Pricing agricultural emissions and rewarding climate action in the agri-food value chain

Trinomics

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Pricing agricultural GHG emissions along the agri-food value chain via emissions trading

AgETS study

Executive Summary – PART 1

The objective of the first part of this study is to analyse potential applications of the polluter pays principle towards agricultural greenhouse gas (GHG) emissions at the EU level. The focus of this part is on five options for an Emission Trading System (ETS) that could *incentivise climate mitigation action in agriculture effectively and efficiently*. Part 1 of this study outlines the design aspects of an ETS covering agricultural emissions that are common to all five options, such as governance and administrative aspects, as well as the unique aspects for each option, such as the scope, point of obligation and specific needs for monitoring, reporting, and verification (MRV) of emissions. The ETS options are then assessed according to indicators within the categories of 'effectiveness', 'efficiency', 'relevance', 'coherence', and 'added value'. The results are based on a review of relevant theoretical and empirical literature as well as interviews with experts, and inputs from a stakeholder survey and workshop. Part 2 of this study, "*Linking carbon removals in the land sector to an agricultural Emissions Trading System (AgETS+Removals Study)*", considers how the ETS options analysed in this first part could be extended to financially reward Land Use, Land Use Change, and Forestry (LULUCF) carbon removals.

The current agricultural emissions trajectory warrants the exploration of policy instruments beyond the current climate policy framework for agriculture. Approximately 13.2% of the EU27's total net GHGs can be attributed directly to the agricultural sector (agricultural fuel uses not included). The largest sources of these emissions come from enteric fermentation from livestock, nitrous oxide emissions from soils mainly from the use of synthetic fertilisers, manure management from livestock production, and emissions from organic soils caused by agricultural production on drained peatlands. Current projections show that agricultural emissions will remain stagnant with existing measures, and will go down by approximately 5% with additional measures by 2030, while the land-based net carbon removals are predicted to decrease. To limit the increase of the global mean temperature (GMT) well below 2°C, the EU has committed to net zero emissions by 2050 – meeting this target will require ambitious emission reductions in the agricultural sector.

Stronger incentives could lead to more climate action in EU agriculture. As a common tool to prevent pollution, it is worthwhile to consider applications of the polluter pays principle to address the problem of greenhouse gas emissions in the agricultural sector. These policies can take form in many various policy instruments, including regulations, environmental standards, taxes, environmental liability, and emissions trading. One of the main objectives of the polluter pays principle is to address the problem of negative externalities. Social and environmental costs from the emission of GHGs are not consistently incorporated into the cost structure of the agri-food value chain, and thus are a burden on other market participants, future generations, and the ecosystem. Polluter pays policy options can close the gap between market prices and the true cost of agri-food goods by quantifying and monetizing them.

There are challenges unique to the agricultural sector that need to be taken into consideration in the design of a polluter pays policy. First, the **large number of farms across the EU** (over 9 millions) will make implementing and administering a polluter pays option a complex endeavour. Second, as of date, there is a **lack of consistent usage of on-farm GHG emission MRV tools** across the EU that are needed for the administration of a polluter pays policy. Third, if a polluter pays policy results in reduced production within the EU, the reduction could potentially be substituted by increased production outside the EU where agri-food production is more GHG intensive – this is referred to as '**carbon leakage**.' The corresponding increase in emissions abroad could, at least in part, offset EU emission reductions. Fourth, there is a **lack of economic security for many farmers** in the EU and sustained emphasis on providing income support to farmers has been a major barrier to implementing effective climate policy instruments for the agricultural sector. Lastly, there may be a **reluctance of social acceptance** of the introduction of a polluter pays policy by agri-food stakeholders and marginalised social groups, such as consumers with low incomes due to concerns about cost.

This study considers and incorporates five objectives into the design and assessment of the polluter pays policy options, including:

- minimising the burden of implementation and balance costs and benefits of the system;
- implementing a reliable and cost-effective MRV;
- providing safeguards against carbon leakage;
- providing financial incentives for innovation and changes in agricultural production and supporting farmers in this transition;
- and be inclusive and fair so that no stakeholders or vulnerable social groups feel left behind.

In selecting potential polluter pays policy options, key criteria were considered for a comprehensive set of policy options. This included: whether it should be a quantity-based or a price-based or a hybrid policy; whether the price should be applied directly to GHGs, agricultural inputs or outputs, or specific agricultural activities; the scope of pollution; and who are the obligated 'polluters.' Other criteria for selection included: the feasibility of applying the policy option at the EU-level; data availability on GHG emissions for a particular instrument; whether carbon leakage could be addressed; and whether there were existing empirical examples to better understand potential impacts.

For this study, five emission trading systems (ETS), with variations in the point of obligation and the scope of GHG emissions covered, were selected as potential policy options to analyse. The key advantages of an ETS are that it could induce a change in practices and innovation via price signals, and effective emission reductions can take place where they cause the lowest economic costs. The decision to focus this study on five ETS options was based on legal feasibility as well as regulatory flexibility in the range of mitigation actions that could be incentivised through a carbon pricing policy, both on-farm and up- and downstream.

Based on the above considerations, the five analysed ETS options are as follows:

- **An on-farm ETS for all GHG emissions:** this option includes all greenhouse gas emissions from agriculture in its scope, including net LULUCF emissions from croplands and grasslands (emissions from sources minus removals from sinks). The point of obligation would be all types of farms (arable, livestock, and mixed).
- **An on-farm ETS for livestock emissions only:** this option focuses on emissions from livestock production, specifically from enteric fermentation and manure management. However, the option excludes land use emissions from arable crops grown for feed purposes. The point of obligation would be for livestock and mixed farms.
- **An on-farm ETS for peatlands only:** this option applies to emissions from drained peatlands utilised for agricultural production. The point of obligation would be farms on such lands.
- **An upstream ETS:** this option focuses on emissions from enteric fermentation (feed production and importation), nitrous oxide emissions from soils (use of fertilisers), and urea application

(use of fertilisers). The point of obligation would be for fertiliser producers and feed producers and importers.

- **A downstream ETS:** this option focuses on emissions from enteric fermentation and manure management. The point of obligation would be for meat and dairy processors.

Several cross-cutting aspects were taken into consideration in the design of an agricultural ETS, including: how emission units are to be measured, the process of setting a cap, potential thresholds for participation, regulatory flexibility, use of revenues, price management, governance, administration, operationalisation, and compliance. On energy related agriculture emissions, it was assumed that an application of the polluter pays principle to these emissions could potentially be better addressed by an extension of coverage of the recently adopted fuel combustion based new emissions trading system for buildings, road transport and additional sectors than by coverage by an agricultural ETS. Various approaches to reducing the risk of carbon leakage are taken into consideration, such as the introduction of a Carbon Border Adjustment Mechanism for agri-food goods, free allocation of allowances for a limited time period, and renegotiation of bilateral trade agreements.

An emissions trading system depends on accurate and trusted data on the emissions for which each regulated entity is responsible. This poses a particular challenge for the agriculture sector as there are measurement challenges and GHG inventories rely much more on approximate mechanisms for estimating agricultural emissions than in the case of other sectors. An MRV system must balance cost-effectiveness with environmental integrity to ensure that genuine emission reductions are accomplished whilst balancing the administrative costs of the system.

To balance integrity with cost-effectiveness, this study analyses two approaches that can be combined in practice. The first approach is the **default method**, applying to all regulated entities; this would be a relatively simple standard calculation of emissions, performed through a centrally-managed database, and based on default emission factors and readily identifiable data (for example, livestock numbers, sales of fertiliser). The second approach is the **certified method**. In the certified approach, farms would be able to opt out of the default calculation by volunteering for a more detailed farm level calculation of net emissions at their own expense, with certification by a verified third-party assessor using certification schemes recognised by the Commission (similar to the approach proposed for the Carbon Removals Certification Framework). These certified emissions calculations would reflect climate-friendly management techniques which the default calculation fails to pick up, and would state how the farm's emissions differed from the emissions implied by the default calculation.

To encourage the participation of non-obligated farms in the different policy options, this study recommends that farms that are not required to participate in an ETS (non-obligated parties) would have the opportunity to generate credits based on emission mitigation on their farms – we refer to such participation as the **certified on-farm voluntary credits.** Credits generated by non-obligated parties could be utilised by obligated parties (e.g. downstream processors) to help meet their obligations under an ETS. Having non-obligated farms participate in this way can increase the mitigation potential of each option while offering an opportunity for farms engaging in pro-mitigation behaviour to generate additional income. However, if the emission reductions certified under this approach overlap with the scope of the ETS in place (e.g. if livestock farmers sell credits for the reduction of livestock emissions to downstream meat or dairy processors), then the ETS cap would need to be adjusted accordingly to ensure that the policy is effective for the sector as a whole.

The different ETS policy options explored in this study pose different strengths and weaknesses as tools to effectively and efficiently achieve cost-effective emission reductions in the agricultural sector, while incentivising relevant actors, maintaining coherence with EU legislation, and providing added value compared to similar policies at the Member State or regional level. The selection of a policy option involves certain strengths and trade-offs along the indicators outlined in Table A based on potential positive and negative impacts. In summarising the assessment of the five options, green signifies that the option will potentially have mostly positive impacts for that particular indicator, while red indicates mostly negative impacts, and yellow indicates both positive and negative impacts.

Table A Assessment of the Agricultural ETS options

Criteria	Indicator	All-GHGs ETS	Livestock ETS	Peatlands ETS	Upstream ETS	Downstream ETS
Effectiveness	Incentivise actors along the value chain to mitigate agricultural emissions					
	Biodiversity co-benefits					
	Impacts on consumer budgets and welfare					
	Distributional impacts on Member States					
	Speed/ease of implementation					
	Distributional impacts on farms					
	Stakeholder acceptance					
Efficiency	Impacts on sectoral competitiveness and trade balance					
	Risk of carbon leakage					
	Administrative burden and costs					
Relevance	Incentivise responsible actors to innovate and change practices					
Coherence	Coherence with EU policies					
Added value	EU added value					

The on-farm ETS options have the potential to incentivise the mitigation of agricultural emissions, by providing farmers with a direct price signal to reduce their emissions, in which farmers may be incentivised to either make changes to their inputs (fertilizer use, number of livestock), or adopt new on-farm management practices that can reduce emissions. Indeed, findings from several studies indicate that the market impacts from carbon pricing policies for agriculture substantially affect mitigation outcomes in agriculture. For on-farm mitigation actions, estimates from the literature show that ending intensive practices on organic soils, adopting nitrification inhibitors, precision farming, and higher legume share have high mitigation potential at low costs.

Because the **price signal is not directly applied to farming activities**, the upstream and downstream options have a slightly more moderate incentive for reducing agricultural emission reductions. However, both options present an opportunity to facilitate actions in other areas of the value chain that can impact agricultural emissions. For both off-farm options, farmers can participate in the 'certified on-farm voluntary MRV' approach, which can incentivize a wider range of on-farm mitigation actions. However, the degree to which mitigation actions could be incentivised would depend on how effectively up- and downstream actors pass on the incentives for on-farm mitigation actions as well as whether the financial benefits of selling allowances in an ETS auction outweigh the costs of adopting mitigation actions.

The administrative burden and costs for MRV would be higher for the on-farm options, particularly the all-GHG ETS, due to the sheer number of regulated entities. While de minimis thresholds can potentially reduce the number of entities, there will still be relatively high numbers compared to the off-farm options. The administrative burden for the livestock option would be comparatively lower to the all-GHG option due to the objectively easier to implement measurements of emissions (i.e. use of already existing data), although the number of participants could still be quite high, even with the use of thresholds. While the peatlands option would have less participants compared to the other on-farm options, the costs of MRV could be relatively high per regulated entity for the peatlands option due to the complexity of on-farm monitoring. The use of thresholds for the peatlands ETS may disincentivise collective efforts for re-wetting, and therefore it may not be advisable to introduce them for this option. The burden of administrative costs of a peatlands option will be unevenly distributed across Member States, some Member States will have extremely low (or non-existant) obligations under this option due to lack of peatland soil, while Member States such as Germany will have a higher burden.

The use of proxy measurements could reduce the costs of the on-farm options, as accurate on-farm measurements of GHG emissions will be costly for the all-GHG and peatlands ETS options. For the livestock option, estimates can be based on livestock numbers and can be more accurately measured using additional refinements to data collection. However, while increasing accuracy, further refinement could increase costs. The upstream and downstream options will rely on emission factors rather than direct measures. With the use of conservative emission factors, the use of proxies does not necessarily imply lower environmental integrity. However, default emission factors may have negative consequences for innovation and mitigation decisions.

Even with the use of thresholds, the on-farm options will lack speed and ease of implementation. The livestock option will be comparatively easier to implement than the all-GHG or peatlands option, but the use of thresholds may create perverse incentives for farms to divide their holdings into smaller installations. Comparatively, the upstream and downstream options could ease difficulties associated with the implementation of the on-farm options.

