CARBON REMOVALS ON THE ROAD TO NET ZERO

Exploring EU policy options for negative emissions

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Abstract

Negative emissions will be needed on an increased scale to meet the EU's climate targets, in particular climate neutrality by 2050. This Policy Insight examines different policy options for the EU to support the deployment of negative emissions technologies. After presenting an overview of measures to support negative emissions around the world, the EU's climate policy frameworks are reviewed from the perspective of (potentially) integrating negative emissions. This is followed by a review of specific policy measures to support negative emissions in the EU. The paper recommends a wide portfolio of policy measures over time, to account for technology differences and the changing demands of climate policy for different time horizons as climate neutrality approaches (followed by net-negative emissions thereafter).

This Policy Insight builds on a scoping paper by CEPS (Elkerbout & Bryhn, 2021) that discussed the need for negative emissions more in detail, as well as various options for negative emissions technology.

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1. Introduction

Negative emissions will play an important role in reaching the Paris Agreement's temperature goals and in achieving the EU's climate neutrality target for 2050 and aim of net-negative emissions thereafter. While definitions vary, for the purpose of this paper, negative emissions are considered the removal and sequestering of carbon dioxide (CO_2) from the atmosphere by deliberate human activities[1]. The need for negative emissions is evident from the 1.5°C report by the Intergovernmental Panel on Climate Change (IPCC), where CO_2 removal plays a role in all pathways with no or limited overshoot, and in cases to bring the temperature down after a peak, as well as in the EU's own pathways compatible with 1.5°C. The IPCC's most recent Assessment Report (AR6) also confirms that all global mitigation pathways that limit warming to 1.5°C make use of CO_2 removal to some extent.

There are several different technologies for negative emissions, with varying levels of deployment and technological readiness. More technologies may emerge in the future. In principle, a negative emissions policy should aim to draw down atmospheric concentrations of CO_2, but how this is done is a separate question. Therefore, EU policy should in principle be open to involving and supporting all negative emissions technologies. However, it may want to favour some technologies over others based on objective criteria, such as permanence or co-benefits and side effects. Additionally, some Member States may want to provide more technology-specific support if this fits with the structure of their economy and emissions profile.

The IPCC has discussed negative emissions technologies (NETs) in its assessment reports, as well as in the special reports on 1.5°C and on land. NETs covered by the IPCC include afforestation and reforestation, biochar, soil carbon sequestration, enhanced weathering, bioenergy with carbon capture and storage (BECCS), direct air capture (DAC) and oceanic fertilisation. These technologies utilise to different extents biological and chemical or technological processes to either extract or store CO_2[2], with some being hybrids. They also come with different trade-offs, side effects and co-benefits, especially where land use is concerned.

Policy is already moving to regulate and incentivise negative emissions, both within and outside the EU. Within the EU, the role of removals is already incorporated in legislation through the EU Climate Law, though capped within the 2030 target. Their role has been further elaborated in the recent communication on *Sustainable Carbon Cycles*, which emphasises the growing importance of carbon removals over the coming decades towards the 2050 target. It also explains their role once climate neutrality is achieved. Two different avenues are discussed in this context: carbon farming and industrial carbon capture, use, storage and removal. The former envisages a system for rewarding European farmers for increasing carbon uptake

[1] See Elkerbout & Bryhn (2021) for a discussion of definitions.

[2] In some cases, after CO_2 is captured it will be stored in a physical form as carbon (C). The overall aim of this paper is to describe negative emissions, i.e. the reduction of atmospheric CO_2 concentrations; hence CO_2 storage refers to all forms of storage, irrespective of its physical form.

through farming practices, while the latter aims to foster a value chain for managing carbon flows through industrial solutions. Moreover, important accounting principles will be laid down in a proposal for a carbon removal certification mechanism due later in 2022. Meanwhile, some MEPs – including lead lawmakers – are considering amendments to include negative emissions in EU climate legislation being revised as part of the Fit-for-55 package (see Section 3.4).

Nevertheless, further targeted policy support will be needed to ensure NETs are available to provide the negative emissions envisaged for the future. This policy paper outlines existing policy initiatives and explores different policy options to scale negative emissions deployment in the EU, and how they interact with existing climate policies. The paper builds on the concepts and NETs discussed in an earlier scoping paper (Elkerbout & Bryhn, 2021).

2. Overview of existing policy support for NETs

While negative emissions technologies have only recently received increasing attention among policymakers in the EU, there are a number of initiatives already planned or implemented around the world. Most of these are focused on specific NETs. In the US, for example, several policy instruments have concentrated on supporting DAC. There are also specific initiatives on NETs with biogenic storage, such as New Zealand's incorporation of forestry in its Emissions Trading System (ETS), as well as California allowing for credits from reforestation under its cap-and-trade programme. While the UK has so far favoured direct innovation and deployment funding, inclusion of removals in the UK ETS is still under consideration with the government aiming to launch a call for evidence[3]. A non-exhaustive list of existing policy initiatives directly supporting NETs is provided in Table 1 and some are discussed further below.

Table 1. Overview of existing policy initiatives for NETs (non-exhaustive)

Policy name	Type	NETs covered	Location
45Q	Tax credit	DAC(S) BECCS	US
Regional Direct Air Capture Hubs	Funding	DAC	US
Direct Air Capture Technologies Prize Competition	Funding	DAC	US
New Zealand Emissions Trading Scheme	Inclusion in trading scheme	Afforestation	New Zealand
Low-Carbon Fuel Standard	Credits linked to traded performance standard	DACS	California, US
Compliance Offsets Program	Inclusion in trading scheme	Reforestation	California, US

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf, p. 193.[4] The EU allowed a limited number of international credits into the ETS until the end of Phase 3 (2020).

Reverse auctioning for BECCS (System för omvänd auktionering av stöd till Bio-CCS)	Funding	BECCS	Sweden
Strategic Innovation Fund	Funding	DAC	Canada
Tax Incentive for Carbon Capture, Utilization, and Storage	Tax credit (*proposed*)	DAC	Canada
Direct air capture and greenhouse gas removal innovation programme	Funding	DAC Biochar BECCS Enhanced weathering Chemical or electrochemical removal of CO_2 from seawater, etc. (NETs related to forest management, soil management or ocean fertilisation excluded)	UK
Cluster sequencing for carbon capture, usage and storage deployment	Funding	Engineered greenhouse gas removals / NETs utilising geological storage	UK
Innovation Fund	Funding	NETs applying some form of technology relevant to ETS industry sectors (e.g. with CCS)	EU

Source: authors' compilation.

