confirms that focusing solely on carbon sequestration can result in poor environmental outcomes. Land-use changes related to carbon farming can result in increased biodiversity, increase water quality and better nitrogen balance. On the other hand, loss of remnant vegetation can lead to degraded ecosystem services. Diversity is the key to generating co-benefits, as biodiversity and carbon farming have many mutually beneficial relationships, which increase the resilience of agroecosystems. Carbon farming can also alter the leaching of nitrogen and phosphorus nutrients, with results that can be highly variable both in terms of greenhouse gas emissions balance and in terms of impacts on water and soil quality, which need to be closely monitored.

The LIFE Carbon Farming Scheme project has also elaborated a tool to assess the socio-economic impact of carbon farming[168], based on a four-phase impact assessment process, including a contextual analysis, a mapping of potentially affected people, an engagement with these affected people and an analysis and action planning. Among the potential positive impacts, there is the access to market-led carbon schemes that can contribute to the economic diversification of famers. Among the potential negative risks, the project looks at potential issues around increasing land prices and land grabbing. To deal with these impacts, it is recommended to build collaboration arrangements and platforms at various levels (local, national, EU) not only for identifying synergies and reducing the burden for a single actor, but also to ensure that there is sufficient understanding of the complexity around some of the salient issues as well as capacity and leverage to address them.

- **Minimum requirements**

The minimum requirements for sustainability should go beyond existing mandatory requirements. Besides the EU legislation referred to under the previous section on co-benefits, minimum requirements can build further on the already existing Taxonomy screening criteria for forestry (see Box 4) and restoration of wetlands.

Box 4 – How minimum requirements for biodiversity in forest activities are operationalised in the Climate Delegated Act of the Taxonomy Regulation

The Do No Significant Harm criteria for biodiversity from the Taxonomy Regulation Climate Delegated Act on forestry activities provide an example of how minimum requirements that are relevant for biodiversity can be operationalised. Those criteria are:

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[167] Naukkarinen (in prep) Impacts of carbon farming practices on biodiversity, nutrient leaching and climate – a literature summary.Report from activity A4 of the LIFE CarbonFarmingScheme project

[168] Loponen et al. 2022. The socio-economic impact on carbon farming: a scalable and adjustable model for assessing social impacts. LIFE CarbonFarmingScheme; Report of Activity C3. https://content.st1.fi/sites/default/files/2022-04/LIFE-Report-of-Activity-C3_03-2022_P.pdf

- In areas designated by the national competent authority for conservation or in habitats that are protected, the activity is in accordance with the conservation objectives for those areas.
- There is no conversion of habitats specifically sensitive to biodiversity loss or with high conservation value, or of areas set aside for the restoration of such habitats in accordance with national law.
- An afforestation / forest management plan must include detailed information on provisions for maintaining and possibly enhancing biodiversity in accordance with national and local provisions, including the following:
    - ensuring the good conservation status of habitat and species, maintenance of typical habitat species;
    - excluding the use or release of invasive alien species;
    - excluding the use of non-native species unless it can be demonstrated that:
      (i) the use of the forest reproductive material leads to favourable and appropriate ecosystem condition (such as climate, soil criteria, and vegetation zone, forest fire resilience);
      (ii) the native species currently present on the site are not anymore adapted to projected climatic and pedo-hydrological conditions;
    - ensuring the maintenance and improvement of physical, chemical and biological quality of the soil;
    - promoting biodiversity-friendly practices that enhance forests' natural processes;
    - excluding the conversion of high-biodiverse ecosystems into less biodiverse ones;
    - ensuring the diversity of associated habitats and species linked to the forest;
    - ensuring the diversity of stand structures and maintenance or enhancing of mature stage stands and dead wood.

Based on these criteria, the planting of tree monocultures, and any other forestry activity without a positive impact on biodiversity, will be excluded.

In the case of carbon removals based on agricultural activities taking place in ecologically sensitive areas (e.g. protected areas, areas under restoration commitment, Natura 2000), among others, a ban on all pesticides could be considered. For activities taking place in less ecologically sensitive areas, minimum requirements could be less stringent with a greater number of considerations referred to co-benefits.