The upstream and downstream options can facilitate a wider whole-value chain approach to addressing agricultural emissions by incentivising both on-farm and off-farm actions and innovations to reduce emissions. An upstream ETS can incentivize innovations in low-emitting feed and fertilisers by altering the composition of the products they manufacture. On the farmers side, increased prices may incentivise more efficient use of feed and fertilisers or switching to lower-emissive products. To reduce costs, the upstream option could facilitate the uptake of more agro-ecological farming practices that would reduce the need for fertilizer inputs. The downstream ETS can incentivize the reduction of consumption of animal products, incentivise innovations in meat replacements, or the substitution of high emissive animal products with lower emission products, or changing the production of food to reduce the product’s final carbon footprint. Similar to the upstream option, individual on-farm mitigation will be incentivised by changes occurring downstream, where demand for less GHG-intensive types of meat or less GHG-intensive crops will shape on-farm production.

New vertical arrangements in agri-food chains could be facilitated through the possibility to generate certified on-farm voluntary credits. This approach could incentivise collaboration between up-and-downstream actors with farms to reduce emissions and enable transitions towards more climate-friendly value chains. Such arrangements could address asymmetric added value distribution within agri-food value chains, by having up- and downstream actors provide financial support for changing production practices on farms through payments for certified on-farm voluntary credits. However, under this approach, the largest farms will benefit from economies of scale. Therefore, the ETS will need to provide opportunities for small- and medium-sized farms to benefit from improved monitoring and e.g. if applicable participate in auctioning through collective groupings, such as a cooperative, similar to the proposed Carbon Removal Certification Framework, so that they may benefit from such opportunities but not face barriers due to administrative costs.

Regarding the point of obligation, the on-farm options and the upstream option received neutral to positive support, while the downstream option was received the most positively among stakeholders that participated in a survey carried out to inform this study (see Table B below). While the majority of stakeholders consulted agree that increased climate ambition for the agricultural sector is needed and that carbon pricing is an effective mechanism to facilitate this, concerns were raised regarding the administrative feasibility and potential negative impacts on farm income for the on-farm options.

Table B Stakeholder Response to Support for Point of Obligation

Response	1 (strongly oppose)	2 (oppose)	3 (neither oppose nor support)	4 (support)	5 (strongly support)	No opinion	Average rating[1]
Food processors (downstream ETS)	6%	4%	17%	20%	43%	10%	4.00
Other actors (e.g., retailers, consumers)	15%	2%	12%	8%	23%	30%	3.48
Fertiliser and feed producers (upstream ETS)	19%	7%	14%	18%	32%	11%	3.40
Farmers (on-farm ETS)	22%	11%	14%	15%	27%	11%	3.17

In moving forward with considering an ETS option for agriculture, combinations of various design aspects of the policy options presented in this study could be taken under consideration. For instance, a processor approach that combines the upstream and downstream points of obligation, or incorporating the largest polluters from the livestock and peatlands options. Such an approach could attempt to maximise the benefits of the design aspects of the policy options presented in this study.

If moving forward with an ETS for agriculture is considered, preliminary actions should be taken to phase-in such a policy. In particular, there would be a need to **establish a harmonised GHG reporting tool** in the EU. Such a tool would need to provide farms with context-specific detailed and up-to-date information on cost-effective high mitigation potential actions. Within the reporting tool, a Decision Support Platform (DSP) should be included to communicate such information in a practical and understandable format. The DSP could provide farms with an action plan to record mitigation practices that will improve the GHG performance of a farm. Advice, support, and training will also be needed to support a DSP. Equitable access and use of these resources will need to be taken into consideration, as

[1] Based on Likert scale rating, ranging from 1=strongly oppose to 5=strongly support.

widespread use could be impeded by the prevailing disparities in terms of internet accessibility, digital literacy, and familiarity among farmers across regions and Member States.

Planning for how to direct transitional aid through the form of subsidies, grants, and loans for farms, would need to take place prior to implementation. Farms will face large upfront costs for investment needed in equipment, changes in management regimes, technology, machinery, etc. The EU might need to provide time-limited financial support to 'de-risk' such upfront costs so that opportunities for transitioning are available for all farms, and not just large farms that can afford such upfront costs. Funds from the Common Agricultural Policy (CAP) could be aligned in a complementary manner with revenues from an ETS. While revenues from an ETS can be utilised for transitional aid once occuring, depending on the availability of CAP funds, other sources at both the EU and Member State level might be needed for a time-limited period. Opportunities for financing from financial institutions will be needed for transitional aid as well, and the further development of risk sharing mechanisms between private and public financing is needed so that small and medium sized farms have access to private financing options.

This exploratory study serves as background analysis for the assessment of an ETS for agriculture (should this be the future policy direction), although many questions still remain open. The study identifies a number of open questions and areas for further research, including:

- The feasibility of a Carbon Border Adjustment Mechanism for agri-food goods due to complexities associated with tracing such goods
- The implications of tariff rate quotas for an agricultural ETS
- The link between evidence of consumer behaviour and theoretical risks of carbon leakage
- The impacts of marketing strategies on willingness of consumers to change consumption behaviour
- Potential distributional impacts across Member States and income groups on consumer budgets and ways to address them
- The broader policy 'mix' needed to facilitate climate mitigation in the agricultural sector

Résumé - Partie 1

L'objectif de la première partie de cette étude est d'analyser les applications potentielles du principe du pollueur-payeur aux émissions agricoles de gaz à effet de serre (GES) au niveau de l'UE. Cette première partie se concentre sur cinq options de système d'échange de quotas d'émission (SEQE) susceptibles d'*encourager les mesures d'atténuation du changement climatique dans l'agriculture de manière efficace et efficiente*. La première partie de cette étude décrit les aspects de la conception d'un SEQE couvrant les émissions agricoles qui sont communs aux cinq options, tels que les aspects administratifs et de gouvernance, ainsi que les aspects propres à chaque option, tels que le champ d'application, le point d'obligation et les besoins spécifiques en matière de surveillance, de déclaration et de vérification (MRV) des émissions. Les options du SEQE sont ensuite évaluées en fonction d'indicateurs relevant des catégories "efficacité", "efficience", "pertinence", "cohérence" et "valeur ajoutée". Les résultats de cette étude sont basés sur une revue de la littérature théorique et empirique pertinente, ainsi que sur des entretiens avec des experts et des contributions provenant d'une enquête et d'un atelier avec les parties prenantes. La deuxième partie de cette étude, "*Linking carbon removals in the land sector to an agricultural Emissions Trading System (AgETS+Removals Study)*", examine comment les options du système d'échange de quotas d'émissions analysées dans cette étude pourraient être étendues pour récompenser financièrement l'absorption du carbone liées à le secteur de l'utilisation des terres, du changement d'affectation des terres et de la foresterie (UTCATF).

La trajectoire actuelle des émissions agricoles justifie l'exploration d'instruments politiques allant au-delà du cadre actuel de la politique climatique pour l'agriculture. Environ 13,2 % des émissions nettes totales de gaz à effet de serre de l'UE27 peuvent être attribuées directement au secteur agricole (les utilisations de combustibles agricoles ne sont pas incluses). Les sources les plus importantes de ces émissions sont la fermentation entérique du bétail, les émissions d'oxyde nitreux des sols provenant principalement de l'utilisation d'engrais synthétiques, la gestion du fumier provenant de la production animale, et les émissions des sols organiques causées par la production agricole sur les tourbières drainées. Les projections actuelles montrent que les émissions agricoles resteront stagnantes avec les mesures existantes et diminueront d'environ 5 % avec des mesures supplémentaires d'ici à 2030, tandis que les absorptions nettes de carbone par les terres devraient diminuer. Pour limiter l'augmentation de la température moyenne mondiale (GMT) bien en dessous de 2°C, l'UE s'est engagée à atteindre un niveau d'émissions nettes nulles d'ici 2050.

Des incitations plus fortes pourraient conduire à une plus grande action en faveur du climat dans l'agriculture de l'UE. En tant qu'outil commun de prévention de la pollution, il est intéressant d'envisager l'application du principe du pollueur-payeur pour résoudre le problème des émissions de gaz à effet de serre dans le secteur agricole. Ces politiques peuvent prendre la forme de nombreux instruments différents, notamment des réglementations, des normes environnementales, des taxes, la responsabilité environnementale et l'échange de droits d'émission. L'un des principaux objectifs du principe du pollueur-payeur est de résoudre le problème des externalités négatives. Les coûts sociaux et environnementaux des émissions de GES ne sont pas systématiquement intégrés dans la structure des coûts de la chaîne de valeur agroalimentaire et pèsent donc sur les autres acteurs du marché, les générations futures et l'écosystème. Les options de la politique du pollueur-payeur peuvent combler l'écart entre les prix du marché et le coût réel des produits agroalimentaires en les quantifiant et en les monétisant.

L'élaboration d'une politique de pollueur-payeur doit tenir compte de certains défis propres au secteur agricole. Tout d'abord, le **grand nombre d'exploitations agricoles dans l'UE** (plus de 9 millions) rendra la mise en œuvre et l'administration d'une option de pollueur-payeur complexe. Deuxièmement, à ce jour, il **n'y a pas d'utilisation cohérente des outils de MRV des émissions de GES dans les exploitations agricoles à** travers l'UE, qui sont nécessaires pour l'administration d'une politique de pollueur-payeur. Troisièmement, si une politique de pollueur-payeur entraîne une réduction de la production au sein de l'UE, cette réduction pourrait être remplacée par une augmentation de la production en dehors de l'UE, où la production agroalimentaire est plus intensive en GES - c'est ce que l'on appelle la "**fuite de carbone**". L'augmentation correspondante des émissions à l'étranger pourrait, au moins en partie, compenser les réductions d'émissions de l'UE. Quatrièmement, **de nombreux agriculteurs** de l'UE manquent **de sécurité économique** et l'accent mis sur l'aide au revenu des agriculteurs a constitué un obstacle majeur à la mise en œuvre d'instruments efficaces de politique climatique pour le secteur agricole. Enfin, les acteurs du secteur agroalimentaire et les groupes sociaux marginalisés, tels que les consommateurs à faibles revenus, peuvent être **réticents à accepter socialement** l'introduction d'une politique du pollueur-payeur en raison de préoccupations liées au coût.

Cette étude prend en compte et intègre cinq objectifs dans la conception et l'évaluation des options de la politique du pollueur-payeur, à savoir

- minimiser la charge de la mise en œuvre et équilibrer les coûts et les avantages du système ;
- la mise en œuvre d'un MRV fiable et rentable ;
- fournir des garanties contre les fuites de carbone ;
- fournir des incitations financières à l'innovation et aux changements dans la production agricole et soutenir les agriculteurs dans cette transition ;
- et être inclusifs et équitables afin qu'aucune partie prenante ni aucun groupe social vulnérable ne se sente exclu.

Lors de la sélection des options potentielles de politique de pollueur-payeur, des critères clés ont été pris en compte pour un ensemble complet d'options politiques. Il s'agissait notamment de déterminer s'il devait s'agir d'une politique fondée sur les quantités ou sur les prix ou d'une politique hybride; si le prix devait être appliqué directement aux GES, aux intrants ou aux extrants agricoles ou bien à des activités agricoles spécifiques; quelle était l'ampleur de la pollution et qui étaient les "pollueurs" obligés. Parmi les autres critères de sélection figuraient la faisabilité de l'application de l'option politique au niveau de l'UE, la disponibilité de données sur les émissions de GES pour un instrument particulier, la possibilité de remédier aux fuites de carbone et l'existence d'exemples empiriques permettant de mieux comprendre les incidences potentielles.

Pour cette étude, cinq options du SEQEs, avec des variations dans le point d'obligation et l'étendue des émissions de GES couvertes, ont été sélectionnés comme options politiques potentielles à analyser. Les principaux avantages d'un système d'échange de quotas d'émission sont qu'il peut induire un changement dans les pratiques et l'innovation par le biais de signaux de prix, et que les réductions d'émissions effectives peuvent avoir lieu là où elles entraînent les coûts économiques les plus faibles. La décision de centrer cette étude sur cinq options du SEQE a été prise en raison de la faisabilité juridique et de la souplesse réglementaire de l'éventail des mesures d'atténuation qui pourraient être encouragées par une politique de tarification du carbone, tant dans les exploitations agricoles qu'en amont et en aval.

Sur la base des considérations ci-dessus, les cinq options analysées pour le système d'échange de quotas d'émission sont les suivantes :

- **Un système d'échange de quotas d'émission à l'échelle de l'exploitation pour toutes les émissions de GES :** cette option inclut toutes les émissions de gaz à effet de serre provenant de l'agriculture dans son champ d'application, y compris les émissions nettes de l'UTCATF provenant des terres cultivées et des prairies (émissions provenant des sources moins l'absorption par les puits). Le point d'obligation serait tous les types d'exploitations agricoles (cultures, élevage et exploitations mixtes).
- **Un système d'échange de quotas d'émission au niveau de l'exploitation pour les émissions du bétail uniquement :** cette option se concentre sur les émissions provenant de la production animale, en particulier de la fermentation entérique et de la gestion du fumier. Elle exclut toutefois les émissions liées à l'utilisation des terres provenant des cultures arables destinées à l'alimentation animale. Le point d'obligation serait pour les exploitations d'élevage et les exploitations mixtes.
- **Un système d'échange de quotas d'émission au niveau de l'exploitation pour les tourbières uniquement :** cette option s'applique aux émissions provenant des tourbières drainées utilisées pour la production agricole. Le point d'obligation serait les exploitations agricoles situées sur ces terres.
- **Un système d'échange de quotas d'émission en amont :** cette option se concentre sur les émissions provenant de la fermentation entérique (production et importation d'aliments pour animaux), les émissions d'oxyde nitreux provenant des sols (utilisation d'engrais) et l'épandage d'urée (utilisation d'engrais). Le point d'obligation serait pour les producteurs d'engrais et les producteurs et importateurs d'aliments pour animaux.
- **Un système d'échange de quotas d'émission en aval :** cette option se concentre sur les émissions provenant de la fermentation entérique et de la gestion du fumier. Le point d'obligation serait pour les transformateurs de viande et de produits laitiers.