NETs can receive indirect support from policies that target related technologies or shared infrastructure. This particularly involves transport and storage infrastructure for carbon capture and storage (CCS), which is a key component of direct air capture and storage (DACS) and BECCS technology. As CCS is also an emissions reduction technology by itself, support for the technology can benefit both emissions reductions in energy-intensive industries as well as negative emissions technologies that employ CCS. Within the EU, support for CCS already exists for various stages. At the R&D stage, CCS is eligible for funding from Horizon Europe, while scale-up and demonstration are covered through the ETS Innovation Fund as well as through the Connecting Europe Facility. Certain negative emissions projects are also eligible, as long as they apply ETS-relevant technologies. As of 2021, one NET project has been selected, specifically, a large-scale BECCS project (BECCS Stockholm). Moreover, CCS and other forms of permanent storage are incentivised through the EU ETS, as CO_2 captured and stored can help meet obligations under the scheme. EU state aid rules have also allowed for support for CCS, both operational and investment. The Netherlands is one of the Member States that have used the opportunity to invest in carbon capture, usage and storage (CCUS) projects, committing EUR 2 billion to the Porthos CCUS hub at the Port of Rotterdam. Norway and the UK have committed significant support for CCUS projects. The UK has additionally launched a specific expression of interest calling for greenhouse gas removal projects that want to take part in a CCUS cluster sequencing programme. Notably, Sweden is taking this a step further in the direction of negative emissions with plans to launch reverse auctions for BECCS. A total of SEK 36 billion has been allocated for the period between 2026 and 2046. In the UK, dedicated

funding is also being provided for NETs, with GBP 70 million being made available through an innovation funding programme competition.

Support for scaling up and operationalising CCS technology exists beyond Europe, and in some cases for supporting NETs. In the US, BE(CCS) and DAC(S) receive support through the 45Q tax credit, which is worth up to USD 50 per tonne of CO_2 if the captured carbon is stored and USD 35 if it is used, including for enhanced oil recovery. Under the proposed Build Back Better Act, the tax credit could be increased up to USD 180 USD for DACS projects. Such a tax credit is comparable to a direct subsidy, which in the EU would be a form of state aid. In California, the Low-Carbon Fuel Standard provides additional support for CCS and DACS. Fuels produced using technologies that reduce emissions are issued credits, which need to be acquired by fuel producers whose carbon intensity is too high relative to a benchmark. As a tradeable performance standard, this creates incentives for innovation in low-carbon fuels. Importantly, credits are also available for DACS irrespective of whether there is a fuel component or the project is located in California (CARB, 2019). As such, the policy provides broad support for DACS technology in general, which can be combined with the 45Q tax credit. Additionally, the recently enacted Infrastructure Investment and Jobs Act in the US included USD 12 billion in support for the CCUS value chain (IEA, 2021). Of this, USD 3.5 billion is specifically made available over a five-year period for four DAC Hubs, each storing 1 million tonnes of carbon from the atmosphere (Wenger, 2021). The approximate EU equivalent would be an Important Project of Common European Interest for DAC. The same Act also provides funding through a DAC technologies prize competition, with USD 15 million made available for the pre-commercial stage and USD 100 million for commercial activities.

Canada is likewise supporting CCUS, including DAC, with an investment tax credit, which will be available from 2022. DAC has also received support with direct innovation funding through the Strategic Innovation Fund, which provided CAD 25 million to a project aiming to use DAC to produce synthetic fuels in 2019. Although projects involving low-carbon fuels do not result in negative emissions, such support can nevertheless support DAC learning, and if combined with CCS could still deliver negative emissions.

Outside the EU there are also examples of inclusion of removals, specifically from forests, in emissions trading schemes[4]. Within the New Zealand ETS, credits are awarded for afforestation efforts (McDonald et al., 2021). Still, owners of forest land within the system also face obligations, meaning that they are required to purchase credits to offset any deforestation. Forests from before 1990 were automatically included in the scheme, while newer ones have the choice to join voluntarily. In California, a small share of the compliance obligation under the regional ETS can be offset with credits from reforestation. This is limited to 4 % of total obligations from 2021 through 2025 and increased to 6 % thereafter until 2030. Removals are

[4] The EU allowed a limited number of international credits into the ETS until the end of Phase 3 (2020).

given a role in another planned offset system under development in Canada, for which specific protocols are being developed for inclusion of forest management and soil carbon approaches.

International cooperation provides another avenue of support to NET deployment. Switzerland and Iceland signed a declaration of intent to cooperate on carbon removal and CCS, with the activities taking place in Iceland, while Switzerland could use carbon credits through Article 6.2 of the Paris Agreement[5]. This showcases that there is an interest in using international carbon markets to assist negative emissions deployment. International cooperation between public and private institutions can also further leverage existing funding commitments. The European Investment Bank and Breakthrough Energy Catalyst announced in November 2021 they would mobilise USD 1 billion over a five-year period to support innovative climate technologies including DAC.

3. Policy foundations

3.1 EU headline and separate targets: political choices

The political targets applicable to negative emissions are crucial to forming the way in which NETs are approached and what policy instruments may be considered in the EU. A key issue that can affect the acceptance of negative emissions is ensuring their support does not jeopardise support for and efforts to reduce emissions. In this regard, differentiating between negative emissions and emissions reduction efforts in policy making could be helpful. Separate targets would be a way to achieve this, as they would distinguish the overarching policy goals for negative emissions (or carbon removals) and emissions reductions.

Separate negative emissions targets at the EU level would need to be agreed by the European Council by consensus, as is also the case for emissions reduction targets. A tentative step towards this was taken in December 2020, with the 'at least -55 %' reduction target being expressed as a 'domestic net' target. Furthermore, in the European Climate Law, the contribution of the sink[6] to the 'net -55 %' target is limited to 225 million tonnes.

The more concrete a negative emissions target is formulated, the better it can support the investment case for negative emissions technologies. Volume (or quantity) and target years are obvious components, but further specification is possible by targeting natural and technological negative emissions options separately. In addition, while the EU's GHG targets for now are fully domestic, a return to international targets is possible (as was the case for the first and second Kyoto compliance periods for the EU) – especially with an agreed rulebook for Article 6 of the Paris Agreement. However, while it is a theoretical option to invest in negative emissions

[5] Agreements Article 6 (admin.ch).

[6] It is arguably unclear whether this refers exclusively to the LULUCF sink or to all negative emissions. Sinks are defined as comprising natural and technological removals, but the preamble and Art. 4 of the Climate Law refer to (enhancing) natural sinks.

outside the EU in the future, this might be politically unattractive in spite of its cost-effectiveness and the export potential for some countries, as the investment and its co-benefits would then flow outside the EU economy. The Commission nevertheless sees its certification mechanism as 'trailblazing'[7] for international carbon markets under Article 6.

Member States can also set their own negative emissions targets, which go beyond the EU targets. Several Member States, especially in northern and western Europe, already have higher GHG targets for 2030 or for climate neutrality before 2050. EU policy does not prevent Member States from pursuing more negative emissions. Indeed, the future certification mechanism may make it easier for Member States to move in this direction.

Another concept that is sometimes discussed when quantifying and crediting climate change mitigation activities is additionality. In the context of negative emissions, this could mean that only activities that are additional to business-as-usual – and would not have occurred anyway – should be credited. This concept is more important for voluntary markets, where an EU certification mechanism could also play a role, than for compliance carbon accounting frameworks.