The minimum requirements for forest activities can also build further on private certification schemes on sustainable forest management and associated certification schemes. In Europe, the concept of sustainable forest management has been introduced in 1993 at the pan-European reporting under the Ministerial Conference on the Protection of Forests in Europe (MCPFE) process, which later become Forest Europe[169]. The work of Forest Europe has led to the adoption of a definition of sustainable forest management[170] and a system of 6 criteria and 34 indicators[171]. The criteria cover environmental dimensions (forest resources and global carbon cycles, forest ecosystem health and vitality, forest biological diversity) as well as socio-economic dimensions (productive functions of forests, protection functions (soil and water), and socioeconomic functions). This framework is used by EU countries to monitor and report progress on the management of their forests at national level. At local level, forest certification, and associated labelling, inform consumers about the sustainability of the forests from which wood and other forest products were produced.

Box 5 – Third-party certification bodies on sustainable forest management

At the level of forest owners and managers, several voluntary schemes are available to certify the compliance with sustainable forest management principles and criteria. Certification can improve forest management, allowing both consumers and companies to have an important role in forest conservation through their choice of certified products.

They are two types of forest certification:

- the certification of forest management assesses whether forests are being managed according to a specified standard of sustainable forest management;
- the certification of the chain of custody verifies that certified material is identified or kept separate from non-certified or non-controlled material through the production process, from the forest to the final consumer.

To label an end-product as certified, both forest management certification and chain-of-custody certification are required.

The two most known schemes are the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). Both schemes promote environmentally sustainable, socially responsible and economically viable forest management and have been widely adopted in developed countries, particularly in Europe. In 2018, around 19% of EU forest was certified under FSC scheme, while about 40% was under PEFC scheme, with large differences among Member States[172]. Stakeholders are actively involved in the forest certification process and in the standards definition through participatory approaches.

The FSC forest management certification relies on a global general framework of 10 principles and 56 associated criteria[173]. Thereafter, national Standards Development Groups adapt the global requirements at the regional and/or national level, in order to reflect the diverse legal, social and geographical conditions of forests in different parts of the world, creating a local standard based on global principles. 15 national FSC standards are present in the EU.

The PEFC is an umbrella organization that endorses national forest certification systems. National forest certification systems use an international benchmark standard[174], including 6 criteria close to Forest Europe framework, to develop their national standards. PEFC is not a standards agency but a mutual recognition scheme. National systems are assessed by third-party assessor. Many national systems exceed the international requirements, going even further to include additional, nationally relevant requirements.

4.4 Sustainability criteria for carbon storage products

Sustainability of products is one of the most active areas of European regulation, including with the recent package of measures, published on 30 March 2022, to make sustainable products the norm in the EU. As these provisions specifically target the sustainability of products, they are a particularly relevant basis for developing appropriate safeguard clauses for carbon storage products, and for framing the disclosure of co-benefits.

EU policies also include relevant sectoral initiatives such as the Construction Products Regulation (CPR)[175], which the Commission proposes to revise[176]. Safeguards and co-benefits disclosure for carbon removals associated to construction products could largely rely on CPR provisions. In addition, the proposal for an Ecodesign for Sustainable Products Regulation[177] aims to set product-level requirements that promote energy efficiency, circularity and the overall reduction of environmental and climate impacts, and to improve product sustainability information for consumers and supply chain actors.

For other products, an increasing number of sectoral product sustainability initiatives will be developed and improved over time. Sustainability targets set in the various regulations, notably in terms of energy and resource saving and climate change adaptation, should be reflected in safeguard clauses, while any contribution to these targets beyond the commitments could be subject to co-benefit disclosure or minimum requirements. In the meantime, and until all relevant sectorial initiatives are published, the framework could be equipped with additional ad-hoc criteria potentially tailored out for each removal activity and/or objective not yet covered.

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[175] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC. http://data.europa.eu/eli/reg/2011/305/2021-07-16

[176] COM (2022) 144 final Proposal for a Regulation of the European Parliament and of the Council laying down harmonised conditions for the marketing of construction products, amending Regulation (EU) 2019/1020 and repealing Regulation (EU) 305/2011. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0144

[177] COM/2022/142 final. Proposal for a Regulation of the European Parliament and of the Council establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0142

ANNEX 10: TRANSPARENCY CRITERIA

1 INTRODUCTION

Transparency of the certification process is crucial for creating a robust and effective system to incentivise uptake of carbon removal activities.