Plusieurs aspects transversaux ont été pris en considération dans la conception d'un système d'échange de quotas d'émission pour l'agriculture, notamment : la manière dont les unités d'émission doivent être mesurées, le processus de fixation d'un plafond, les seuils potentiels de participation, la flexibilité réglementaire, l'utilisation des revenus, la gestion des prix, la gouvernance, l'administration, l'opérationnalisation et le respect de la législation. En ce qui concerne les émissions agricoles liées à l'énergie, il a été supposé que l'application du principe du pollueur-payeur à ces émissions pourrait être mieux traitée par une extension de la couverture du nouveau SEQE basé sur l'allumage de combustibles, récemment adopté pour les bâtiments, le transport routier et d'autres secteurs, que par la couverture d'un SEQE pour l'agriculture. Diverses approches visant à réduire le risque de fuite de carbone sont prises en considération, telles que l'introduction d'un mécanisme d'ajustement frontalier du carbone pour les produits agroalimentaires, l'allocation gratuite de quotas pour une période limitée et la renégociation des accords commerciaux bilatéraux.

Un système d'échange de quotas d'émission dépend de données précises et fiables sur les émissions dont chaque entité réglementée est responsable. Cela représente un défi particulier pour le secteur agricole où les difficultés de mesuration et les inventaires de GES reposent beaucoup plus sur des mécanismes approximatifs pour estimer les émissions comparé à d'autres secteurs. Un système MRV doit trouver un équilibre entre la rentabilité et l'intégrité environnementale afin de garantir de véritables réductions d'émissions tout en équilibrant les coûts administratifs du système.

Pour concilier intégrité et rentabilité, cette étude analyse deux approches qui peuvent être combinées dans la pratique. La première approche est la **méthode par défaut**, qui s'applique à toutes les entités réglementées. Il s'agirait d'un calcul standard relativement simple des émissions, effectué à l'aide d'une base de données gérée de manière centralisée et basé sur des facteurs d'émission par défaut et des données facilement identifiables (par exemple, le nombre de têtes de bétail, les ventes d'engrais). La deuxième approche est la **méthode certifiée**. Dans le cadre de cette méthode, les exploitations agricoles pourraient renoncer au calcul par défaut en se portant volontaires pour effectuer, à leurs frais, un calcul plus détaillé des émissions nettes au niveau de l'exploitation, avec certification par un évaluateur tiers vérifié utilisant des systèmes de certification reconnus par la Commission (similaire à l'approche proposée pour le cadre de certification des réductions d'émissions de carbone). Ces calculs certifiés des émissions refléteraient les techniques de gestion respectueuses du climat que le calcul par défaut ne prend pas en compte, et indiqueraient en quoi les émissions de l'exploitation diffèrent des émissions impliquées par le calcul par défaut.

Afin d'encourager la participation des exploitations agricoles non déjà soumises aux obligations des différentes options politiques, cette étude recommande que les exploitations agricoles qui ne sont pas tenues de participer à un système d'échange de quotas d'émission (parties non obligées) aient la possibilité de générer des crédits sur la base de l'atténuation des émissions dans leurs exploitations - nous appelons cette participation les **crédits volontaires certifiés dans les exploitations agricoles.** Les crédits générés par les parties non obligées pourraient être utilisés par les parties obligées (par exemple, les transformateurs en aval) pour les aider à remplir leurs obligations dans le cadre d'un système d'échange de quotas d'émission. La participation des exploitations agricoles non obligées peut augmenter le potentiel d'atténuation de chaque option tout en offrant aux exploitations agricoles qui adoptent un comportement favorable à l'atténuation la possibilité de générer des revenus supplémentaires. Toutefois, si les réductions d'émissions certifiées dans le cadre de cette approche coïncident avec le champ d'application du SEQE en place (par exemple, si les éleveurs vendent des crédits pour la réduction des émissions du bétail aux transformateurs de viande ou de produits laitiers en aval), le plafond du SEQE devra être ajusté en conséquence, afin de garantir l'efficacité de la politique pour l'ensemble du secteur.

Les différentes options politiques du SEQE explorées dans cette étude présentent des forces et des faiblesses différentes en tant qu'outils permettant d'atteindre de manière efficace et efficiente des réductions d'émissions rentables dans le secteur agricole, tout en incitant les acteurs concernés, en maintenant la cohérence avec la législation de l'UE et en apportant une valeur ajoutée par rapport à des politiques similaires au niveau de l'État membre ou de la région. La sélection d'une option politique implique certains points forts et compromis en fonction des indicateurs décrits dans le tableau A, sur la base des impacts positifs et négatifs potentiels. En résumant l'évaluation des cinq options, le vert signifie que l'option aura potentiellement des impacts principalement positifs pour cet indicateur particulier, tandis que le rouge indique des impacts principalement négatifs, et le jaune indique des impacts à la fois positifs et négatifs.

Tableau A Évaluation des options du SCEQE agricole

Critères	Indicateur	Tous les GES ETS	SCEQE pour le bétail	SCEQE pour les tourbières	Système d'échange de quotas d'émission en amont	Système d'échange de quotas d'émission en aval
Efficacité	Inciter les acteurs de la chaîne de valeur à réduire les émissions agricoles					
	Co-bénéfices de la biodiversité					
	Impacts sur les budgets et le bien-être des consommateurs					
	Impacts distributifs sur les États membres					
	Rapidité/facilité de mise en œuvre					
	Impacts distributifs sur les exploitations agricoles					
	Acceptation des parties prenantes					
Efficacité	Impacts sur la compétitivité sectorielle et la balance commerciale					
	Risque de fuite de carbone					
	Charge administrative et coûts					
Pertinence	Inciter les acteurs responsables à innover et à modifier leurs pratiques					
Cohérence	Cohérence avec les politiques de l'UE					
Valeur ajoutée	Valeur ajoutée de l'UE					

Les options du système d'échange de quotas d'émission au niveau de l'exploitation ont le potentiel d'encourager l'atténuation des émissions agricoles, en fournissant aux agriculteurs un signal de prix direct pour réduire leurs émissions, ce qui peut inciter les agriculteurs à modifier leurs intrants (utilisation d'engrais, nombre de têtes de bétail) ou à adopter de nouvelles pratiques de gestion au niveau de l'exploitation qui peuvent réduire les émissions. En effet, les conclusions de plusieurs études indiquent que les effets sur le marché des politiques de tarification du carbone pour l'agriculture affectent considérablement les résultats en matière d'atténuation dans l'agriculture. En ce qui concerne les mesures d'atténuation au niveau de l'exploitation, les estimations tirées de la littérature montrent que l'arrêt des pratiques intensives sur les sols organiques, l'adoption d'inhibiteurs de nitrification, l'agriculture de précision et l'augmentation de la part des légumineuses ont un fort potentiel d'atténuation à bas coût.

Étant donné que le **signal de prix n'est pas directement appliqué aux activités agricoles**, les options en amont et en aval ont une incitation légèrement plus modérée à la réduction des émissions agricoles. Toutefois, les deux options offrent la possibilité de faciliter les actions dans d'autres domaines de la chaîne de valeur qui peuvent avoir une incidence sur les émissions agricoles. Pour les deux options hors exploitation, les agriculteurs peuvent participer au "MRV volontaire certifié sur l'exploitation", ce qui peut encourager un plus large éventail de mesures d'atténuation sur l'exploitation. Toutefois, le degré d'incitation des mesures d'atténuation dépend de l'efficacité avec laquelle les acteurs en amont et en aval répercutent les incitations pour les mesures d'atténuation au niveau de l'exploitation, ainsi que de la question de savoir si les avantages financiers de la vente de quotas dans le cadre d'une vente aux enchères du SCEQE l'emportent sur les coûts liés à l'adoption de mesures d'atténuation.

La charge administrative et les coûts du MRV seraient plus élevés pour les options sur l'exploitation, en particulier le système d'échange de quotas d'émission de gaz à effet de serre, en raison du nombre élevé d'entités réglementées. Bien que les seuils de minimis puissent potentiellement réduire le nombre d'entités, ce nombre restera relativement élevé par rapport aux options hors agriculture. La charge administrative de l'option "élevage" serait comparativement moins lourde que celle de l'option "tous GES" en raison des mesures d'émissions objectivement plus faciles à mettre en œuvre (c'est-à-dire l'utilisation de données déjà existantes), bien que le nombre de participants puisse encore être assez élevé, même avec l'utilisation de seuils. Alors que l'option des tourbières compterait moins de participants que les autres options sur l'exploitation, les coûts du MRV pourraient être relativement élevés par entité réglementée pour l'option des tourbières en raison de la complexité du suivi sur l'exploitation. L'utilisation de seuils pour le SEQE pour les tourbières peut décourager les efforts collectifs pour la ré-humidification, et il n'est donc pas conseillé de les introduire pour cette option. La charge des coûts administratifs de l'option relative aux tourbières sera inégalement répartie entre les États membres ; certains États membres auront des obligations extrêmement faibles (voire inexistantes) dans le cadre de cette option en raison de l'absence de tourbières, tandis que des États membres tels que l'Allemagne auront une charge plus lourde.

L'utilisation de mesures indirectes pourrait réduire les coûts des options relatives aux exploitations agricoles, étant donné que des mesures précises des émissions de GES dans les exploitations agricoles seront coûteuses pour les options "tous GES" et "tourbières" du système d'échange de quotas d'émission. Pour l'option "élevage", les estimations peuvent être basées sur le nombre de têtes de bétail et peuvent être mesurées avec plus de précision en affinant la collecte des données. Toutefois, tout en améliorant la précision, ces améliorations pourraient augmenter les coûts. Les options en amont et en aval s'appuieront sur des facteurs d'émission plutôt que sur des mesures directes. Grâce à l'utilisation de facteurs d'émission prudents, l'utilisation d'approximations n'implique pas nécessairement une moindre intégrité environnementale. Toutefois, les facteurs d'émission par défaut peuvent avoir des conséquences négatives sur les décisions en matière d'innovation et d'atténuation.

Même avec l'utilisation de seuils, les options sur l'exploitation manqueront de rapidité et de facilité de mise en œuvre. L'option "élevage" sera comparativement plus facile à mettre en œuvre que l'option "tous GES" ou l'option "tourbières", mais l'utilisation de seuils peut créer des incitations perverses pour les exploitations agricoles à diviser leurs exploitations en installations plus petites. Par comparaison, les options en amont et en aval pourraient atténuer les difficultés liées à la mise en œuvre des options au niveau de l'exploitation.

L'utilisation de mesures indirectes pourrait réduire les coûts des options relatives aux exploitations agricoles, étant donné que des mesures précises des émissions de GES dans les exploitations agricoles seront coûteuses pour les options "tous GES" et "tourbières" du système d'échange de quotas d'émission. Pour l'option "élevage", les estimations peuvent être basées sur le nombre de têtes de bétail et peuvent être mesurées avec plus de précision en affinant la collecte des données. Toutefois, tout en améliorant la précision, ces améliorations pourraient augmenter les coûts. Les options en amont et en aval s'appuieront sur des facteurs d'émission plutôt que sur des mesures directes. Grâce à l'utilisation de facteurs d'émission prudents, l'utilisation d'approximations n'implique pas nécessairement une moindre

intégrité environnementale. Toutefois, les facteurs d'émission par défaut peuvent avoir des conséquences négatives sur les décisions en matière d'innovation et d'atténuation.

Les options en amont et en aval peuvent faciliter une approche plus large de la chaîne de valeur pour lutter contre les émissions agricoles en encourageant les actions et les innovations dans les exploitations et en dehors de celles-ci pour réduire les émissions. Un système d'échange de quotas d'émission en amont peut encourager les innovations dans le domaine des aliments pour animaux et des engrais à faible taux d'émission en modifiant la composition des produits qu'ils fabriquent. Du côté des agriculteurs, l'augmentation des prix peut inciter à une utilisation plus efficace des aliments pour animaux et des engrais ou à l'adoption de produits moins émissifs. Pour réduire les coûts, l'option en amont pourrait faciliter l'adoption de pratiques agricoles plus agro-écologiques qui réduiraient les besoins en engrais. Le système d'échange de quotas d'émission en aval peut encourager la réduction de la consommation de produits d'origine animale, les innovations en matière de remplacement de la viande, le remplacement des produits d'origine animale à forte émission par des produits à plus faible émission, ou la modification de la production d'aliments afin de réduire l'empreinte carbone finale du produit. Comme dans le cas de l'option en amont, l'atténuation individuelle dans les exploitations sera encouragée par les changements survenant en aval, où la demande de types de viande ou de cultures à moindre intensité de GES influencera la production dans les exploitations.