The overarching EU climate policy framework since 2021 is the European Climate Law. Article 2 of the Climate Law puts the EU's climate neutrality target for 2050 into EU law, but also states that the EU 'shall aim to achieve negative emissions thereafter'. The Climate Law emphasises that 'removals by sinks' can be both natural and technological[8]. Finally, the Climate Law deals with the potential risk of moral hazard by limiting the contribution of removals to the EU's -55 % net reduction target for 2030 to 225 million tonnes. However, in Article 4, a distinction is made between natural and technological sinks: the EU and its Member States 'shall prioritise swift and predictable emissions reductions and, at the same time, enhance removals by natural sinks'. So far, therefore, nature-based negative emissions have been given priority over technological options in EU policy although the carbon cycles communication suggests that this may change in the future.

Negative emissions can potentially play a role in each of the three main climate policy frameworks of the EU: the EU ETS, effort sharing and Land Use, Land Use Change and Forestry (LULUCF). One of the most basic roles of these frameworks is to ensure accurate accounting of greenhouse gases across different sectors.

[7] See page 21 of the Sustainable Carbon Cycles Communication.

[8] The scoping paper discusses this dichotomy, which is not ideal for every type of NET, since some options are best described as hybrid, while other categorisations depending on the storage or capture type can also make sense. However, the nature/technology distinction is commonly used in the policy debate.

3.2 Carbon accounting in existing EU policy frameworks

3.2.1 The EU Emissions Trading System

The EU ETS covers emissions from the power sector, energy-intensive industry and intra-EU aviation. Under the Fit-for-55 proposals of summer 2021, the EU ETS would be extended[9] to maritime transport, road transport and the energy use of buildings as well. Negative emissions do not play a role in the EU ETS currently, nor are there plans for this in the Commission's ETS revision proposal, although some MEPs support the inclusion of removals in the ETS[10]. Indirectly, however, some of the EU ETS rules can affect negative emissions deployment. For a start, the ETS contains provisions on how to treat emissions that are captured, transported and stored. These rules affect the business case for CO_2 transport and storage infrastructure – the same infrastructure that will be used by negative emissions technologies such as BECCS and DACS.

Another relevant accounting rule is the combustion of biomass, which takes place in several EU ETS sectors. The zero-rating for biomass combustion means that no ETS allowances need to be surrendered for emissions arising from biomass combustion. If installations combusting biomass were to also apply CCS (i.e. BECCS), negative emissions would technically be delivered within an ETS sector, although not in practice as installations exclusively using biomass are excluded from the ETS.

High-integrity monitoring, reporting and verification rules underpin the credibility of the EU ETS. The measurement and reporting of emissions in ETS installations today is highly accurate and reliable. An installation surrenders a given number of EU allowances (EUAs) based on third-party verified emissions data; we can be fairly certain that this represents its actual GHG emissions. For that reason, any other unit of accounting allowed in the EU ETS would need to have similarly high reliability. Hence, in the context of negative emissions, only units representing fully permanent removal should be allowed in the EU ETS, so as to not undermine the credibility of the EU carbon market. An open question for potential ETS integration is whether negative emissions credited under a future EU certification mechanism should be limited to NETs involving CCS or also others which involve permanent removal. The potential integration of the EU ETS and negative emissions is discussed in Section 4.3.

3.2.2 Effort Sharing Regulation, LULUCF & carbon farming

The Effort Sharing Regulation (ESR) covers the GHG emissions from current non-ETS sectors, i.e. road transport, the energy use of buildings, non-ETS industry, waste and agriculture. The coverage of agricultural GHG emissions makes this framework potentially important in the context of nature-based removals and the carbon farming initiative.

[9] Extension to road transport and buildings is controversial and may be opposed by the co-legislators.

[10] See, for example, Amendment No 73 in Rapporteur Pieter Liese's report on the ETS revision (https://peter-liese.de/images/ETS_DRAFT_Report_13-01-2022_new.pdf).

While the effort sharing framework is not an emissions trading system, it nevertheless has some characteristics of a carbon market: the emissions of every Member State are capped in line with their individual reduction targets. Member States are then allocated 'annual emissions allocations' (AEAs) with 1 AEA being equal to 1 tonne of CO_2e. A limited amount of trading among Member States and between different years is possible, referred to as 'flexibility mechanisms'. Additionally, some flexibility is possible between the LULUCF Regulation and effort sharing, with overachievement in LULUCF being available to comply with effort sharing targets.

Up to today, the effort sharing framework has only been used to establish individual trajectories of emissions reductions in non-ETS sectors for the Member States. Yet, the framework could easily be applied to negative emissions as well in the future, with individual negative emissions targets per Member State. Differentiation between Member State targets could be based on relative GDP per capita, as is the case today for non-ETS emissions, or on another indicator such as share of historical emissions. The certification mechanism could generate the units necessary for the accounting, with the possibility that non-permanent removals are discounted or they are cancelled if reversal (i.e. re-emission of the removed carbon) occurs.

Under the LULUCF framework today, the objective is to balance emissions and removals from the land-use sectors (informally called the 'no-debit rule'). With the proposed update of the regulation under the Fit-for-55 package, the objective is strengthened to a removals target of 310 million tonnes of CO_2e by 2030. In addition, by 2035, the combined land-use, forestry and agriculture sectors should reach climate neutrality.

To create incentives for individual landowners, the EU is considering a carbon farming initiative. With carbon farming, the removals in the land-use and forestry sectors would be expanded by creating incentives for landowners to manage their land in such a way that the carbon uptake is increased. Carbon farming practices include NETs such as afforestation and reforestation, but also soil carbon enhancements, or peatland rewetting and restoration. Biochar can also improve soil quality, although the carbon removal from biochar is achieved by pyrolysis[11]. Carbon farming therefore falls within the domain of nature-based negative emissions technologies. Certification of carbon activities through the EU mechanism can create a potential income stream for landowners. Some landowners see carbon farming as requiring a broader definition comprising the management of carbon sinks, flows and greenhouse gas emissions arising from land use. Indeed, certain soil types can be a source of emissions and reducing these is a policy objective as well. Yet, as far as the certification mechanism is concerned, crucially it will certify only those activities leading to negative emissions.

Under the common agricultural policy, 30 % of income support has to be for 'greening'. Farmers can receive these green direct payments if they comply with certain practices such as crop diversification, the maintenance of permanent grasslands, and dedication of 5 % of arable land

[11] Some industries refer to the process of 'PyCCS', with biochar being the resultant product.

to ecological focus areas to protect biodiversity. Of these practices, only grassland maintenance has direct impacts on climate change mitigation, as grasslands act as a carbon sink. In the future, green direct payments linked to additional negative emissions deployment could be envisaged. For example, expanded soil carbon sequestration could be mandatory to some extent in order to qualify for direct income support. Mandating the deployment of negative emissions for farmers could be attractive given the unavoidable residual GHG emissions in the agriculture and land-use sectors. This would, however, only work if these land/soil-based NETs have achieved some scale already. Additional incentive payments for farmers who deploy NETs could be more suitable for creating increased demand for emerging land/soil-based NETs.

It is also possible to imagine an indirect obligation for farmers, where instead of deploying negative emissions themselves, they acquire credits issued under the EU's certification mechanism. The issue of permanence could in theory also be addressed by allowing a public authority to cancel credits issued in case of a reversal of removal (i.e. re-emission of greenhouse gases that were earlier removed).