Drawing from existing experiences[178] from regulated and voluntary carbon markets, the sustainability criteria of the Renewable Energy Directive, and the certification rules of Organic Agriculture, three best practices have been identified:

- Functioning of certification schemes through sound internal governance,
- Verification of carbon removals through independent third party-auditing, and
- Tracking and tracing the certified carbon removals through a robust registry system.

This horizontal criterion is independent of the type of carbon removal activity, and unlike the other criteria it applies to the certification schemes that certify the carbon removals and not to the economic operators that produce them.

2 FUNCTIONING OF CERTIFICATION SCHEMES

2.1 Challenges

Certification schemes have the key role of ensuring that the certified projects fulfil the QUALITY criteria. Their capacity to do so depends on having in place sound internal rules that regulate how the certification scheme is governed to effectively support its mission and that stakeholders have a transparent and accessible view into their decision-making. The review[179] of the certification schemes operating under the 2018 Renewable Energy Directive points to a number of good practice rules that are generally applicable to certification schemes operating in other fields:

2.2 Existing approaches

- Management structure: All schemes should establish a management structure to ensure that the scheme has the necessary legal and technical capacity, including:
    - *Board of Directors*. The Board is ultimately responsible for all actions and activities of the scheme, although for practical purposes it may delegate day-to-day responsibility of managing the scheme to a Secretariat. A legal document, such as an Articles of Association, should set out the specific roles of the board members, the process for (re-)electing members, terms of engagement, a description of how decisions are taken and how conflict of interest is prevented. The Board should have broad and appropriate representation that fits the specific operational context.

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[178] This annex is largely based on the information and analysis contained in the following three reports: 1. Guidehouse (2021) Report on the harmonisation and strengthening of sustainability certification for biofuels, bioliquids and biomass fuels under REDII; 2. Umwelt Bundesamt (2021), Certification of Carbon Removals – Part 2; 3. ICARE (2022), Étude comparée des standards de compensation existants.

[179] Guidehouse (2021)

- *Secretariat* (Management team): The Secretariat is responsible for the day-to-day management of the organisation. This includes both technical functions (e.g. scheme development, quality assurance and certification), as well as activities such as marketing or communications. It is good practice that the role of such a team, and importantly its relationship with the Board, is clearly defined.
- *Technical Committees or Working Groups*: A Technical Committee is often included in the governance structure of certification schemes. The use of such an expert committee helps to ensure that the Board has the necessary technical capacity. It is important to avoid potential conflict of interest by ensuring that an individual's role within a Technical Committee is not compromised in any way by their external activities.

- Stakeholder consultation. Schemes should have an open consultation system with a clearly defined process to promote the involvement of stakeholders in the development of the certification rules and in the decision making (e.g. decision to grant or withdraw certification). The system can include either round-table discussions with stakeholders or targeted consultations, depending on the specific context. The process should set out a timeline for stakeholder consultation, to be defined by the certification scheme, depending on the specific context. The ISEAL Code of Good Practice on Setting Social and Environmental Standards[180] provides best practice guidance on standard development and revision.

- Complaints management. Establishing a robust complaints process is an important component of the governance of a scheme. Such procedures improve the reliability of schemes, support their continuous improvement and provide transparency to scheme users and external stakeholders. Schemes should have a clear process for dealing with complaints made by third parties against economic operators and certification bodies. As a minimum, the process should include: how complaints are filed and the evidence that is to be provided; guidance on which complaints are in scope, and which are not; step-by-step overview of how complaints are handled, from the receipt of the initial complaint through to resolution, and the associated timeframe for each step; and decision making process for complaints and the process for appealing decisions. The complaints process should be transparently available on the voluntary scheme's website.