De nouveaux accords verticaux dans les chaînes agroalimentaires pourraient être facilités par la possibilité de générer des crédits volontaires certifiés dans les exploitations. Cette approche pourrait encourager la collaboration entre les acteurs en amont et en aval et les exploitations agricoles afin de réduire les émissions et de permettre la transition vers des chaînes de valeur plus respectueuses du climat. Ces dispositions pourraient remédier à la répartition asymétrique de la valeur ajoutée au sein des chaînes de valeur agroalimentaires, en faisant en sorte que les acteurs en amont et en aval apportent un soutien financier à la modification des pratiques de production dans les exploitations agricoles par le biais de paiements pour des crédits volontaires certifiés dans les exploitations. Toutefois, dans le cadre de cette approche, les plus grandes exploitations bénéficieront d'économies d'échelle. Par conséquent, le système d'échange de quotas d'émission devra permettre aux petites et moyennes exploitations de bénéficier d'un meilleur suivi et, le cas échéant, de participer à la vente aux enchères par l'intermédiaire de groupements collectifs, tels que les coopératives, à l'instar du cadre proposé pour la certification de l'absorption du carbone, afin qu'elles puissent bénéficier de ces possibilités sans être confrontées à des obstacles liés aux coûts administratifs.

En ce qui concerne le point d'obligation, les options sur l'exploitation et l'option en amont ont reçu un soutien neutre à positif, tandis que l'option en aval a reçu l'accueil le plus favorable parmi les parties prenantes qui ont participé à une enquête réalisée pour étayer la présente étude (voir le tableau B ci-dessous). Bien que la majorité des parties prenantes consultées conviennent qu'il est nécessaire d'accroître l'ambition climatique du secteur agricole et que la tarification du carbone est un mécanisme efficace pour faciliter cette ambition, des préoccupations ont été exprimées quant à la faisabilité administrative et aux incidences négatives potentielles sur le revenu des exploitations pour les options sur l'exploitation.

Tableau B Réponse des parties prenantes au soutien apporté au point d'obligation

Réponse	1 (fortement opposé)	2 (s'opposer)	3 (ne s'oppose pas et ne soutient pas)	4 (soutien)	5 (fortement en faveur)	Pas d'avis	Note moyenne[2]
Transformateurs de denrées alimentaires (en aval du système d'échange de quotas)	6%	4%	17%	20%	43%	10%	4.00
Autres acteurs (par exemple, détaillants, consommateurs)	15%	2%	12%	8%	23%	30%	3.48
Producteurs d'engrais et d'aliments pour animaux (système d'échange de quotas d'émission en amont)	19%	7%	14%	18%	32%	11%	3.40
Agriculteurs (ETS à la ferme)	22%	11%	14%	15%	27%	11%	3.17

Dans le cadre de l'examen d'un système d'échange de quotas d'émission pour l'agriculture, des combinaisons de divers aspects des options stratégiques présentées dans cette étude pourraient être prises en considération. Par exemple, une approche processeur qui combine les points d'obligation en amont et en aval, ou l'intégration des plus gros pollueurs dans les options élevage et tourbières. Une telle approche pourrait tenter de maximiser les avantages des aspects de la conception des options politiques présentées dans cette étude.

Si la mise en place d'un système d'échange de quotas d'émission pour l'agriculture est envisagée, des mesures préliminaires devraient être prises pour mettre en œuvre progressivement une telle politique. Il serait notamment nécessaire de **mettre en place un outil harmonisé de déclaration des émissions de gaz à effet de serre** dans l'UE. Cet outil devrait fournir aux exploitations agricoles des informations détaillées et actualisées, spécifiques au contexte, sur les mesures rentables à fort potentiel d'atténuation. L'outil de déclaration devrait comporter une plate-forme d'aide à la décision (PAD) permettant de communiquer ces informations dans un format pratique et compréhensible. La plateforme d'aide à la décision pourrait fournir aux exploitations agricoles un plan d'action pour enregistrer les pratiques d'atténuation qui amélioreront la performance de l'exploitation en matière de GES. Des conseils, un soutien et une formation seront également nécessaires pour soutenir un DSP. L'accès et l'utilisation équitables de ces ressources devront être pris en considération, étant donné qu'une utilisation généralisée pourrait être entravée par les disparités existantes en termes d'accessibilité à l'internet, de culture numérique et de familiarité des agriculteurs dans les régions et les États membres.

La planification de l'orientation de l'aide transitoire sous forme de subventions, d'allocations et de prêts pour les exploitations agricoles devrait avoir lieu avant la mise en œuvre. Les exploitations agricoles devront faire face à des coûts initiaux importants pour les investissements nécessaires en matière d'équipement, de changements dans les régimes de gestion, de technologie, de machines, etc. L'UE pourrait être amenée à fournir une aide financière limitée dans le temps afin de réduire les risques liés à ces coûts initiaux, de manière à ce que toutes les exploitations puissent bénéficier des possibilités de transition, et pas seulement les grandes exploitations qui peuvent se permettre ces coûts initiaux. Les fonds de la politique agricole commune (PAC) pourraient être alignés de manière complémentaire sur les recettes d'un système d'échange de quotas d'émission. Si les recettes du système d'échange de quotas d'émission peuvent être utilisées pour l'aide transitoire, en fonction de la

[2] Basé sur une échelle de Likert, allant de 1=tout à fait contre à 5=tout à fait pour.

disponibilité des fonds de la PAC, d'autres sources, tant au niveau de l'UE que des États membres, pourraient être nécessaires pour une période limitée dans le temps. Des possibilités de financement par les institutions financières seront également nécessaires pour l'aide transitoire, et le développement de mécanismes de partage des risques entre le financement privé et public est nécessaire pour que les petites et moyennes exploitations agricoles aient accès aux options de financement privé.

Cette étude exploratoire sert d'analyse de fond pour l'évaluation d'un système d'échange de quotas d'émission pour l'agriculture (si telle était l'orientation politique future), bien que de nombreuses questions restent ouvertes. L'étude identifie un certain nombre de questions ouvertes et de domaines nécessitant des recherches plus approfondies, notamment :

- La faisabilité d'un mécanisme d'ajustement carbone aux frontières pour les produits agroalimentaires en raison des complexités liées au traçage de ces produits;
- Les implications des contingents tarifaires pour un système d'échange de quotas agricoles;
- Le lien entre les preuves du comportement des consommateurs et les risques théoriques de fuite de carbone;
- L'impact des stratégies de marketing sur la volonté des consommateurs de modifier leur comportement de consommation;
- Incidences potentielles de la répartition entre les États membres et les groupes de revenus sur les budgets des consommateurs et moyens d'y remédier;
- Le "mix" politique plus large nécessaire pour faciliter l'atténuation des effets du changement climatique dans le secteur Agricole.

1. Policy rationale

1.1. Introduction

To limit the global mean temperature increase below 2°C, it will be essential to reduce agricultural emissions, as it is a significant emitter of greenhouse gases (GHGs).

Through the European Climate Law, the EU has set a goal of reducing emissions by at least 55% by 2030 and a target of climate neutrality by 2050. The EU has developed an overarching policy framework for achieving these emissions reductions. Of particular relevance for agriculture is the recently revised reduction target under the Effort Sharing Regulation of -40% by 2030 for sectors not covered under the EU ETS, which includes agriculture. In addition, the recently revised Land Use, Land Use Change, and Forestry (LULUCF) Regulation sets an EU-wide target for increasing the net sink to -310 $MtCO_2e$ by 2030, which will require emission reductions from land used for agriculture, particularly land used for croplands (both organic and mineral soils) as well as grasslands utilised for grazing livestock. Furthermore, for the revised LULUCF Regulation, the Commission had proposed that as from 2031 emissions from agriculture that are currently considered to fall within the effort sharing sector would be included in the scope of the LULUCF Regulation, and a target for climate neutrality in the AFOLU (agriculture, forestry and other land use) sector was proposed for 2035.[3] In addition, the most recent funding periods (2014-2020 and 2023-2027) for the Common Agricultural Policy (CAP) have specified climate mitigation as a strategic objective, for which the Commission evaluates the performance of the policy. For the new funding period, 40% of the CAP budget should be climate-relevant: At least 25% of the budget in the first pillar will be allocated to eco-schemes, and at least 35% of funds in the second pillar will be allocated to measures supporting climate, biodiversity, environment, and animal welfare. A number of Directives, including the Industrial Emissions Directive, the Soil Monitoring Law, the Carbon Removal Certification Framework, and strategies, such as the Farm to Fork Strategy, will have implications for emissions reductions in the agricultural sector as well.

The objective of this study is to propose potential applications of the polluter pays principle towards agricultural GHG emissions. As a form of the polluter pays principle, carbon pricing measures can induce a change in practices and innovation that can reduce emissions. As will be outlined below, sufficient mitigation options are available to farmers, as well as upstream and downstream operators. Incentives to adopt such options can be facilitated by price signals.

1.2. Agriculture emissions facts

Table 1 shows an overview of the sources and types of GHG emissions in the agriculture sector.

Table 1 Source of emissions and type of greenhouse gas

Source of Emissions	GHG		
	CH_4	N_2O	CO_2
Cropland emissions from organic soils	x	x	x
Cropland emissions from mineral soils			x
Grasslands			x

[3] However, during the ordinary legislative procedure, the Parliament and Council did not retain this provision on the post-2030 system. In this respect, it was agreed that the Commission will look at regulatory options to address agricultural emission when making a new legislative proposal to review the LULUCF Regulation after 2030.

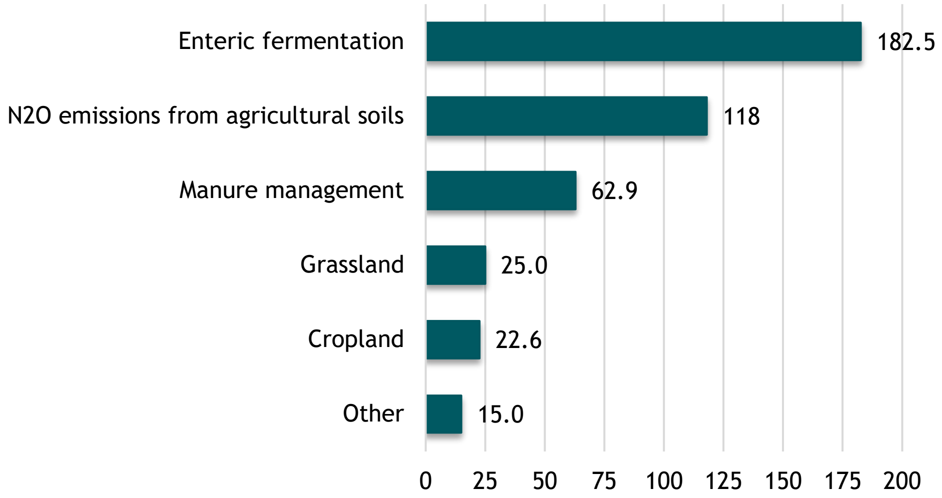
Burning crop residues	x	x	
Crop residues		x	
Enteric fermentation	x		
Nitrous oxide emissions from agricultural soils		x	
Manure management	x	x	
On-farm energy use	x	x	x
Urea[4] application	x	x	x
Liming[5]			x
Rice farming	x		
Other carbon-containing fertilisers			x

According to the EEA (2023), approximately 13.2% of total net GHG emissions of the EU-27 in 2021 can be directly attributed to the agricultural sector as defined in the emission inventories. This estimate accounts for the key sources of agricultural emissions, including enteric fermentation, manure management, N_2O emissions from managed soils (CRF category 3., accounting for 11,7% of total net emissions), and relevant LULUCF net emissions, mainly CO_2 net emissions from cropland and grassland use[6] (CRF categories 4.B and 4.C, accounting for 1.5% of the total net emissions). Emissions from energy use in agricultural production are not included in this estimate, as inventory data under the energy sector is only available in aggregate for energy consumption in agriculture, forestry and fisheries (CRF category 1.A.4c). These sources were together responsible for app. 2.4% of total EU-27 GHG net emissions in 2021 (this excludes indirect energy emissions, e.g. from the highly energy-intensive production of fertilisers, pesticides and agricultural machinery). It should be noted that this estimate does not account for the embedded emissions of agricultural inputs such as e.g. imported animal feed.

GHGs emitted from agricultural activities include both CO_2 emissions and non-CO_2 emissions, mainly methane (CH_4) and nitrous oxide (N_2O). In the EU, GHG accounting from agriculture is governed by two separate pillars, with emissions calculated separately, depending on the source. The first pillar, under the Effort Sharing Regulation (ESR), governs non- CO_2 emissions (CH_4 and N_2O) and CO_2 emissions related to agricultural energy use, as well as liming, urea application and other carbon-containing fertilisers. The second pillar, under the LULUCF Regulation, governs CO_2 emissions from land use and calculates net sources and sinks from land use that includes both emissions and removals from land use in the agricultural sector (namely croplands and grasslands). According to data from the EEA (2023), most emissions from this sector come from enteric fermentation (CH_4), N_2O emissions from soils, and manure management (CH_4 and N_2O) (see Figure 1). Over the last decade, the agricultural sector has not further reduced its GHG emissions, however increasing production efficiencies have led to reduced GHG emissions per unit produced. This is largely attributed to increasing agricultural production since the 1970s. According to Bennetzen et al (2015), agricultural production and greenhouse gas emissions have been steadily decoupled in recent decades, with GHG emissions per unit product declining by 39% for crop production and by 44% for livestock production.