3.3 Article 6 of the Paris Agreement

Article 6 of the Paris Agreement allows for international cooperation to achieve the nationally determined contributions (NDCs) that countries pledge to achieve. Removals are in principle allowed and referenced throughout Article 6. However, the criteria of the Supervisory Body of the UN Framework Convention on Climate Change (UNFCCC) establishing specific accounting rules (on, e.g. permanence and additionality) may differ from similar criteria being applied through the EU's certification mechanism. This would be a barrier to international cooperation, and could also affect project developers, who would need to deal with more rulebooks.

Article 6 contains two separate approaches for international cooperation, in Articles 6.2 and 6.4. Article 6.2 focuses on internationally transferred mitigation outcomes (ITMOs) between countries, while Article 6.4 focuses on projects for which credits are generated, which can be used for compliance with an NDC of a Party (i.e. a country that ratified the Paris Agreement) or simply to show additional mitigation efforts.

Since the EU has a common NDC, 6.2 trading of ITMOs at the individual Member State level would not be an obvious choice. Article 6.2 mentions the use of ITMOs 'towards NDCs'. Member States that have adopted higher domestic (net) emissions reductions or negative emissions targets would arguably not be seen as contributing to the EU's common NDC through their additional mitigation efforts. While the corresponding adjustment technically would apply to the GHG inventory, which is separate per Member State, such adjustments could interfere with the EU's main carbon accounting frameworks (ETS, ESR, LULUCF) that underpin its NDC. Hence, 'corresponding adjustments' would not be made between NDCs. Article 6.2 would still be a possible future avenue to cooperate on negative emissions with countries outside the EU. This would require the EU to develop a political consensus on the import or export of NET units and on Article 6 in general.

The use of Article 6.4 would arguably be possible at the Member State level. Specifically, it could facilitate higher ambition for Member States that want to go beyond EU targets. Nevertheless, some countries may be concerned about investment and finance flowing out of the Member State. While acquiring and voluntarily cancelling Article 6 removal credits can deliver increased domestic climate ambition in a cost-effective way, this may be unattractive as the co-benefits of the investment accrue to the host country. Likewise, the EU could in the future develop a consensus to deliver a share of its climate targets through international mitigation efforts, which could be either emissions reductions or removals, but also be limited to just removals. Fulfilling a potential international target (which could either be part of a future 'net' EU target or be separate and additional to domestic mitigation efforts) can be facilitated by Article 6.4.

3.4 Fit-for-55: European Parliament positions on negative emissions

The Fit-for-55 package of legislative proposals will lead to an overhaul of the EU climate policy frameworks. The European Parliament has started taking positions on several of the key files and refers to CO_2 removals in a number of different legislative files.

As part of the LULUCF revision, the Commission proposes to establish binding, annual Member State targets for 'net greenhouse gas removals' from the LULUCF sector. These targets would apply from 2026 onwards, with the environment committee of the European Parliament supporting an intermediate target of at least 490 million tonnes, up from 310 in the Commission proposal. Such separate targets support the demand for negative emissions, although they are limited to natural NETs linked to forests and carbon farming. The environment committee also supports net-negative targets for the LULUCF sector after 2035, as well as reaching a balance between emissions and removals in croplands, grasslands and wetlands already by 2030. Whereas the Commission proposes to allow Member States to transfer an overachievement of a removals target to other Member States, the environment committee proposes a floor price of EUR 250 per tonne, an amount that ostensibly deters making use of this flexibility.

For the revision of the Effort Sharing Regulation, the environment committee proposes a specific definition of eligible removals by referring to the concept of a 'carbon capture removal' and defining it as 'the removal of carbon dioxide from the atmosphere by means other than photosynthesis'. While this definition excludes afforestation and reforestation while allowing all other forms of removal, the term 'carbon capture removal' might lead to the undue conclusion that it only relates to NETs involving CCS[12], and not to other permanent options such as biochar as well. The carbon capture removal would also be allowed for the general compliance obligation of the Effort Sharing Regulation, although the environment committee wants to limit this to 5 % of a Member State's effort sharing contribution. The Commission's

[12] Also, Amendment 4 of the environment committee's opinion on the effort sharing revision refers only to CCS and CCU.

proposal, conversely, is to form a new reserve if the EU collectively overachieves on the LULUCF targets, so that this reserve can be used by Member States having difficulty meeting their effort sharing targets.

Finally, with regard to the ETS revision, the environment committee refers to removals being eligible for compliance under the ETS, albeit limited to BECCS and DAC, by issuing allowances for every tonne of removals. This represents a high degree of integration with negative emissions as there are no quantitative limits proposed. On the other hand, the eligible technologies are limited, with non-permanent and non-carbon-capture NETs being excluded.

The environment committee's proposals across the different legislative revisions show a range of options for the integration of negative emissions being considered, with some proposals being noticeably more restrictive than others. It also shows that flexibility to reach emissions reduction targets remains an important consideration for lawmakers. At the same time, lawmakers are also recognising in some cases that accelerating emissions reductions and removals are both required. These positions only represent an intermediary negotiation position and not yet the final position of the environment committee, nor of the European Parliament as a whole. Furthermore, the Council of Ministers may have very different preferences, leading to different outcomes for negative emissions under the Fit-for-55 package once the revision processes are completed.

Beyond the main climate policy frameworks, the Commission proposed a dedicated policy instrument for decarbonising aviation fuels: ReFuel EU aviation. This legislative proposal makes reference to DAC as a potential source of CO_2 to create synthetic e-fuels, which would enable a near 100 % reduction in aviation emissions in theory. Hence, increased demand for synthetic aviation fuels can support investments in DAC as well as CO_2-capture from biomass to source the CO_2 as a feedstock. The Fit-for-55 package also contains several other policy elements benefiting the CCUS value chain, including clarification of CCU rules in the EU ETS, investigation of suitable storage sites for CO_2 by the Commission, and CO_2 infrastructure funding through the Connecting Europe Facility and TEN-E Regulation.

3.5 An EU certification mechanism

The EU carbon removal certification mechanism is a prerequisite for further policy incentives for negative emissions technologies. Such a mechanism is essential to account for negative emissions activities. As some approaches to negative emissions, such as afforestation, would already be accounted for in the carbon accounting frameworks discussed above, avoiding double counting is important.

The overarching issue to which the certification mechanism should provide a solution is whether all carbon removals should be treated the same or whether different classes, tiers or units should be created.

A review (Umweltbundesamt, 2021) for the Commission of existing certification mechanisms found the following key design issues:

- mechanism governance – methodology development, approval, accounting approaches to manage double counting and administrative/transaction costs
- additionality – definitions of additionality, baseline setting methods and additionality tests
- leakage – approaches to quantifying and managing leakage and differing definitions of system boundaries
- uncertainty – methodologies for quantifying and managing the uncertainty of mitigation impact
- permanence – approaches for managing the risk of impermanence
- sustainability – safeguards to protect against negative side effects and approaches for increasing co-benefits
- verification and validation – evaluation of different verification and validation approaches.