- Internal monitoring and transparency. Schemes should have in place a system of internal monitoring to verify compliance of economic operators with the provisions of the scheme. Such internal audits should be undertaken when relevant information on potential non-conformities has been brought to the attention of the scheme by external parties, and also to cross-check the work conducted by external auditors. Typically, internal monitoring should be undertaken on an annual *basis.* In addition, it is also good practice for the schemes to put in place a website which provides information in a readily accessible and transparent format.

- Non conformity. In addition, certification schemes should have harmonized and clear rules on the implications of any non-conformities by the economic operator identified during the validation and verification audits (see below), assessing: under which circumstances verification reports are withdrawn or suspended; what procedures are in place to ensure that any non-conformities that do not lead to immediate withdrawal or suspension of the

[180] ISEAL. ISEAL Codes of Good Practice, (link).

certificate are corrected. ISO 17021 provides further clarifications on the application of suspensions.

3 VERIFICATION OF CARBON REMOVALS

3.1 Challenges

Verification of the economic operator's activities by an independent verification body, conducting third-party auditing is a critical component of the overall credibility of the carbon removals. Typically, certification is based on a two-step process: 1) a first validation where the carbon removal project's conformity to its referred methodology is assessed; 2) a regular verification of the achieved carbon removals.

A strong validation and verification system ensures that verification bodies are thoroughly scrutinised and that auditing activities provide reliable reassurance that carbon removals certificates are only issued to projects that comply with the QUALITY criteria, including the related certification methodologies. There are 3 main issues to be addressed: the obligation and regularity of third-party auditing, the competence of the auditors; and the accreditation of verification bodies.

3.2 Existing approaches

Third-party auditing of economic operator

Typically, most validations are based on an internal documentary review by certification schemes themselves (e.g. Label Bas Carbon, partly by MoorFutures, Registro Huella de Carbono, Eco region Kaindorf). The Peatland Code and Woodland Carbon Code use a third-party to validate projects. Best practices in verification consist of having projects validated and verified through the intervention of third party auditing. The most virtuous schemes provide a list of independent organizations able to carry out these audits and are transparent about the criteria for choosing these organizations. For instance, the Label Bas Carbone requires that the validation of projects and the verification of their results are carried out by an independent auditing body, chosen from the list made available by the board of auditors eligible to verify projects.

Regular checks make it possible to verify that the project is functioning and evolving as planned during certification. The majority of existing certification schemes require periodic documentary checks, often on the basis of annual reports, but do not require systematic field visits for all projects. These visits are set up randomly or are only required for certain projects (example: large-scale projects for the Clean Development Mechanism). For instance, the Gold Standard imposes an annual report on all projects and a systematic field check every 5 years during their certification.

Auditors' competence

It is critical that the verification body (or bodies) remains independent from the certification scheme to ensure it can verify an economic operator's compliance with the scheme's standards without external interference. Schemes generally require that verification bodies operating on behalf of the scheme are accredited to ISO 17065[181]. This standard requires a clear separation between the certification scheme owner and the verification body. Furthermore, it attributes the responsibility to award or withdraw a certificate to the verification body. This serves to limit the emergence of conflict of interest between the certification scheme owner and the verification body. Furthermore, auditors should have the general skills for performing audits; and the auditor should have the appropriate specific skills necessary for conducting the audit related to the scheme's criteria[182]. ISO 19011:2018[183] outlines guidelines for the competence and evaluation of auditors. The Label Bas Carbone provides project developers with the criteria for the independence of auditors, so as to allow the choice of an external auditor from this list. In this case, the project developer must prove the competence of the chosen auditor.

Accreditation of verification bodies

Accreditation is the third-party attestation of a verification body's demonstrated competence to carry out specific conformity assessment tasks. A decision on accreditation is taken based on the demonstrated competence of a verification body to evaluate compliance with a standard. Accreditation is a key aspect in establishing the quality of the certification and verification process and should follow the rules set out in Regulation (EC) No 765/2008[184]. This is achieved through continued assessment of the verification body and in particular ensuring that the verification body and its auditors are operating according to relevant ISO.