[4] a white crystalline solid containing 46 percent nitrogen as an animal feed additive and fertilizer
[5] the application (to soil) of calcium- and magnesium-rich materials in various forms, including marl, chalk, limestone, burnt lime or hydrated lime. In acid soils, these materials react as a base and neutralize soil acidity
[6] It should be noted that there are differences in how Member States define grasslands and report related emissions, with some countries including unmanaged grassland and woody vegetation which does not meet the definitions of forest land within scope.

Figure 1 EU agricultural emissions by source in 2021 (in MtCO2e)[7]



Note: the 'other' category includes emissions from rice cultivation (CRF 3.C), liming (CRF 3.G), urea application (CRF 3.H), other carbon-containing fertilisers (CRF 3.I), burning crop residues (CRF 3.F), and other agricultural emissions (CRF 3.J). As noted above, emissions from on-farm energy use are accounted for under 'energy use' together in one category of Agriculture/Forestry/Fishing, and have therefore not been included.

Half of the GHG emissions from agriculture (CRF 3) in the EU come from only four Member States: France, Germany, Spain, and Poland (EEA Dataviewer 2023). Within Member States, the sector's share of GHG emissions varies, with the agricultural sector accounting for the largest share of emissions in Ireland (33.1%), Lithuania (30.5%), Romania (29%), Denmark (26.1%), and the lowest share in Malta (4.1%), Czechia (6.2%) and Slovakia (7.2%) (ibid).

Non-CO_2 emissions from agriculture

Enteric fermentation: 182.5 $MtCO_2e$

According to the EPA (2014), enteric fermentation is fermentation that takes place in the digestive systems of animals. In particular, ruminant animals (cattle, buffalo, sheep, goats) have a large "fore-stomach," or rumen, within which microbial fermentation breaks down food into soluble products that can be utilized by the animal. The microbial fermentation that occurs in the rumen enables ruminant animals to digest coarse plant material that monogastric animals cannot digest. Methane is produced in the rumen by bacteria as a by-product of the fermentation process. As of 2021, 79% of EU-27 agricultural methane emissions are from enteric fermentation, : 85% of total enteric methane comes from cattle (beef and dairy); 9% comes from sheep, 2% from swine, and 3% from other livestock (EEA Dataviewer 2021).

According to the guidance to Member States for the update of the 2021-2030 National Energy and Climate Plans (NECPs)[8], practices to reduce methane emissions from enteric fermentation should focus on incentives for breeding to reduce methane intensity, for improving health and fertility (vaccinations, hygiene practices, mobility management, treatments for illness, etc.) for optimising feed management and use of pastures/grazing, and using appropriate feed additives. There is no clear-cut conclusion as

[7] Emissions from on-farm energy use have not been reflected on the chart, as they are reported on by Member States in aggregate under one category of Agriculture/Forestry/Fishing (CRF 1.A.4.c). The combined emissions across the three sectors amounted to 77 $MtCO_2e$.

[8] Ricardo (2023). Guidance to Member States in improving the contribution of land-use, forestry and agriculture to enhance climate, energy and environment ambition.

to the climate impacts of transitioning from intensive livestock production to extensive production, or vice versa. Most LCA studies find that organically reared cattle emit more emissions per kg of meat or milk produced per capita than their conventional counterparts, largely because of the amount of meat that is obtained for a given quantity of emissions or land used. For example, the FAO's Livestock Long Shadow report (2015) calculates that intensive livestock systems contribute 5% to global GHG emissions, while extensive systems account for 13% of the total.

While intensive production requires less land than extensive production, the type of land required is different. Feed for intensive production is produced on arable land that could be used to grow food for humans – approximately 60% of EU cereal production is used in animal feed (Westhoek et al 2011). Approximately 65-70 million hectares of arable land is needed to produce feed from cereals and forage for the EU livestock sector (ibid). About one third of this arable land is used to feed animals in the dairy sector (ibid). This suggests that reducing livestock numbers would reduce demand for feed and would make more land available for growing human food, which in turn would lead to lower prices which is good for consumer food security (LEAP, N.D.). Sandstroem et al (2022) estimate that replacing food-competing feedstuff with food system by-products and residues could free up enough land to increase the current global food supply by 13% in terms of kcal and 15% in terms of protein content. In contrast, much but not all extensive livestock production occurs on grasslands that is not suitable for arable crops (Broderick 2018). According to Cheng et al (2022), a global shift by 12% from monogastric to ruminant livestock could reduce GHG emissions by 5%; this is mainly because monogastric livestock requires more grain feed with substantial land use change implications and conversion from forest to croplands, which could lead to exacerbating biodiversity loss and threaten valuable carbon sinks. The output from released cropland could feed up to 525 million people worldwide (ibid).

Downstream and upstream actors can also impact emissions by exercising leverage along the value chain, with consequences for the supply and demand for high GHG intensity food products. Food processors and retailers can play a large role in driving food demand through marketing strategies, product portfolio diversification and product reformulation, promoting a shift in consumption from beef and dairy to less GHG intensive types of meats, alternative protein, or to more vegetables and starchy foods. The significance of impacting consumer choices is highlighted in the Commission's Guidance (2022) for Member States updating their NECP proposals, which recommends the promotion of more sustainable diets with less red and processed meat and more plant-based protein sources as a measure to reduce methane emissions from agriculture. Downstream actors can also encourage on-farm emission reductions through supplier programs supporting innovation and offering price incentives for farmers to employ practices reducing the GHG intensity of their meat and dairy production. Upstream agri-food chain actors, such as animal feed producers, can impact livestock emissions through product formulation, e.g by developing and integrating feed additives which reduce emissions from enteric fermentation.

N_2O emissions from agricultural soils: 118 $MtCO_2e$

N_2O emissions from soils are mainly related to the use of synthetic fertilisers as well as manure spreading. In agricultural systems, N_2O is primarily produced through two microbial pathways: nitrification, which converts ammonium (NH_4^+) to NO_3^-, and denitrification, which converts NO_3^- to N_2. Both processes produce N_2O as a by-product and can occur simultaneously in soil (Zhu et al 2013). N_2O

emissions from soil can vary according to different bio-physical characteristics, in particular the level of moisture in soil[9], which can play a large role in determining how much N_2O is emitted from soil.

The best way to reduce these emissions is to optimize the process of fertilisation (known as fertiliser management practices). This is understood as a precise selection of the fertiliser dose. The dose selection is closely related to the application of fertilisers. To minimize the dose and GHG emissions, these fertiliser dose solutions primarily reduce the time of contact between fertilisers and air by their covering by soil shortly after application in the field or their application directly into the soil. Using this method, emissions can be reduced between 13% (Smith et al 2012) and 20% (Roe et al 2021). Fertiliser use efficiency can also be enhanced through variable-rate application. The development and roll-out of remote sensing techniques for the monitoring of nitrogen concentrations in crop tissues can enable increasingly targeted applications of fertiliser in terms of timing, area, and quantity. Developers and manufacturers of agricultural machinery and other precision agriculture solutions can facilitate and accelerate adoption of the related practices. Similar for improved fertiliser application efficiencies, to reduce N_2O emissions from manure spreading, measures can include choice of application method, as well as optimising rate and timing of application to match crop requirements. It should be noted that improving fertilizer efficiency by itself does not lead to absolute emission reductions. Therefore, a whole farm approach monitoring total fertiliser use is needed to ensure absolute emission reductions (McDonald et al 2021).

Other on-farm options could focus on regenerative agricultural practices, such as using legume crops or pastures in rotation instead of nitrogen fertiliser, where nitrogen in the form of organic matter is released more slowly and is used more effectively by growing plants, or from practicing minimum tillage for cropping which minimizes organic matter breakdown and the release of N_2O. However, it should be noted that such practices can potentially increase the use of herbicides (Klein, 2019). Technological options such as precision agriculture (e.g. variable rate distribution of nutrients) or nitrification inhibitors could reduce nitrate leaching and the production of N_2O, although inhibitors can lead to increased ammonia (NH_3) emissions (Lam et al 2016). Upstream actors, in particular fertiliser producers, can play an important role in reducing N_2O emissions related to the application of fertiliser through product innovation and the integration of urease and nitrification inhibitors.

CH_4 and N_2O emissions from manure management: 62.9 $MtCO_2e$

The ongoing intensification of livestock production has led to increasing volumes of manure to be managed and can increase GHG emissions. In 2021, 71% of emissions from manure management were CH_4 is the rest N_2O. In terms of sources, 47% of manure methane comes from cattle; 46% comes from pigs. Methane emissions from livestock manure depend on the amount of manure that is produced and the portion of the manure that decomposes anaerobically. The type of manure management system used, and the climate (mainly temperature) are the primary factors that determine the extent of anaerobic decomposition that takes place. Optimal conditions for methane production include anaerobic, water-based environment, a high level of nutrients for bacterial growth, a neutral pH (close to 7.0) and warm temperatures.

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[9] In soil, the oxygen content is largely controlled by soil moisture; when soil moisture is high, oxygen content is low and vice versa. Soil oxygen content is also controlled by microbial respiration and is related positively to the moisture content up to levels near saturation when a lack of oxygen inhibits many microbial processes. During periods of high microbial activity, soil oxygen is consumed, leading to an increase in N_2O production from nitrification (Zhu et al. 2013). Denitrifiers also consume N_2O when soil moisture is very high (Firestone and Davidson 1989).

The guidance for NECPs recommends the promotion of manure storage techniques to reduce emissions from manure management, such as cooling slurry, slurry acidification, covering manure and slurry stores. The guidance also recommends anaerobic digestion with biogas recovery for renewable energy (AD) to mitigate methane from manure management, with the additional benefit of reducing dependence on natural gas imports. Some livestock producers, if not going for AD, can reduce the amount of methane that escapes into the atmosphere by constructing lids or caps for lagoons or tanks where manure is kept. The recovered methane is then flared or oxidised in a biofilter.

Production of N_2O during storage and treatment of manure can occur via combined nitrification-denitrification of nitrogen contained. The amount of N_2O released depends on the system and duration of storage. Because N_2O production requires an initial aerobic reaction and then an anaerobic process, it is theorized that dry, aerobic management systems may provide an environment more conducive for N_2O production.

In larger farms, the implementation of GHG emission reduction techniques is cheaper per animal, but complicated. One method of reducing GHG emissions is by improving or changing the housing system, which (depending on the animal) could reduce up to 30% of emissions from manure management (Fournel et al 2012; Philippe & Nicks 2015; Samsonstuen et al 2020). Changing the housing system can be relatively cheap but only in new buildings. In existing livestock buildings, it often requires a change in construction, which can be expensive.

LULUCF emissions from agriculture

For LULUCF sector emissions, according to latest inventory sent by countries to the UNFCCC and the EU Greenhouse Gas Monitoring Mechanism, as of 2021 the net sink is -230 $MtCO_2e$ (EEA Dataviewer 2023). LULUCF emissions and removals for the following categories of land use are indicated below (those in bold are relevant to the agricultural sector) (ibid.):

- Forest land: - 280.8 $MtCO_2e$
- **Cropland: + 22.6 $MtCO_2e$**
- **Grassland: + 25 $MtCO_2e$**
- Wetlands: + 21.3 $MtCO_2e$
- Settlements: + 27 $MtCO_2e$
- Other land: + 1.2 $MtCO_2e$
- Harvested wood products: - 47.4 $MtCO_2e$

Croplands

More than one-fifth (22 %) of the EU27's area is covered by cropland (EUROSTAT, 2019). Denmark (51 %) and Hungary (44 %) have the highest proportion of their area covered by cropland. For the vast majority of the EU member states (MS), cropland accounted for between 15 % and 35 % of the total area, with this share falling to 10 %–15 % in Latvia, Estonia and Portugal, while the lowest proportions were registered in Slovenia (9 %), Finland (6 %), Ireland (6 %) and Sweden (4 %). In absolute terms, France, Germany, Spain and Poland had the biggest areas of cropland in 2015.

Organic Soils

Accounting for both emissions and removals, organic soils (which represent 1.2% of total cropland area) are a net source of emissions. According to the *Annual EU GHG inventory 1990-2021 and inventory* *report 2023*, croplands remaining croplands on organic soils (4.B.1) emit 24.7 MtCo2e per annum and land converted to cropland (4.B.2) emit 6.4 MtCO2e per annum. The emissions from organic soils originate from the constant drainage of organic soils for agricultural use, including peatlands. However, accounting for emissions from peatlands is inconsistent across Member States and therefore the reported emissions under the LULUCF may not be accurate for all Member States. About 5.8 Mha of EU27+UK peatland area is drained, the majority of which can be found under grassland (2.7 Mha) and cropland (1 Mha) (Greifswald Mire Centre et al., 2019). Germany, Finland, Poland, Ireland, Romania, and Sweden are among the main contributors to GHG emissions from drained peatlands (ibid). In the EU, drained peatlands (of which a large proportion is used for agricultural purposes, but also is used for forestry purposes) emit approximately 220 $MtCO_2e$ per year, making up 5% of total EU GHG emissions in 2017 (Greifswald Mire Centre et al., 2019).