One important question is what the certification mechanism should 'produce': should it be a unit of accounting equal to one tonne of CO_2e removed or would there also be certification of 'activities' without necessarily creating a unit? Should any units be tradeable, and should the validity of units be limited in some circumstances? Should they be fungible with other carbon accounting units such as EUAs or AEAs? Alternatively, the mechanism could also credit activities without producing units expressed in t/CO_2e.

If units are created, the question is what they could be used for. Should it just be voluntary activities, such as companies wanting to prove they are net zero throughout their supply chain, or should countries and companies be able to acquire the units to use for other climate policy obligations?

A related question is whether the mechanism should credit all removals (like Guarantees of Origin do for renewable electricity) or only those that are deemed additional. This question is only relevant insofar as the credits issued under the mechanism are used in voluntary markets or to avoid double counting with existing carbon accounting frameworks.

A concept that arose in the Article 6 negotiations during COP26 might be potentially interesting for the crediting mechanism as well: while not adopted in the end, there was the idea to create two types of units: one for voluntary purposes and one for compliance only[13] with the latter requiring an adjustment (the 'corresponding adjustment') to the GHG inventory. The crediting mechanism could likewise differentiate between units to be used for voluntary and for compliance purposes, but also provide guidance on how to claim financial contributions linked to climate finance.

[13] The 'Paris Agreement support units' and 'Paris Agreement adjustment units', respectively.

Some of the activities (or products) that the mechanism will certify will be closely linked to activities that are still carbon-intensive, for which, as a result, emissions reduction policy still plays a role. Certain construction materials are an example, where there is the possibility for certain materials to absorb carbon over time. However, this is a separate issue from the energy (and for now) carbon-intensive production process of such materials. Likewise, for some carbon farming practices, reducing emissions from soils and increasing the uptake of carbon in soils can both be pursued by landowners through improved management. While from the perspective of the landowner remuneration for both reductions and removals of carbon may be important, it is critical that the certification mechanism only focuses on the negative emissions component of the activity, to ensure environmental integrity and the separation between the two types of climate change mitigation policies.

Irrespective of the units potentially created, the certification mechanism should promote transparency about the underlying activity. It should therefore give information about the provenance of the certified activity, especially with a view to permanence: what negative emissions technology was used and how permanent is the removal? Who is liable if there is risk of reversibility? It should also give information about side effects and co-benefits of the NET employed as well as any fungibility with existing carbon accounting frameworks. Possible ways to address the fungibility of NET units under EU carbon accounting frameworks include the following:

- EU ETS – in principle only fully permanent and irreversible allowed (because of installation-based accounting and liability rules);
- Effort Sharing – in principle any type of permanence allowed (as long as Member States ensure compliance and deal with reversibility);
- LULUCF – only land-based and carbon farming approaches.

In the aggregate, the combined certified activities will also support better monitoring and verification of all GHG flows and stocks, in line with the larger objective of sustainably managing carbon cycles. Finally, when certifying activities, it is helpful to follow as much as possible international standards, such as ISO standards[14] on carbon removal, in so far as they are compatible with the EU's climate objectives. Coherence with IPCC carbon accounting guidelines should also be assumed. Together, such coordinated accounting practices should support more international cooperation on negative emissions as well, including, potentially, through Article 6 of the Paris Agreement.

The planned EU certification mechanism may also help foster transparency and trust within the market when it comes to negative emissions. As such, it could boost voluntary initiatives, for example, by providing a transparent mechanism for companies that want to offset their scope 3 emissions with negative emissions.

[14] https://www.iso.org/news/ref2384.html

4. Options for an EU negative emissions policy

There are several potential avenues EU policy can take to further support negative emissions. These can both be direct or more indirect. One option would be to encourage Member States to provide targeted support for negative emissions. Adapting existing EU policy tools to cover negative emissions provides another avenue. The EU could also enact specific policy instruments for NETs. A selection of such different options is discussed in the sections below.

While existing and planned policies may work to support some – mainly CCS-based – NETs, they do not provide incentives for NETs in general. The sustainable carbon cycles communication refers to targets for annual removals (5 megatonnes) and non-fossil sources of carbon (20%) for use in chemicals and plastics production, but more dedicated policy support, focusing specifically on lowering atmospheric carbon concentration, may be warranted.

4.1 Building on existing climate policies and supporting Member States

If negative emissions are recognised as a key component of EU climate policy, then support for negative emissions technologies should also be made available through existing policies that support the EU's mitigation efforts. This could involve dedicated R&D support in Horizon Europe for a broad portfolio of NETs, but also demonstration support through the EU Innovation Fund. If certain types of NETs are considered unsuitable for funding through the Innovation Fund, a dedicated demonstration fund could be considered.

Existing or pending policies that primarily support emissions reductions in energy-intensive industries or other parts of the EU economy can benefit certain negative emissions technologies indirectly. In the context of industrial decarbonisation, there is increasing policy attention on the potential of public procurement to create demand for climate-neutral materials. Some climate-neutral production methods would use technologies that (partially) overlap with NETs, in particular CCUS applied to point-source GHG emissions from cement or steelmaking, for example.

The new EU state aid guidelines that explicitly allow for the funding of NETs are one way for the EU to encourage Member State support for negative emissions. The reasoning to encourage support for negative emissions through state aid is arguably the same as for regular decarbonisation: cost barriers limit the market potential and early-stage technologies that contribute to environmental objectives merit support[15]. Inclusion of negative emissions in the EU's environmental state aid guidelines provides a means for the European Commission to coordinate and structure support for NETs. The guidelines give a broad definition of 'CO_2 removal', which in principle comprises every NET other than forest NETs. Nevertheless, in its assessments, the Commission should ensure that potential future NETs which are not perfectly captured by existing definitions can still receive aid if potential is demonstrated.

[15] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52014XC0628(01)&from=SV

Such an inclusion of NETs could be envisaged to be either technology-specific or technology-neutral. The former would be more similar to the inclusion of, e.g. CCS technology, though may run the risk of not being flexible enough to support new and emerging technologies. The latter would allow for support for a multitude of NETs, but would likely be best accompanied with conditions on permanence and other factors, though this may very well be addressed through the EU certification mechanism. In either case, clarity on the possibility for state aid to NETs could encourage Member States to enact a variety of policy initiatives that could help support negative emissions.

Tax credits are another way in which Member States could support the case for negative emissions, which could be enabled through changes in the EU state aid guidelines. Notably, the 45Q tax credit in the United States serves as an existing example of such a policy. Key aspects of the policy are its inclusion of DAC and CCS-based removals, and differentiation between storing and using CO_2 captured, with higher credits awarded for storing CO_2 and lower credits for CO_2 use. Proposals have been tabled to extend the deadline for when projects can start, as well as for increasing the credits and providing direct payments.

In the ETS Innovation Fund, as well as in some Member States[16] separately, the use of carbon contracts for difference (CCfD) is planned. CCfDs support investments by paying a subsidy based on the difference between the ETS carbon price[17] and a strike price necessary to make an investment work. Such subsidies could also be extended and made available to negative emissions technologies. However, CCfDs are primarily a way to structure subsidies/public funding: they depend on some budget being available in the first place to support investments, whether for emissions reductions in energy-intensive industries or for negative emissions. While ETS auction revenues are a possible source, these revenues accrue to Member States in principle.