There are two approaches that are commonly used in the context of certification:

- National: Accreditation bodies are appointed in each country that the standard operates and endorsed, or recognised, at a government level. Many of the larger national accreditation bodies are members of the International Accreditation Forum (IAF). This organisation ensures that its members accredit in compliance with the appropriate international standards. The IAF has worldwide coverage in almost one hundred countries, with members located in Europe, the Middle East, Asia and the Americas. The majority of the IAF members are signatories to the IAF Multilateral Recognition Arrangement (MLA). The agreement accepts the equivalence of the accreditation systems operated by the signing members.
- The European co-operation for Accreditation (EA) has been formally appointed by the European Commission in Regulation (EC) No 765/2008 to develop and maintain a multilateral agreement of mutual recognition between European and third country national accreditation bodies. There are around fifty EA members, these are classified as either 'Full' or 'Associate' Members. The EA Multilateral Agreement (EA MLA) is an agreement between the EA Full Members whereby the signatories recognise and accept the equivalence of the accreditation systems operated by the signing members. A Bilateral Agreement (BLA) between an EA Associate Member and EA has the same purpose and bilateral signatories to the EA MLA are required to meet the same requirements as EA Full Members. The EA is also an IAF MLA signatory.

[181] ISO (2012). ISO 17065:2012, Conformity assessment - Requirements for bodies certifying product, processes and services, (link).

[182] The sustainability framework under CORSIA requires certification bodies to appoint competent auditor(s) in accordance with the process set out in ISO 19011. In addition it makes reference to competence in the assessment of groups under a group audit approach. ISO.

[184] Regulation (EC) No 765/2008, (link).

Fixed costs of third-party validation and verification can be important. The more stringent the certification requirements (high monitoring, precision, individual additionality demonstration, quantification…), the higher the costs. Options to reduce verification costs include:

- Diversification of third parties involved in validation and verification processes. For example, some standards (Woodland Carbon Code, Peatland Code, MoorFutures) allow the same third party to carry out both the validation and verification of a project, whereas the CDM required to use a different entity. One other way to reduce costs is to have a wider pool of potential auditors and to allow wider types of profiles. For verification purposes, the Registro Huella de Carbono have not appointed or selected specific verifiers, so any forest engineer who present the adequate qualification could carry out the verification procedure. The French Label Bas Carbone also allows for an extended choice of verifiers in a perspective of lowering costs.
- Remote-sensing solutions could be a way to reduce MRV costs and especially verification costs. For instance, for carbon farming activities, existing monitoring and reporting under the LULUCF, the land parcel information system under the Common Agriculture Policy, national forest inventories, as well as data from the Copernicus space observations could help building a reliable monitoring system, which will become more granular over time.

4 TRACEABILITY OF CERTIFICATES THROUGH REGISTRIES

4.1 Challenges

Once a project is validated and verified, there is a need to trace the carbon removals in order to avoid the risk of fraud, e.g. double funding of the same project or the double use of the same certificate. Experience with the Renewable Energy Directive but also with the EU ETS points to the need to have robust registries in place to track and trace certificates in order to avoid the risk of fraud[185]. In particular, under the 2018 Renewable Energy Directive, the Commission has been tasked to put in place an EU database linking relevant national databases in order to ensure transparency and traceability of renewable fuels.

Fraud can occur through e.g. double issuance and double use: Double issuance is a situation in which more than one certificate is issued for the same removal activity. For instance, this can occur when the same project is registered under two different certification schemes or twice under the same scheme. Double use is a situation in which the same certificate is used several times to make the same claim. Such risks are particularly relevant for the voluntary carbon market where a certificate could be sold on from one buyer to another. If these subsequent trades are not comprehensively tracked, the risk exists that several buyers will make the same claim (e.g. to offset emissions) based on a single certificate.

4.2 Existing approaches

Avoiding double issuance

The existence of a register ensures the full traceability of carbon removal certificates and minimizes the risk of double issuance. Best practice is to keep a public record of all certificates issued, as well as the volume cancelled, and volume withdrawn. The majority of the reviewed

[185] EURACTIV (2021). Five EU member states demand stricter oversight of biofuels, (link).

certification schemes both for the Renewable energy Directive and the voluntary carbon removal market[186] keep a database or registry that specifies the volume of certificates issued and withdrawn.