Perez Dominguez et al. (2020) estimated that the maximum annual additional mitigation through retiring and re-wetting organic soils in the EU would be 51.7 $MtCO_2e$ in 2030; in addition, ceasing peat extraction could avoid annual emission of 9Mt CO2-e (European Commission, 2020a). Roe et al. (2021) estimate that the feasible mitigation from re-wetting peatlands would be 54 $MtCO_2e$ per year (average over 2020-2050). On a per hectare-basis, peatland restoration is a highly effective mitigation action. At the upper end of the range, Günther et al. (2020) estimate the level of avoided emissions achieved by re-wetting to be up to 29 t CO_2-e per ha per year, while the MoorFutures methodology, a German carbon farming mechanism, posits a range of potential impact of 3.5-24 t CO_2-e per ha per year, depending on previous land use and final state (Joosten et al., 2015).

Because peatland restoration is not always possible in all used lands in the EU, other potential practices can reduce these emissions, such as dry-rewetting techniques, increasing water table levels, or paludiculture, which is the productive use of wet and re-wetted peatlands that preserves the peat soil. Paludiculture uses above ground biomass, while below ground biomass remains for peat formation. Harvested biomass can be used as food, feed, fibres for industrial biochemistry, for production of construction materials, high quality liquid or gaseous biofuels, for heat production through direct combustion or for further purposes such as extracting and synthesizing pharmaceuticals and cosmetics (Wetlands International, 2023).

Loss of SOC in mineral soils

Approximately 45% of the mineral soils in Europe have a low to very low organic carbon content (0-2%) due to management practices – losses of soil organic carbon (SOC) causes substantial emissions (Rusco et al 2001; Boettcher et al 2019).

Maintaining and enhancing SOC requires a positive balance of carbon inputs and carbon losses from soils. It is relevant to any farming system, and a wide range of carbon farming practices exist. This section focuses on SOC sequestration on croplands and grasslands. According to McDonald et al (2021), practices with the highest potential for maintaining and improving SOC levels include: 1) cover cropping; 2) improved crop rotations (e.g. through inclusion of legumes and other nitrogen fixing crops); 3) maintaining grassland without ploughing up; 4) conversion from arable land to grassland; 5) organic farming; and 6) management of grazing land and grassland (for example, by optimising stocking densities or grassland renovation). Mitigation potential: The estimates for additional SOC sequestration in EU croplands range from 9 Mt CO_2eq/yr (Frank et al., 2015) to 58Mt CO_2eq/yr per year (Lugato et al., 2014) to 70 Mt CO_2eq/yr (Roe et al., 2021). In addition, because a large share of cropland soils that are mineral soils would continue losing SOC without changes in management, stopping and reversing the losses is equally important (Wiesmeier et al., 2020).

Grasslands

Grasslands tend to be concentrated in regions with less favorable conditions for growing crops or where forests have been cut down. Some of these are found in northern Europe (e.g. Finland and Sweden), while others are in the far south, i.e. the south of Spain. Just above one-fifth of the EU27's area (21 %) is covered by grassland (Eurostat 2020). There is a broad range across EU member states, with Ireland having 56 % of its total land area as grassland and Finland and Sweden less than 6 % of the land. Permanent grasslands cover 34% of the EU's agricultural area (Eurostat 2020).

Unlike forests, where vegetation is the primary source of carbon storage, most of the grassland carbon stocks are in the soil. Cultivation and urbanisation of grasslands, and other modifications of grasslands through desertification and livestock grazing can be a significant source of carbon emissions. Soil organic carbon (SOC) storage in grasslands is impacted by climate, soil characteristics, topography, vegetation and management, but arguably management has had the largest impact on SOC storage due to intensified management of agricultural lands. Land use change from grassland to cropland systems causes losses of SOC. Activities causing degradation of grasslands include livestock overgrazing and planting less productive species relative to native vegetation, and management practices such as tillage (sown grasslands), cutting management, inorganic and organic fertilizer use, types of fertilizer applied, and water management.

Grasslands remaining grasslands demonstrate substantial emissions. Carbon emissions from grassland mainly occurs in Germany and Ireland, with France and Italy having the largest sinks for grasslands. The main factor impacting carbon emissions from managed grassland is drainage of organic soils, which accounted for 3% of the total grassland area. Intensification of grasslands also has a negative impact on the climate regulation of grasslands. Grass is still among the cheapest high-quality feed sources for efficient ruminant meat and dairy production (Van Den Pol et al 2018). In many regions across the EU, permanent grasslands are experiencing increasing livestock densities, received higher nutrient inputs, and were subjected to higher cutting frequencies, modulated by drainage, irrigation, resowing and over-sowing with improved cultivars, as well as weed control with herbicides (Peeters 2009).

Protection and restoration of grasslands (i.e. revert arable land into grassland) is a key factor in increasing sequestration. For grasslands, Roe et al. (2021) estimate that grasslands in the EU could feasibly sequester 27 MtCO_2e per year (at a cost of less than USD100/t). In a simulation modelling approach, Gocht et al (2016) estimate that if farmers revert arable land into grassland by 5%, the calculated net effect of converting 2.9Mha into grassland is a reduction of 4.3 MtCO_2e. Sequestration would be most effective in France, Italy, Spain, the Netherlands, and Germany (ibid). Larger farms and farms specializing in cereals and protein crops, mixed field cropping and mixed crop livestock systems would have the highest mitigation potential at relatively low costs (ibid).

However, in the near term, the main contribution that grasslands can make is regarding the avoidance of conversion. Grasslands store a large amount of carbon in the EU, and the conversion of grasslands to croplands entails large-scale loss of soil organic carbon. Converting croplands back into grasslands will yield sequestration benefits, but this will occur over a longer time-scale. Indeed, grasslands lose SOC easier and much faster than it takes to recover SOC, and therefore avoiding conversion will be of high importance to maintain carbon stocks (Smith 2014).

Projected emissions under current policy framework

The EEA data viewer provides an overview of historic net emissions from the agricultural sector for the EU-27, as well as provides changes in net emissions (both non- CO_2 emissions and LULUCF emissions) as projected by Member States. Taking into account the pre-FF55 policy framework as well as additional measures proposed by Member States two years ago , it appears that policies included in the projections from 2021 are not sufficient to reduce emissions in the agricultural sector . Even the scenarios that include additional measures do not demonstrate sufficient ambition to substantially decrease emissions in the next 10-15 years. This differs from trends in other sectors.

For non- CO_2 emissions, only a 1.5% decrease is expected between 2020 and 2040 (EEA 2021b). According to the most recent version of the annual EU Climate Action Progress Report[10] (2023), if policies and measures that were planned are implemented, a slightly larger decrease of 5% is projected (also see: EEA 2021b). During the 1990s and early 2000s, policies and efficiency gains reduced the emission intensities of some agricultural products, leading to emission reductions. However, for the past decade efficiency gains have been offset by increases in agricultural production. According to the latest progress report, “more effort is needed to implement mitigation measures in the agricultural sector,” as aggregated projections demonstrate that Member States will fall short of the ESR target of -40% with current measures.

For LULUCF emissions, Member State projections suggest that net removals will decrease at EU level, from an average of 298 $MtCO_2e$ per year in 1990-2020 to 191 $MtCO_2e$ in 2021-2040 (EEA 2022). Additional measures reported by Member States are expected to increase average net removals in 2021-2040 by 9% (EEA 2022). By 2030, removals of 190 $MtCO_2e$ are expected with existing measures and 209 $MtCO_2e$ with planned additional measures. Therefore, the EU is currently not on track to meet the legally binding target of net LULUCF sector removals of -310 $MtCO_2e$ under the LULUCF Regulation.

These predicted trends in the land sector suggest the need for additional policy measures to facilitate on-farm practices that will mitigate climate change, as outlined above. This study will explore the potential of policy options applying the polluter pays principle as a means of addressing agricultural emissions.

1.3. Application of the Polluter Pays Principle in the European Union: legal precedent for its application to agricultural GHG emissions

The ‘polluter pays’ principle (PPP) is one of the main tenets of the European Union’s (EU) environmental policy (Petrašević & Poretti 2022). The theory behind its application is that the polluter should hold responsibility for the cost of pollution, including the cost of prevention, control, and removal of pollution, as well as the cost it causes for society. In practice, the PPP is meant to discourage polluters from environmental pollution by holding them liable for the pollution by means of having the polluters, and not the taxpayers, bear the cost. As a common tool to prevent pollution, it is worthwhile for the European Union to consider applications of this principle to address the problem of greenhouse gas emissions in the agricultural sector, in particular because one of the essential policy

[10] https://climate.ec.europa.eu/system/files/2023-10/com_2023_653_en_0.pdf

instruments utilised to achieve the EU's climate objectives, the EU Emission Trading System (ETS), is an application of this principle.

Currently, the European Union applies the polluter pays principle in its policies through various types of policy instruments, including regulations, environmental standards, environmental liability, and emissions trading. Therefore, there is substantial legal precedent, as well as multiple policy options to consider in how the polluter pays principle could be applied towards GHG emissions in the agricultural sector. A carbon tax would in principle be a direct application of the polluter pays principle; and individual Member States make use of taxes and levies as a means of implementing national-level commitments (for example, tax instruments used to reduce emissions from road transport, in order to meet air quality standards). However, tax instruments are, in practice, less favoured as an EU means of achieving environmental protection. This is because of the difficulty in ensuring agreement on the necessary legislation as a result of the requirement for unanimity in Council.

Emissions trading: In the case of greenhouse gas emissions, where the challenge of attributing a specific responsibility for environmental damage to individual emitters applies, the EU has implemented the polluter pays principle through the introduction of an emissions trading system, applying currently to approximately 40% of the EU's total emissions. This approach is the EU's main decarbonisation tool and sets an overall limit on emissions, but allows the entities covered by the system to buy and sell emissions allowances (and thereby transfer responsibility for achieving emissions reductions), leading to the implementation of an effective price on emissions. It also generates revenues which can finance complementary policies. An ETS is in theory a clear implementation of the polluter pays principle; however, the availability of free allowances for those industries potentially affected by risks of carbon leakage to outside the EU, who may not face an effective carbon price, reduces the clarity in practice.

Box 1 EU Emissions Trading System - a brief history and future outlook

Set up in 2005, the EU ETS is the world's first international emissions trading system.

The first, pilot phase (2005-2007) of the EU ETS saw the establishment of the necessary ETS infrastructure, while allowing businesses the time to adjust to the new requirements, with nearly all allowances handed out for free. Phase II (2008-2012) introduced a lower cap and a slightly lower proportion of free allocation (app. 90%) – however, both initial trading periods were characterised by an oversupply of allowances, resulting in a low carbon price.

Phase III (2013-2020) involved a more substantial overhaul of the system, through the replacement of national caps with a single, EU-wide cap, increasing the role of auctioning, and the harmonisation of rules for free allocation. However, the transfer of surplus allowances from the second phase initially contributed to the carbon price remaining at low levels. In response to the oversupply, the Market Stability Reserve was introduced into the system and became operational in 2019, leading to a more robust carbon price.

By the end of the current period, Phase IV (2021-2030), installations from sectors covered by the EU ETS are set to decrease emissions by 62% compared to 2005 levels, which is a significant increase from the pre-Fit For 55 target of -43%. To eliminate the persistent discrepancy between the cap and defacto emissions, the reformed ETS will include two one-off adjustments (‘re-basings’) of the cap, reducing it by 90 million allowances in 2024 and an additional 27 million in 2026.

In addition, a new Carbon Border Adjustment Mechanism (CBAM) will be implemented, starting in 2026. The mechanism is intended to mirror the impacts of the EU ETS for non-EU producers in sectors such as cement, aluminium, fertilisers, electric energy production, iron and steel. Once fully operational, it will require importers to purchase CBAM certificates at a price set by the Commission based on weekly average EU Allowance (EUA) prices, and subsequently surrender a volume of certificates corresponding to the emissions embedded in the imported goods. Free allocation under the EU ETS will be phased out in parallel with the phasing-in of CBAM in the period 2026-2034.

The EU ETS sector coverage has also increased from the initially regulated power and centralised heat generation and energy-intensive industries, to encompass intra-EEA aviation and, from 2024, maritime transport. Separately, a new emissions trading system is being created for fuel combustion in buildings, road transport and additional sectors (mainly small industry not covered by the existing ETS), with a cap applying from 2027 set to achieve 42% emission reductions in 2030 compared to 2005 levels. The new ETS 2 will complement the EU ETS sectoral coverage, broadening EU-level carbon pricing to cover all major sectors of the economy except agriculture and land-use. The new system is set to come into force in 2027, with the supply of allowances frontloaded by auctioning an additional 30% in the first year of operation, to ensure a smooth start. Designed as an upstream system, it will regulate the distributors of fuel in the relevant sectors, rather than households and other end-consumers. However, in light of the impact of the energy crisis, as an additional means of safeguarding vulnerable households beyond the newly introduced Social Climate Fund, the ETS 2 will be delayed to 2028 if oil or gas prices are exceptionally high. EU ETS and ETS 2 together will cover approximately three quarters of the EU’s total emissions.