For the inclusion of negative emissions in the effort sharing framework, one could envisage negative emissions units credited by the EU's certification mechanism being fungible with AEAs, subject to politically determined quantitative limits. However, double counting with LULUCF emissions and sinks should be avoided. For example, afforestation leads to an expansion of the natural sink, which in principle could be credited under the certification mechanism. Yet, the increased sink would already be accounted for under the LULUCF Regulation. Such units should therefore not be fungible with existing units of carbon accounting like EUAs (in the EU ETS) or AEAs (in effort sharing), but rather should be limited to voluntary markets. An alternative would be to apply 'corresponding adjustments', similar to how Article 6 of the Paris Agreement will operate, so that credited negative emissions activities for compliance frameworks are not counted under the LULUCF framework.

[16] For instance, the Netherlands, Germany and the UK (while still a Member State).

[17] Or in the case of effort-sharing sectors, a reference price linked to abatement costs in these sectors.

4.2 Direct procurement

Under direct procurement, a public authority would purchase credits representing carbon dioxide removal or negative emissions. This can be envisaged at both the Member State and EU level. If the procuring party is a Member State, it will want to consider its domestic context in determining which types of negative emissions to consider. Member States will have comparative advantages in some approaches over others, depending on geography, land use and energy mix. At the EU level, a wider portfolio of NETs would be merited.

The main question is what to procure exactly. Here, the EU's carbon removal crediting mechanism can play an important role. If the mechanism distinguishes between different negative emissions technologies, for example by distinguishing between how permanent the removal from the atmosphere is, the public authority can decide itself which types of negative emissions technologies to support.

The second question for the public authority is whether it wants to procure a predetermined volume of negative emissions or allocate a given budget and try to maximise the volume within that envelope.

Beyond the carbon removal certification mechanism, the EU could also play a role through state aid control. Given that 'removal credits' would not be procured to comply with international climate policy obligations (e.g. to contribute to an NDC under the Paris Agreement, which EU Member States do not submit individually), there is a case to be made that such procurement would fall within the remit of state aid control. In particular, the justification for direct procurement could be that there is no market demand yet, nor (full) integration of negative emissions in carbon accounting compliance mechanisms such as the EU ETS.

4.2.1 Competition and price discovery?

Fostering a degree of competition to improve cost-effectiveness is important as public funds are being used. In the early stages of technology maturity, activities that up to that stage are uncompetitive will likely need some public finance. This supports price discovery for nascent negative emissions technologies.

Reverse auctions and tenders are two ways in which competition can be fostered. With reverse auctions, multiple sellers compete for a single buyer (the public authority) or for a given amount of available money; hence, it is reversed. At the end of such an auction, the lowest cost bidder would normally win. This requires the public authority to carefully specify other requirements which the bidders need to comply with, such as those regarding permanence, technologies, scale-up potential, and (mitigation of) side effects. At the same time, it is also possible to have a more general tendering system, where bids are evaluated based on a number of criteria, of which price only has to be one of many.

It is also possible for a public authority to set a fixed price per tonne and commit to buying or providing finance for any quantity that suppliers can deliver[18]. This would require the authority to decide on an appropriate price level itself (at which supply would be available), and leaves open the total volume of negative emissions to be procured. This approach would create a high degree of certainty for NET developers, although depending on the timing there is a risk of supporting those NETs that score well on maturity but are not necessarily the most attractive from a broader, long-term perspective.

Sweden has already committed to give state aid for BECCS through reverse auctions, with the Swedish parliament adopting a budgetary framework for a 21-year period.

4.2.2 Feasibility and timeline

Direct procurement can also be an attractive option to scale up negative emissions technologies in the short run. The justification for this is that early deployment may need more public support, to drive learning effects and bring down costs. With lower costs, especially if the costs of some permanent negative emissions technologies start approaching the EU ETS carbon price level, other policy options that are less demanding for treasuries may become more feasible.

Member States are free to pursue direct procurement of negative emissions themselves already today. Even the certification mechanism and supportive state aid rules are not a strict precondition, though these undoubtedly make it easier and more attractive. If the EU wanted to procure negative emissions directly, more constraints may arise. The budget and financial commitment is the most pressing question. One option is to use a share of ETS auction revenues to create a fund from which negative emissions credits would be procured. To illustrate, around half a billion euro could be generated by using the auction proceeds of 1 % of auctioned allowances (~ 7.5 million allowances) at a carbon price of 75 EUR/t.

Another option would be to agree on direct procurement through the EU budget. Given its inherent limitations (e.g. the seven-year cycle) and the divergent opinions on negative emissions among EU Member States, this does not seem feasible. Technology neutrality may also be more important at the EU level compared with the Member State level.

4.3 EU ETS inclusion

While the EU ETS has been limited to emissions reductions, including negative emissions could be a way to widen the instrument and provide support for NETs. Companies included in the EU ETS have a compliance obligation. Installations need to surrender one EU allowance for every tonne of CO_2e emitted. If credits representing a tonne of CO_2 removed were allowed for compliance, i.e. to cover for a tonne of emissions, a persistent source of demand for negative emissions would be created.

[18] https://www.frontiersin.org/articles/10.3389/fclim.2021.685227/full (Model 1).

There are different ways in which negative emissions could be incorporated in the ETS, ranging from separate systems to full fungibility and integration (elaborated and analysed by iCap; see La Hoz Theuer et al., 2021). One way would be to connect the two markets through the government. Public authorities (or in the case of the EU, the European Commission) would procure NET units and then either allocate them for free or auction them – at a regular interval or because of certain triggers like price spikes. This could also be envisaged without the government as an intermediary. The public authority would only set quantitative and qualitative limits, but ETS emitters would acquire the NET units directly from the negative emissions market (or from NET developers). This option is similar to how the EU ETS operated for part of Phase 3, when a limited volume of Kyoto credits was still allowed. Finally, completely integrating negative emissions without restrictions could lead to significant demand for negative emissions as long as they are cheaper than emissions reductions. However, this could significantly deter regular emissions reductions in ETS sectors and may therefore run into political opposition by watering down the primacy[19] of reductions over removals. Furthermore, complete integration of negative emissions should only be considered once there is sufficient maturity in various ETS-eligible NETs, to mitigate the risk of adverse selection.

Beyond incentivising negative emissions technologies and allowing for offsetting of residual emissions, negative emissions have the potential to provide liquidity to the EU ETS. This may become important as the market becomes very tight in the second half of the 2030s and reaches zero in 2040 (according to the current ETS proposal by the Commission)[20]. As the ETS cap approaches zero, the lack of market liquidity could increase volatility. The associated price spikes might be unattractive and provide an additional rationale for the inclusion of accounting units other than EUAs.

4.3.1 Fungibility or discounting?

The permanence and additionality of ETS-included removals should be unconditional and unequivocal. Any uncertainty should lead to exclusion or at least to steep discount rates being applied. The EU's certification mechanism will play a critical role here, with NET units eligible for use under the ETS requiring certification and monitoring that maintains the ETS's high integrity of accounting.