In particular, the majority of carbon removal schemes keep a register that links each certificate to a project and identifies them via a serial number. For instance, the Verified GHG standard (VCS) presents on its website the volume of certificates registered, in the process of being registered, withdrawn, as well as the volume of certificate kept aside ("buffer pool"). This scheme also links each removal certificate to a removal project on its website. Each project is identified by a serial number and must detail its location. It gives rise to a certain number of removal certificates to which a serial number is also assigned.

Avoiding double use

In the voluntary carbon market, traceability between sale of a certificate and purchase by an organization makes it possible to avoid double counting of removals from a double use or a transfer. Existing schemes have a varying performance in the area: only less than a quarter follow the transfers of certificates (sale of certificates not withdrawn, in particular for the purpose of speculation). The best practices consist in identifying the acquirer of the certificates during each sale, as well as to report the transfers of certificates (sale from one acquirer to another without withdrawing the certificate).

Certification schemes could ensure in two ways that such double use is avoided. First, their registry and project database systems can provide for functionalities that allow the carbon certificate holders to specify the purpose for which a carbon certificate is cancelled. Alternatively, certification schemes could require all users to specify the purpose. The level of detail provided in documenting cancellations and requirements also plays a role for facilitating that double use is avoided. For instance, the VCS standard links each certificate withdrawn to a purchaser on its site. Transfers are only possible between VCS accounts, which allows them to be tracked.

Registries should be ready for the different uses of certificates – public financing, private financing through commercial contracts, or carbon markets – that demand different functionalities of the registry. For certificates – which are non-tradeable (e.g. Label Bas Carbone in France) – it will not be necessary to trace further transfers. For time-limited certificates, it will be important to ensure that any claims are annulled at the end of the time period.

Link to national registries and Nationally Determined Contributions under the Paris Agreement

In the context of international and voluntary carbon markets, it has been discussed for years how to account in a transparent way for the climate benefits from traded carbon credits – irrespective of whether a credit is based on emissions reductions or carbon removals:

- Double claiming does not result in double counting of GHG emission reductions under the Paris Agreement, as long as only one country counts a relevant emission reduction or removal as having taken place within its territory at any given time, including after any international transfer. In the context of international transfer of emissions reductions or removals, such as

[186] ICARE (2022)

those envisaged under Article 6 of the Paris Agreement, the host country would make a "corresponding adjustment" to its own accounts to ensure that it no longer counted the abatement, which was now being used by the acquiring country.

- In the context of voluntary markets, the host country would count the GHG emissions reduction or removal. When it comes to the overall merits of corresponding adjustments for voluntary markets, there is a debate over whether they would increase overall mitigation efforts and result in a net climate benefit. Those in favour of applying corresponding adjustments in voluntary carbon removal markets argue they increase the credibility of voluntary transactions, for example by managing real or perceived risk of double claiming. These views are countered by concerns that demands for corresponding adjustments under voluntary markets, and the associated institutional capacity requirements and understanding regarding implications for NDCs, would limit carbon removal purchases and private finance flows.

There is an ongoing debate as to whether a compensation claim by a company requires an accounting adjustment by the host country. It is important to underline that different potential types of support have different implications for the applicable standards of accounting and quantification. Much depend on the nature and coverage of targets/claims towards which it is proposed to count a particular certified outcome. For example where a certificate is proposed for use to compensate for emissions under one target, in circumstances that the underlying removals may also be counted towards another target, and hence the risk of potential double counting arises, an accounting adjustment on the part of the host country may be needed to avoid double claiming.

In contrast where a carbon removal is used to demonstrate a direct contribution to a single, e.g. corporate, target (and not as an offset between emissions or removals under two distinct targets) generally no adjustment is needed. Where there is an adjustment proposed between buyers and sellers with different targets, quantification will need to be consistent with the sellers target to avoid overselling. While it is not proposed to address accounting or quantification requirements directly in this proposal, such requirements will however need to be specified when particular uses are mandated.