By the end of 2026, the Commission will assess whether to introduce emissions from municipal waste incineration into the EU ETS from 2028. Besides the positive impact on reducing GHG emissions, the inclusion of municipal solid waste incineration could incentivise waste providers to further recover materials from the residual waste stream, especially if the higher costs could be allocated towards them. Recovery of materials for circular economy purposes would result in carbon savings and contribute to a reduction in the amount of disposed waste. High incineration costs would also create an enabling framework for low-carbon alternatives for managing residuals, such as material recovery and biological treatment facilities. The potential inclusion of waste incineration in the EU ETS provides a particularly relevant example of how a price signal provided by an ETS could potentially facilitate climate-friendly innovations for manure management in agriculture.

Regulation of specific activities, products or installations: The most common form, which in general applies minimum environmental standards directly to individual economic operators (for example, emissions standards under the Industrial Emissions Directive), and generally requires their implementation without compensation. In conjunction with a robust implementation of State aid policy, ensuring that businesses and polluting installations are not subsidised for conforming with the minimum standards of European environmental law, these can be seen as a direct implementation of the polluter pays principle. However, environmental damage could still result even from the level of polluting activity permitted under the IED, and in general Member States do not make individual economic operators liable for the costs of damage in cases where the operator was not negligent, and was in compliance with the environmental standards applying to it.

Broad environmental standards applied at a collective level: Where standards are applied at the level of public authorities (for example, limits on emissions under the National Emissions Ceilings Directive, water quality standards under the Water Framework Directive, or air quality standards) responsibility for measures is more diffuse, and the polluter pays principle is less clearly applied. Each individual installation's emissions are treated as part of a wider background level of diffuse pollution, and the responsibility for action to achieve the relevant standards cannot be assigned as strictly as with the regulation of specific installations or activities. In some cases (for example, article 7 of the National Emissions Ceilings Directive), the legislation even envisages the availability of EU financial support for measures to achieve the minimum standards. Where responsibility for the achievement of environmental standards can be more directly allocated, as in the case of water suppliers and users under the Water Framework Directive, the EU legislation applies the principle of full cost recovery (Article 9). Similarly, the Waste Framework Directive (Article 14) requires the costs of waste management to be "borne by the original waste producer or by the current or previous waste holders". In both cases, however, the robustness of the application of cost recovery at Member State level is patchy.

The most relevant standards for agriculture are found in the Industrial Emissions Directive, which regulates the environmental impacts of large agro-industrial sources. The IED aims to lower emissions by determining conditions under which an industrial installation can operate, ensuring these conditions are in accordance with the principles of its provisions through the permitting process. Permits must be based on Best Available Techniques (BATs), which are the most environmentally effective of the economically viable techniques available. The law currently governs intensive rearing of pigs and poultry, however the Commission's proposal to update the IED includes larger scale cattle farming for the first time, and thresholds for pig and poultry farms have been lowered so as to include more installations under the IED. Commission intends for this update to address non-CO2 emissions from livestock production, as agriculture is the largest source of methane emissions in the EU. Permits granted under the IED for installations covered under the EU ETS do not include an emission limit value for direct emissions of GHGs subject to the ETS – this is to avoid duplication of regulation, since emissions of GHGs are managed by the ETS and not by emission limit values. Thus, if an ETS for agriculture was introduced, a similar approach to emissions from livestock installations would need to be applied.

Environmental liability: The application of the polluter pays principle in EU legislation, and for environmental issues less directly addressed by EU legislation (particularly soils), was reinforced by the adoption of the Environmental Liability Directive in 2004, which required that operators under a broad list of economic activities should be responsible for preventive and remedial action to address a broad range of types of environmental damage. However, the application of the directive remains varied across Member States, in particular with respect to the definition of "significant" damage[11].

[11] See eg Commission Staff Working Document REFIT Evaluation of the Environmental Liability Directive, Accompanying the document Report from the Commission to the European Parliament and to the Council pursuant to Article 18(2) of Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage (SWD(2016) 121 final, 14 April 2016); Nesbit et al "Development of an assessment framework on environmental governance in the EU Member States", study for DG ENV, final report May 2019, p 83; Fogleman et al "Facilitating enforcement of the ELD by competent authorities", study for DG ENV, final report December 2021.

1.4. The current climate architecture: is there a need for an additional policy instrument to address agricultural GHG emissions?

In light of an existing climate policy framework that addresses agricultural GHG emissions, the EU will need to determine whether there is a need for an additional policy measure to address agricultural GHG emissions and removals and if such a measure should apply the polluter pays principle. The European Climate Law makes the EU's climate objective of reducing emissions by at least 55% a legal obligation, and in light of this legal obligation the EU has adopted updates to its climate policy framework as well as introduced new initiatives, referred to as the Fit for 55 package, increasing the overall ambition of its climate framework to meet its Paris Agreement obligations. Under this framework, the agricultural sector continues to fall under the ESR, which governs non-CO_2 emissions in agriculture, as well as CO_2 emissions from liming, carbon-based fertilisers and energy use in the sector, and the LULUCF Regulation, which governs primarily CO_2 emissions from croplands and grasslands on which agricultural activities take place, as well as the forest sector and other land use.

Outside the Fit for 55 package, there are other policy instruments that will have implications for climate mitigation in the agricultural sector. As mentioned above, the IED currently governs, among others, methane emissions from large pig and poultry installations and the Commission has proposed to include cattle, to better address methane emissions from livestock. In addition, the Farm to Fork Strategy, which has set quantified but non-binding targets related to agriculture and food, provides an interface between the EU's climate objectives and a sustainable food system – in particular the targets to reduce nutrient losses and food waste. The Commission has developed a proposal to establish a Carbon Removals Certification Framework for the quantification and certification of carbon removals. The motivation behind this is to enable public or private funding to facilitate on-farm practices that can increase the carbon sequestration in living biomass, dead organic matter in soils by enhancing carbon capture and reduce the release of carbon into the atmosphere. The Commission has proposed a Soil Monitoring Law and intends to propose a Forest Monitoring Law in 2023, both of which could potentially provide a supporting system to improve monitoring of carbon in soils and forests.

The Common Agricultural Policy (CAP) is one of the longest-serving EU policies. Established in 1962, the CAP's first objectives were economic and social. It aimed to increase agricultural productivity and stabilize markets, ensure a fair standard of living for farmers, the availability of supplies and reasonable prices for consumers. Several decades after it was first implemented, the main objectives for which it was set up remain. Two of the core objectives of the CAP are to ensure a fair standard of living for farmers and keeping prices affordable for consumers. Direct payments to farmers have aimed to achieve both, but over the years, have created dependencies on farmers receiving the support. The EC states that direct payments allow farmers to have a safety net, guarantee food security and reward them for the delivery of public goods. Because payments are associated to land, paying per cultivated hectare may increase the area of land under production according to Pe'er & Lakner, 2020; at the same time, agricultural land is on a decreasing trend. The CAP also serves to increase rural employment and economic growth in rural areas (Grodzicki and Jankiewicz, 2022). As the core policy framework for the agricultural sector at the EU-level, the CAP is one of the main policy instruments currently being utilised to address negative environmental outcomes associated with agricultural production, as well as the Natura 2000 directive, Water framework directive, and Nitrate Directive, which are part of the Statutory requirements of the CAP.

One of the controversies vis a vis the CAP and GHG emissions is that in dedicating a significant proportion of its budget to provide direct payments to farmers, it is providing support to activities that result in large-scale GHG emissions. Livestock farms, particularly grazing cattle, receive extensive support from the Voluntary Coupled Support (VCS), which are a form of coupled direct payments, capped at 13% of direct payments of Member States, that are linked to products considered to be from “potentially vulnerable sectors” and therefore relevant for the permanent grassland maintenance. While VCS also provide support for crop cultivation, including leguminous crops which can reduce N_2O emissions, the largest share (74%) of the VCS during the period 2014-2020 went towards livestock production (ECA, 2021). According to an evaluation study of the impact of the previous CAP on climate change and greenhouse gas emissions carried out for the Commission (Alliance Environment, 2019), these payments were likely to support livestock numbers, although were they to be removed, the net effect on GHG emissions is difficult to predict due to lack of counterfactuals, uncertainty in the alternative use of this land, and the role of the leakage associated to increased imports (EC, 2022). Jansson et al (2020) demonstrate that while removing coupled income support would reduce agricultural GHG emissions, a large proportion could be offset by emissions leakage from increasing imports from countries with higher emissions per unit of product (e.g. Brasil).

Successive reforms have been made to the CAP to address environmental and climate challenges as well as related issues such as overproduction. Two key reforms with impacts on GHG emissions and the environment were the 2003 reform that “decoupled” economic support from production and the 2014 reform that introduced the “greening”. The reform of 2003 redefined the CAP structure around two main pillars which continues today. Pillar 1, with over two thirds of the CAP budget, provides income support for farmers (the so-called direct payments) and a second pillar with a budget for rural development. Decoupling the support from production was achieved by fixing the payment (the “Single Farm Payment”) to the land rather than the total production. The decoupling was implemented to avoid the overproduction or non-market oriented production that had taken place during the previous period for certain commodities. This disincentivized large farms from increasing their production further.

The reform also introduced new requirements for farmers, which now had to comply with a more extended conditionality to receive the payment, including the Statutory Management Requirements (relating to the environment, animal welfare and animal, plant and public health policies) as well as adhere to a set of standards called the Good Agricultural and Environmental Conditions (GAECs) aimed at keeping land in good state. Pillar 2, with less than a third of the CAP budget, aimed to fulfil a set of objectives linked to the territorial development and sustainable use of natural resources through a set of optional measures decided by Member States. These included the Agri-Environment Schemes (AES) that had been introduced a decade earlier.

The second reform with potential positive impacts on GHG emissions and the environment was the 2013 reform. For the first time it included climate into the CAP’s objectives, both for Pillars 1 and 2. In Pillar 1 it introduced the “greening”, a conditionality payment consisting in 30% of the direct support accessible to farmers by complying with three good environmental practices with climate implications: crop rotations with at least 3 crops, establishing or maintaining Ecological Focus Areas (EFAs) on at least 5% of arable land and maintenance of permanent grassland. In Pillar 2 AES were renamed into agri-environment and climate measures (AECMs). Climate action was therefore addressed within the CAP through both pillars. In pillar one through the compulsory SMRs, together with GAECs and the Green Direct payments for those receiving support - green direct payments were received for the implementation of mandatory practices such as crop diversification, ecological focus areas and permanent grassland (30% of direct payments). And in Pillar 2 a broader set of optional measures existed, which depended on the Member States' will for implementation (AECMs, organic farming, Natura 2000 sites).

The CAP 2023-2027 has taken a step further in climate and environmental ambition in Pillar 1. It has strengthened conditionality by including elements previously under greening into cross-compliance and providing a long list of measures under the new "eco-schemes" mandatory for Member States, which represent 25% of the Pillar 1 budget (including long list of potential measures e.g. organic farming, carbon farming, and agro-ecology). The level of ambition is left to Member States (but need to be beyond conditionality requirements) in relation to their need assessment, and it remains to be seen how these new measures will perform and what will be the level of farmer uptake. The current CAP seeks to respond to a list of ten specific objectives, one of which is climate action. A novelty in the new CAP is the protection of wetlands and peatlands as part of conditionality (GAEC 2). Its details, currently under Commission approval, are put in place by Member States. However, direct payments are still accessible to farmers cultivating drained organic soils, which are important sources of GHG emissions.

A review conducted by Alliance Environment (2019) estimated that CAP measures contribute to a reduction of 26.2 $MtCO_2e$ annually. Among the interventions, income support is esteemed to have both positive and negative effects on climate mitigation. The largest emissions reduction (19 Mt CO_2e) came from avoided emissions derived from the greening standards for permanent grasslands and ecological focus areas, as well as measures from the rural development programme that added 6.4 Mt CO_2e of avoided emissions, half of which took place in Natura 2000 sites. Overall, the largest reductions were achieved through Pillar I measures addressing land management practices that protected soil organic carbon stocks, as well as those aiming to reduce N_2O emissions from soils and manure. This coincides with an evaluation carried out by the EC on the impact of the CAP on GHG emissions which concludes that CAP interventions have contributed to reducing GHG emissions by around 4%, and 8.7% at best (relative to a 2016 baseline) with greening measures - protection of environmentally sensitive grassland and ecological focus areas - accounting for most of the reductions. The assessment also underlines the important role played by GAECS in protecting soil carbon stocks by reducing soil erosion and increasing organic matter content in soils which are beneficial for carbon storage and sequestration (EC 2021), but it also notes that the impact of greening on avoided emissions may be overestimated since Natura 2000 sites already include a ban on ploughing permanent grassland in their management plans (EC 2021). The Commission notes that emissions after 2010 stabilized, with inter-annual variation below the uncertainty threshold established by the EEA (roughly 6-7%). At the same time, production has increased and emissions per unit of product have decreased (EC 2022).