Another question is what to do with regard to fungibility? Should it be 'one NET unit in, one EUA cancelled'? This works well with a separate removals target. The overall supply in the ETS would then remain the same, while overall net emissions would decline due to the additional negative emissions. The demand for NET credits would only be there if the NET credits were cheaper than EUAs. This limits the utility of this option in supporting the scale-up and early deployment of negative emissions technologies. In the longer term, this model is attractive to

[19] See also this SWP Research Paper on the relationship between emissions reductions and negative emissions.

[20] https://icapcarbonaction.com/en/?option=com_attach&task=download&id=743

deal with residual emissions in the EU ETS, as the model is in principle compatible with a net-zero target or a cap of zero in the EU ETS.

Another option is to allow a limited volume of NET units without adjusting the EUA supply: this would not increase net EU emissions, but it would increase ETS emissions as such. This would thus be a possible disincentive to reduce emissions in ETS sectors in a conventional way, although such an instance of 'moral hazard/mitigation deterrence' would only materialise if NET units were cheaper than EUAs.

An ETS cap expressed as a net-negative emissions target is also conceivable[21], but that would give rise to questions: where does the demand come from? Who would be the party obligated to acquire the NET units to enable net-negative emissions? Some potential answers are below.

- Residual emitters[22]: apply a discount factor, i.e. surrender 2 NET credits to emit 1 tonne. This would put all of the burden of achieving net-negative emissions on residual emitters.
- Historical ETS emitters: any company that had an ETS compliance obligation in a given period (e.g. 2025-2030) would need to surrender NET credits equal to a share of their historic GHG emissions in a given time period (e.g. 5 % of average annual emissions in the same time period). This would be akin to a partial carbon takeback obligation (see Section 4.4). While it would make historical emitters responsible, thereby spreading responsibility to deliver net-negative emissions to a larger pool of actors, the politics would be complicated.
- Effort sharing/ETS linkage: an EU-wide target for net-negative emissions could be adopted. This could then be shared among Member States in a similar way as effort sharing operates today (alternatively, instead of relative GDP per capita, the share of historical emissions[23] could be used to determine Member State contributions to the EU negative emissions target). A share of the units generated by Member States could then be transferred to the ETS.

4.3.2 Feasibility and timeline

Inclusion in the EU ETS would make a difference once (permanent) negative emissions technologies have costs in line with the ETS price and abatement cost of emissions in ETS sectors. For that reason, it would be a powerful instrument to ensure further deployment of negative emissions in the mid-term. Some experience with the functioning of the certification mechanism, in particular in relation to accounting and reversibility, may also be beneficial before inclusion of negative emissions is considered. Another issue to consider with the

[21] The European Commission's *A Clean Planet for All* communication refers to it as well.

[22] Residual emitters in the ETS are those installations that continue to emit GHGs after the ETS cap reaches zero.

[23] Using historical emissions could be one way to reflect the UNFCCC's principle of 'common but differentiated responsibilities', although the exact interpretation of this principle will always be political.

certification mechanism is coordination[24] between the rules on negative emissions eligibility in the main ETS legislation (or derived delegated or implementing acts) and the rules of the mechanism. Depending on the applicable procedure, it may be easier or more difficult to update the negative emissions rulebook, which may complicate further iterations.

There is in principle an opportunity to include negative emissions in the ongoing EU ETS revision, and indeed some MEPs support this. If opposition were to mount in the later stages of the negotiations, a reform in the second half of the 2020s might be more feasible. Still, any ETS revision process – through the ordinary legislative procedure – will take around two years. An agreement to formally examine models of ETS integration to potentially pursue in the future could be beneficial, also to shape stakeholder expectations and preparedness. Such a discussion should include the role of the EU ETS in EU climate policy as climate neutrality approaches, at a time when liquidity would invariably be lower (i.e. the mid-2030s onwards).

In the long-run, it is desirable that negative emissions are financed by the market. This requires a financeable (and in the EU, oftentimes, a bankable) revenue stream. EU ETS inclusion can in principle offer this, although there are other avenues as well.

4.4 Carbon takeback obligation

One idea that has been advocated is a carbon takeback obligation (CTBO), which under certain conditions could provide incentives for negative emissions. While the idea has not been widely discussed with relation to EU policy, it has gained some attention in the UK. The Net Zero All-Party Parliamentary Group recommended implementing a CTBO, and included it in a 10 point net-zero action plan as a way to support commercialisation of CCS and removal technologies. The idea has also been studied in relation to specific markets. A 2021 study, which received financial support from the Dutch Ministry of Economic Affairs and Climate Policy among others, focused on a CTBO for the Dutch natural gas market.

Resembling a producer responsibility scheme for fossil carbon, the central idea behind the obligation is to require fossil carbon producers and importers to permanently store a share of the CO_2 generated from their products, starting with a small share and increasing to 100 % by 2050 to reach net zero[25]. This could be facilitated by a market of tradeable certificates, where any carbon stored would render a certificate which could be purchased to comply with the CTBO. A key aspect of this idea is the concept of carbon storage units. Any carbon permanently stored would render corresponding carbon storage units to the storage provider or operator. These could then be used to comply with own CTBO obligations if applicable or sold in a market to others. Carbon removal units, on the other hand, would be generated when carbon has been

[24] A similar coordination challenge is present with the introduction of the carbon border adjustment mechanism and the impact on free allocation rules, which are governed by the ETS Directive.

[25] E.g. see https://carbontakeback.org/about/

removed from the atmosphere, e.g. through DAC or BECCS (Kuijper et al., 2021). These would be separate and different from carbon storage units.

To ensure that the emissions removed are not again released, it would be important to require permanent storage for any credits to be generated. In order for a CTBO to be an effective instrument to support the scale-up of NETs, it would also be important to focus on the source of the carbon stored. If it could be generated as a result of emissions reductions using CCS, the obligation would likely mainly support the financing of CCS infrastructure as long as capturing emissions remains cheaper than removing them. A requirement that the emissions are removed from the atmosphere and permanently stored, could nevertheless ensure direct support for negative emissions. Design options could include mandating that a certain fraction of the carbon stored must be removed from the atmosphere or a policy choice to allow only carbon removed and stored to be eligible. The latter is more desirable from a negative emissions perspective, as well as to avoid a direct overlap with the EU ETS. In this regard, the EU certification mechanism should play the key role of certifying and determining what removals should be eligible for credits.

The advantages of such a CTBO focused only on negative emissions would be that it could provide a flexible way to secure investment in NETs with permanent storage, while ensuring that producing and importing fossil carbon becomes increasingly costly through a rising share required to be stored. Similar to other trading schemes, though with an emphasis on removing and storing carbon instead of reducing emissions, it could facilitate investment in the most cost-efficient storage options. The small but growing share of carbon emissions covered would provide necessary foresight and set expectations for industry to adapt and invest in capture and storage solutions.