Certification scheme management	
Management structure	All schemes should establish a management structure to ensure that the scheme has the necessary legal and technical capacity. In addition schemes should have minimum rules to ensure stakeholder consultation, complaints process; and internal monitoring and information transparency.
Public consultation and information	All schemes should have minimum rules to ensure stakeholder consultation, complaints process; and internal monitoring and information transparency.
Verification of removals	
Third-party verification	Schemes should have carbon removal projects validated and verified through the intervention of an independent third-party auditing organization. Scheme should require regular verification audits mandatory for all projects, and even field visits at regular intervals.
Auditors' competence	Auditors should remain independent from the certification scheme. In addition auditors should have the general skills for performing audits; and the auditor should have the appropriate specific skills necessary for conducting the audit related to the scheme's criteria.
Accreditation of verifiers	Verifiers should be accredited either by: a) national accreditation authorities referred to in the Commission. Regulation No 765/2008187, setting out the requirements for accreditation and market surveillance; b) by a national accreditation body affiliated to the IAF; c) by being a 'full' member or 'associate' member of ISEAL.
Traceability of removal certificates	
Public Registry	The standard should publish a register listing all the associated projects and certificates. The use of innovative digital technologies such as blockchains can also be considered.
Link between issuance of certificates and projects	The register should make it possible to link each project to a number of the certificate issued, and each certificate issued to a specific project. The identification of each certificate via a serial number is needed.
Publication of use, withdrawals, and transfers of certificates	The use and cancellation of certificates should be reported publicly, within the register.
Risk of double claiming	The scheme should propose a procedure for avoiding the double counting of the project.

[187] Regulation (EC) No 765/2008, (link).

ANNEX 11: SME TEST

1 IDENTIFICATION OF AFFECTED BUSINESSES

The initiative establishing an EU regulatory framework for the certification of carbon removals will not impose direct mandatory requirements on economic operators in the EU. Rather, certification will be an optional, voluntary, activity that could be implemented by SMEs and/or large companies wishing to quantify levels of CO2 removed by project activities and realise any associated benefits. As such, any cost impacts of establishing certifiable activities would be voluntarily bestowed upon participating entities irrespective of their size. The costs of implementation will be determined by the type of removal solution to be implemented, and the applied measurement, reporting and verification (MRV) methods and procedures, rather than the specific size or type of entity undertaking the activity. The initiative will therefore not disproportionately affect SMEs relative to large companies.

This initiative is considered highly relevant for SMEs, as many current and emergent economic operators in the carbon removals and certification fields are SMEs. These firms can be expected to provide a very significant contribution to the implementation of the initiative, which can also include implementation on behalf of larger firms (e.g. project developers). Thus, a certification initiative that attaches direct economic value to SME services and technologies potentially offers significant financial opportunities for economic operators in these sectors. In this sense, an EU framework for the certification of carbon removals is considered highly relevant, in particular for SMEs such as:

- Certification schemes, registry system developers and operators (even the largest global operators are classified as SMEs)
- Project developers and carbon removal consultants
- Landowners hosting certifiable activities (e.g. foresters, farmers, or other land managers)
- Technology developers in emergent removals areas (e.g. biochar producers, direct air capture design, construction and operation, novel CO_2 utilisation pathways)

Larger firms also operate in these businesses, including:

- Large agriculture and forestry companies hosting certifiable activities (e.g. vertically integrated forest product companies; large agri-business)
- Large energy companies engaging in the geological CO2 storage business
- The larger validation and verification companies
- Large consultancies

2 CONSULTATION OF SME STAKEHOLDERS

A total number of 64 SMEs participated to the public consultation conducted in the context of the initiative, representing 43% of the 150 companies and business organisations that provided their input to the consultation. The SMEs replying to the public consultation were mainly service activities (27%), scientific and technical activities (22%) and agriculture and forestry activities (16%). The SMEs respondents expressed a large support to the initiative since 55 (89%) agreed that establishing a robust and credible certification system for carbon removals is the first essential stepping stone towards achieving a net contribution from carbon removals in line with the EU climate-neutrality objective. This is slightly more than the 86% support of all stakeholders in general and only 5 (8%) SMEs disagreed. The SMEs have identified the issue of ensuring precise, accurate and timely measurement of carbon removals as the main challenge of the certification (for 50% of the SMEs).

The opinions expressed by the SMEs on the design of an EU framework for the certification of carbon removals are in line with the views expressed by other stakeholders. For examples, 53% (vs 52% of all stakeholders) expressed their preference for a certification framework allowing the differentiation between different types or sub-categories of carbon removals and 56% (vs 59% of all stakeholders) share the view that carbon removal methodologies should be developed by a public administration rather than private entities.