4.4.1 Feasibility and timeline

While a CTBO could be an efficient way to mandate a certain amount of negative emissions, depending on design, it may be politically challenging to implement for different reasons. One of these is a potential interaction with climate targets, the ETS and its carbon price for the applicable sectors, if emissions reduction activities are included[26]. If only negative emissions are allowed under a CTBO, the same activities should not be made to comply with both ETS and CTBO obligations. By mandating that extractors and importers of fossil carbon pay for negative emissions, , this cost could nonetheless indirectly affect the carbon price of fossil carbon. It could also de facto increase the climate ambition outside of agreed targets and be seen as a net climate target specific to the fossil extraction and importing industry. These aspects may meet significant political opposition at the EU level, from the point of view of mandating a higher de facto climate target, different treatment for different sectors (beyond the ETS/ESR dichotomy – where the EU makes the political choice to adopt stricter climate targets), as well

[26] One example could be BECCS, if this technology is partially applied to an ETS installation.

as the polluter pays principle. Nevertheless, it may also be seen as a way to ensure more responsible management of the carbon stock.

Another possible point of contention could be expectations of negative reactions by trading partners. As previous EU efforts to include international aviation in the ETS met with strong pushback from trading partners, so might a CTBO applicable also to importers. However, the reception of the EU carbon border mechanism could shed some light on how a CTBO may be received internationally. Especially as the obligation would apply immediately to both EU producers and importers, it may seem less targeted towards trading partners. Moreover, that the CTBO also applies to importers would be key to ensuring the integrity of the mechanism, as well as avoiding concerns that it may affect EU competitiveness. Indeed, as long as both EU producers and importers were covered by the obligation, there would be no reason to expect EU producers to be less competitive within the EU market vis-à-vis foreign counterparts. Export competitiveness could nevertheless be negatively affected unless compensated for.

Combined with the time it takes to develop new policy instruments, such political challenges may indicate that a potential CTBO will not become available in the short term. Even if it should receive sufficient political support, it would likely first be subject to debate and its development would have to pass through the normal EU procedures. However, its relevance in the long term could also be questioned, if the obligation to purchase credits is focused on current fossil fuel producers and importers, as quantities put on the market should decrease. The exception to this is if obligations were related to historical emissions.

Indeed, an overarching question of negative emissions policy is who should pay for it. The principle applied to conventional climate policy, i.e. emissions reductions, is the polluter pays principle as set out in Article 192 TFEU. Negative emissions, on the other hand, are not pollution but a drawdown of pollution already released. Some researchers therefore propose that the polluter pays principle can be turned around into a 'Beneficiary-pays Principle' (e.g. Zetterberg et al., 2021.). This turns the question into who benefits from negative emissions. A reduction in atmospheric CO_2 concentrations benefits everyone (globally, even), which could be a justification for society – i.e. the state – to bear the costs through direct procurement or subsidies. If negative emissions are credited and turned into tradeable units, the question becomes even more important. The reason why negative emissions are needed in the first place is because of emissions already released. Hence, the procurement of negative emissions can also be mandated for certain sectors that are responsible for residual or also historical emissions or emissions limited to those occurring after 2050 when the EU should reach net zero. Ultimately, this requires a political choice which will have to be taken in conjunction with similar decisions on the balance between different emissions reduction frameworks (e.g. ETS vs non-ETS, or domestic vs international commitments).

5. Conclusion

Just as no single NET clearly outperforms on all relevant parameters[27], rather than trying to pick or design a single, optimal policy on negative emissions, a combination of measures will likely be the most effective – with the possibility to introduce certain policies in the short term and others more effective in the longer term, when the availability of NETs should be higher. Due to the varying characteristics and technological readiness of different NETs, supporting a wide portfolio of approaches to negative emissions or at least being neutral and open to different technologies when designing policies would be helpful.

Some ways in which negative emissions can be supported simply involve extending existing systems – especially innovation support and state aid – to relevant negative emissions technologies. Some NETs – those using CCS – will also benefit from shared infrastructure, and this could be an extra reason to support CO_2 transport and storage infrastructure.

In the short term, cost reductions through increased economies of scale are important to make negative emissions technologies more competitive. This may require lead markets similar to those discussed in the context of industrial decarbonisation. Direct public support or procurement of an initial volume of negative emissions may be particularly helpful to get the ball rolling. Longer term, the costs of deploying more negative emissions are ideally increasingly borne by the market – even if costs are passed on to consumers. Integration with the existing climate policy frameworks, especially the EU ETS (which is likely to be expanded in sectoral scope) would be attractive to ensure persistent demand for negative emissions. After the ETS cap hits zero in 2040, liquidity in the ETS could be provided by NET units. However, the credibility of the ETS depends on the credibility of its accounting, which is highly accurate. Not all NETs are suitable for inclusion – only those with full permanence are.

Yet, the absence of permanence of negative emissions delivered through nature-based approaches is not disqualifying per se. It just means the right framework should be found. Lack of permanence or reversibility does make it more important to agree on clear rules on liability in the case of reversal of the CO_2 removal. Therefore, accurate monitoring – and improvements therein, for example through better sensors – is important especially with land-based, reversible NETs. Some NETs also do not fit neatly into the natural/technological dichotomy but nevertheless provide potential for delivering increased negative emissions. An EU negative emissions policy should be able to accommodate them. The EU's carbon removal certification mechanism will be essential to addressing these aspects regardless of the type of technology.

While the degree of technological neutrality is, explicitly or implicitly, a political choice, the EU's legislators should be mindful of policies that support specific NET projects versus generally applied policies such as tax breaks. Today, due to the nature of existing policy frameworks, there can be an implicit bias towards nature-based NETs (through LULUCF) and technological

[27] See, e.g. the overview in a study by Umweltbundesamt.

options using CCS (due to the EU ETS). Yet, enhanced weathering, biochar and other NETs can also provide significant negative emissions potential and should not be ignored.

EU climate policy can conceivably lead to competition between conventional emissions reductions and negative emissions technologies (Zetterberg et al., 2021). For example, biomass use can facilitate direct emissions reductions in chemicals, industrial and power processes, but only if combined with CCS will they lead to negative emissions. It thus remains important for EU legislators to consider the balance between (and the impacts triggered by) regular emissions reduction policies – especially in industry and agriculture – and negative emissions policies, and to avoid double counting.

An EU policy for negative emissions should also consider the distributional dimension. This will become a particularly unavoidable question once net-negative emissions need to be achieved. The effort sharing framework could be suitable to share the burden among Member States, while ideas such as a carbon takeback obligation or ETS inclusion could be suitable to place the costs on certain sectors. Still, mandating sectors to procure negative emissions outcomes would be tantamount to higher climate targets for them, which may be politically challenging.

What will be needed in any case is a well-functioning certification mechanism. Beyond the design issues discussed in this policy paper, there are also questions of governance: should the legislation on the mechanism preclude choices on where and how removals should be used or is this better left to the revisions of existing climate frameworks? Should there be delegation with regard to which technologies are eligible? Will it affect the burgeoning voluntary carbon markets?

Fundamental choices on whether to pursue separate targets or prioritise flexibility in meeting climate targets will also affect the incentives for NET deployment, as will any EU decision on Article 6.

The European Parliament and the Council are already pondering these political choices. While the outcome of the legislative processes is yet to be decided, the co-legislators would be well advised to not leave out NET governance altogether when concluding the Fit-for-55 negotiations, so that negative emissions deployment can accelerate in the EU.

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