During the preparation of the initiative, SMEs also had the opportunities to express their views as speaker or participants to a stakeholder conference held on 31 January 2022 with more than 600 participants registered from companies and business organisations.

3 ASSESSMENT OF THE IMPACT ON SMES

For economic operator conducting carbon removal activities, the certification of carbon removals will be a voluntary, and optional, activity. As explained in **Annex 3**, an economic operator opting to apply the EU regulatory framework will see overall benefits associated with increased visibility and trust that an EU framework for the certification of carbon removal would provide. The recognised quality of their carbon removals would create more demand and allow them to get a better price for their removals.

The EU intervention could create new market opportunities for specialist service providers with a deep understanding of carbon removals solutions. Conformity to an EU standard can also help raise capital for project activities.

Regarding the SMEs involved in the business of the carbon removal certification, the long-standing, global certification schemes[188] could see an opportunity to develop a bigger market in Europe. On the other hand, the smaller specialist new entrants and national and regional schemes could continue to organically develop across Europe to become main market actors. Although the large certification schemes offer perceived market power, in terms of actual activity on the ground in Europe, the small local schemes are more prevalent than the larger ones. For example, the Verified Carbon Standard (VCS) reports 1884 registered projects worldwide at the time of writing, only 8 of these are in Europe, while, similarly, the Gold Standard has only 4 certified projects located in Europe among the 1708 projects worldwide. When focusing only at carbon removal projects the numbers are even smaller: only one project in Europe (out of 146 worldwide carbon removal projects) for VCS and none of the 42 Gold Standard carbon removal projects are located in Europe.

The increase demand in carbon removal certification will also be beneficial to accredited validation and verification bodies since they will service would be increasingly required to assess the validity of projects candidate to the certification and the veracity of the carbon removals generated.

Also, many European certificate buyers are willing to pay a premium for locally-originated certificates, suggesting that an EU-based accredited small or micro-size scheme operator could attract higher revenues compared to others types of scheme operators.

4 MINIMISING NEGATIVE IMPACTS ON SMEs

In the public consultation held for this initiative, around half of SME representatives in the land sector (agriculture and forestry) highlighted the affordability of MRV aspects as one of the main criteria for the types of carbon removals the EU should incentivize, while acknowledging the importance of robustness of MRV. Three respondents explicitly pointed to the need for easiness to implement rules for small landowners.

Notably, most existing certification programmes in the voluntary carbon markets, as well as existing EU MRV standards such as the EU ETS Monitoring and Reporting Regulation (MRR), apply different MRV requirements according to the scale of the activity (or installation) undergoing MRV. Future work to define methodological standards for carbon removals in the EU will seek to develop more streamlined small-scale methods with simplified procedures that can offer benefits for SMEs wishing to engage in voluntary carbon removals certification. Establishment of streamlined approaches to small-scale activities should address the needs of SMEs potentially wishing to engage in certification activities.

[188] Notably, neither the larger nor smaller certification schemes can be considered SMEs under the EU classification scheme. For example, Verra (the largest actor in the market) had a turnover in 2019 of around USD 21 million (link) and it presently has a staff headcount of <100.

Some carbon removal programmes aggregate multiple projects of the same carbon farming activity in a single collective project to reduce the MRV costs for small individual projects without scarifying on the quality of the MRV. Such programmes often provide in parallel advice to the farmer on how to manage the land to increase carbon sequestration and therefore potential climate benefits but also economic benefits for the land manager. Part of the economic risk is carried by the programme developer and the project operators face less uncertainties. Most of carbon farming projects targeting soil carbon sequestration build on these programmes.

In other areas, primarily positive benefits can be expected for SMEs relative to other potential economic actors in the marketplace. The development of small-scale streamlined certification methods should help to enlarge the pool of smallholders/SMEs willing to participate in removals certification. By developing common criteria and methodologies for the certification of carbon removal, the initiative will establish a level playing field making easier for small economic operator to develop carbon removal activities that can be recognised for their climate benefits.