The situation is therefore that despite devoting 26% of the budget (around €100 billion) on measures related to climate action, the impact of the 2014-2020 CAP on reducing GHG emissions has been limited. Tracking climate expenditure and establishing the links between climate expenditure and the delivered outcome within the CAP is not straightforward and can be done in multiple ways. The 26% budget allocation to climate has been reassessed by the European Court of Auditors (2021), and Pe'er et al (2020), on the basis that many of the measures contributing to climate mitigation are primarily addressing other objectives (biodiversity, water and air quality, or social and economic needs). They estimate a smaller, 6-18%, percentage of CAP budget to have been dedicated to climate action. The EC further explained its climate mainstreaming methodology and acknowledged that any tracking methods used rely on assumptions and can only produce an approximation of the actual situation (EC's reply to ECA's report). In the new CAP (2023-2027) the EC states that up to 40% of the budget will be climate-relevant and aims to achieve this by enhanced conditionality, the introduction of eco-schemes (that now include 'carbon farming') as well as a higher overall ambition in the objectives set by Member States.

In addition to the percentage of budget devoted to climate measures, the type of funded interventions also plays an important role on the outcomes for climate mitigation. As noted by an ECA study (2021), this is largely due to the fact that the CAP tends to fund measures with a low mitigation potential (i.e. organic farming, cultivation of grain legumes) while other measures which could have a much higher impact on emission reductions are not addressed in the policy (i.e. limiting livestock numbers, management of organic soils). In addition, many of the climate effects of the interventions are indirect, resulting from synergies with other environmental objectives. This is the case of the measures that focus on non-productive land, or the management of Natura 2000 sites. The co-benefits of climate measures are numerous and need to be taken into account. These range from reducing risks of soil erosion and floods, to increased productivity through improved soil health, or increased water availability which contributes to climate adaptation (McDonald et al. 2021). A recent study by Scheid et al. (2023), however, also pointed that safeguards are needed when implementing some measures to increase carbon removals (i.e. carbon farming) to avoid harmful impacts on soil health and biodiversity.

To conclude, data on land degradation and GHG emissions show that despite its objectives, the CAP is not effectively managing to reduce GHG emissions or protect natural resources (EEA 2009, 2019). While the CAP is an important policy framework to support farmers in adopting more climate-friendly practices, it was not designed specifically to address GHG emissions. Rather, its aims to cover a multitude of objectives including environmental objectives such as biodiversity, as well as social and economic objectives for rural areas. The need to introduce an additional policy tool in the farming sector, and its form, need to be assessed considering synergies and complementarity with the CAP, applying the polluter pays principle may be able to support the CAP in facilitating its climate-related objectives. However, in the case of the introduction of a PPP based policy instrument, it will need to be designed in a way to both support and avoid undermining the economic and social objectives of the CAP.

1.5. How can the Polluter Pays Principle address the problem of negative externalities

One of the main objectives of applying the polluter pays principle is to address the problem of negative externalities. The concept of negative externalities relates to the hidden costs associated with production of a product that generates negative impacts on the environment or negative social or economic costs that are not reflected in the final price of that product. Consequently, interventions by governments are necessary to reflect true prices by applying a price that producers must pay equal to the difference between the final price of the good and the costs of negative environmental/

social/economic impacts and therefore compensate for the shortcoming of market prices. Thus, the aim of the polluter pays principle is to “internalize negative externalities.”

Studies suggest that the current systems of economic calculations grossly underestimate the current and future value of natural capital (Abramovitz 1997; Costanza et al 1997; Daily 1997). In practice, there are few agreed data on the cost of agricultural externalities because the costs are highly dispersed and affect many sectors of the economy (Pretty et al. 2001). Similarly, there is no comprehensive valuation framework for the positive externalities produced by agriculture, which include nutrient recycling, wildlife, provision of jobs, contributions to social fabric of rural communities, among others (idem.)

Social and environmental costs from the emission of greenhouse gases are not currently considered in the cost structure of farmers or the subsequent food chain, and are thus a burden on other market participants, future generations, and the ecosystem. External greenhouse gas costs are highest for conventional animal-based products, followed by conventional dairy products, and the lowest for organic plant-based products (Pieper et al 2020). These external costs are not yet included in the market prices for agricultural goods, and lead to significant price distortions and welfare losses for society (ibid). Externalities within the agricultural sector have common features: their costs are often neglected; they occur with a time lag; they often damage groups whose interests are not represented; and the identity of the producer responsible for the externality is not always known (Pretty et al 2001).

To close this gap between market prices and the true cost of agricultural goods, GHG emissions from agriculture should be quantified and monetised (ibid). Applications of the polluter pays principle can facilitate this quantification, and various instruments, such as carbon taxes or emission trading systems, can be used to create a price on emissions aka a ‘carbon price’, which monetises the true costs of GHGs.

Demand for basic food products is considered by economists to be relatively inelastic, with price fluctuations having relatively little impact on consumer demand, which may constrain the necessary shifts from emissions-intensive to less emissions-intensive products. However, several studies indicate higher demand elasticities for certain products with higher emission intensities. In their literature review of over 160 studies of food price elasticity, Andreyeva et al. (2010) find differences in elasticities between different foodstuffs in response to price shifts, with high elasticities for soft drinks, juice, meats, and fruit, while the most inelastic foodstuffs are eggs, cheese, and fats and oils. Gallet (2010) finds variation in elasticities between meat products with the price of high-emissive meats, such as beef and lamb, tending to be more elastic in comparison with lower-emissive meats such as poultry. Sall & Gren (2015) find that meat consumption is more sensitive to price and income changes, than dairy consumption. There is also evidence of high substitution elasticity between sheep and goat meat and pork, fish and chicken meat, respectively (Aepli &. Finger 2013; Jaquet et al 2000). Understanding price elasticities for various agricultural goods may help in designing policies with the greatest impact on consumer food choices, thus impacting agricultural production.

Therefore, it is possible for a well-designed policy instrument to internalise costs while encouraging innovation and more sustainable options (Pretty et al 2001). A polluter pays policy can impact both demand side issues, by changing consumption patterns within the food sector and consumers moving towards less emissions-intensive products to avoid increases in their overall food budgets, e.g. by changing the recipes of products, as well as supply side issues by facilitating innovations that reduce on-farm emissions, e.g. new inputs such as more effective fertilisers.

The application of a polluter pays principle towards agricultural GHG emissions is increasingly being put forward as a potential way of addressing the negative externalities associated with GHG emissions. New Zealand will become the first to price agricultural emissions as of 2025. Agricultural sector leaders and the industry teamed up in a partnership – *He Waka Eke Noa* ("We are in this together") – to design a pricing system. Established in 2019, the partnership brings together key stakeholders such as Māori farming organisations, industry partners, sector experts and scientists, as well as government representatives, to develop practical solutions. It is committed to designing an on-farm pricing system that ensures New Zealand's agricultural products remain internationally competitive while reducing emissions. It also aims to help build resilience in rural communities. In addition, within the EU, Denmark's independent advisory council has recommended a farming emissions tax to help the country meet is agricultural climate targets. In its report, the Climate Council recommended a tax of DKK750 per tonne of CO_2eq to promote more climate-friendly agricultural production, suggesting the tax would incentivise farmers to enhance crop production and move away from cattle farming.

1.6. Challenges and objectives

Despite the potential suitability of applying the polluter pays principle to address negative externalities associated with GHG emissions, the application of this principle within the agri-food sector will be challenging. This sector has tended to be treated as a special case in the application of EU and national environmental policy. There are a range of justifications put forward for this, including, but not limited to:

- The importance of the agricultural sector in delivering some environmental objectives, including habitat and species protection, and water quality;
- The prevalence of SME and small family businesses in the sector, and consequent challenges in responding to demanding or complex legislative requirements;
- The exposure of the sector to international competition, particularly in the case of globally traded agricultural commodities;
- The idea of European food production as a critical cornerstone of food security.

The challenge in developing an approach to climate policy for the agriculture sector which is consistent with the polluter pays principle for GHG emissions is how to address the specific nature of the agriculture sector, including both the arguably more legitimate aspects (prevalence of SMEs; exposure to international competition; synergies and trade-offs of applying the PPP to one externality only (GHG) with other externalities of agriculture such as on overall food security, on biodiversity, on water and air quality), and its political economy specificities.

Drawing from economic literature, the main objective of the application of the Polluter Pays Principle to agricultural GHG emissions is to *incentivise climate mitigation action more effectively and efficiently*. As discussed in section 1.4, the polluter pays principle acts as an economic and legal solution to the problem of negative externalities, as it internalises the externalities. Legally, the principle allocates responsibility for the causes of externalities borne by the public, by assigning liability. It also provides an economic solution by assigning a costs to negative externalities. According to the IMF, the polluter pays principle in the form of carbon pricing should be front and centre in the implementation of mitigation action, as it increases costs associated with emissive activities, incentivising mitigation (IMF 2017).

According to Isermeyer et al (2019), the advantages of carbon pricing policies which comprise a large number of emitters are that they give producers and consumers signals via prices, and therefore participate in reduction and innovation. The importance of the price signal is as follows:

> *''…(it) signals the scarcity of a good in the market economy. Only if all economic operators receive this one shortage signal in an unadultered manner it will be possible to produce the scarce good at the most suitable place in the economy with the least possible effort. This ubiquitous control function of price is a major reason why the market economy is more efficient than the state planned economy. For climate policy, this means there should be a uniform carbon price because this is the only way to harness the full potential of the economy for climate protection and to reduce emissions with the lowest possible costs* (Isermeyer et al 2019, p.18).

Thus, effective emission reductions will take place where they cause the lowest economic costs. By making the polluter pay for some of the external costs they cause, a price on GHG emissions can:

- Ensure that polluters pay for the costs of using the global common 'atmosphere'
- Incentivise obligated parties to improve production or management methods, increase efficiencies, and switch to low-carbon solutions
- Incentivise consumers to modify their consumption habits towards low-carbon solutions
- Generate revenue that can be utilised to fund either environmentally or socially beneficial behaviour, processes and investments.

However, as has been discussed throughout this chapter, there are problem drivers unique to the agricultural sector that will need to be addressed to make the polluter pays principle workable. Therefore, in addition to the objectives of effectiveness and efficiency, this study will also take into consideration five specific objectives which correspond to a unique problem driver within the agricultural sector.

Problem 1: There are many farms in the EU

The sheer number of farms across the EU will make the implementation and administration of a policy instrument applying the polluter pays principle complex. In the EU ETS, direct regulation starts at the level of all installations. This is possible with reasonable effort because there are a manageable number of large emitters in the energy and industrial sectors. However, in agriculture this would involve a great deal of administrative work because there are over nine million farms in the EU. More than 75% of farms are below ten hectares, with nearly two-thirds below five hectares. Implementing this type of regulation is likely to be further complicated by the varied and changing tenure arrangements across EU farms. Based on the latest available Eurostat data, in 2016, 45% of EU's utilised agricultural area (UAA) was rented out (corresponding to 17% of holdings), while 48% of UAA (78% of holdings) was farmed by the owner of the holding[12] (Eurostat 2016). This has implications for policy design with respect to the

[12] The tenure arrangements on the remaining agricultural area include farming on common land (4%) and share farming (in partnership between the landlord and the sharecropper) or other tenure modes (3%).

responsible entity (land manager/land owner), the enforcement of compliance, and incentives for farmers to make the long-term investments that may be needed to reduce emissions.

The small size of the majority of EU farms often increases the relative administrative burden of applying for income support, and therefore it can be assumed that the same would apply in the case of a policy implementing the polluter pays principle. The highest number of small farms is in Romania, where many farms are semi-subsistent. A policy option applying the polluter pays principle may indeed be too administratively burdensome for small farms, especially semi-subsistent farms, and therefore potential policy design features should take this into consideration.

Objective 1: *any policy option applying the polluter pays principle should aim to minimise the burden of implementation, and once implemented, balance the costs and benefits of the system*

Problem 2: GHG MRV tools are not yet commonly used by farmers in the EU

Measuring technologies and carbon accounting methods are improving for the purposes of monitoring, reporting, and verification of on-farm GHG emissions, with numerous ongoing initiatives at the EU level which offer opportunities for fast progress in this area. Examples include the Farm Sustainability Tool (FaST) (currently used on a voluntary basis), or the research and coordination framework implemented as part of the EU Soil Mission. The EU is also implementing legislation that prioritises the collection of on-farm data, with examples including enhanced monitoring under the revised LULUCF Regulation, the proposed Soil Monitoring Law, or the monitoring ambition outlined in the proposed Carbon Removals Certification Framework.

However, GHG MRV tools are not yet commonly used by farmers across the EU and their introduction may be burdensome and complex, particularly in the case of small farms which may not have sufficient capacity to conduct the necessary accounting in the initial phase. The capability and readiness to utilise MRV tools will highly depend on farm size, education and location, and their roll-out will require dedicated advisory support to enable monitoring and reporting, and corresponding significant effort to ensure robust verification. In addition, the asymmetry of information between farmers and regulators over what a farm's GHG balance is and how emissions can be reduced on-farm. This will present a challenge, particularly given the diffuse character of agricultural emissions.

Objective 2: *a policy option applying the polluter pays principle should be based on reliable but cost-effective MRV.*

Problem 3: risk of carbon leakage

Applying the polluter pays principle to reduce GHG emissions in agriculture could prompt the substitution of production for domestic consumption with imported goods, as well as the substitution of EU exports with goods produced abroad. The EU is the largest trader in agricultural products globally, with imports valued at EUR 150bn and exports reaching EUR 197bn in 2021 (i.e. slightly less than half of total agricultural production, valued at EUR 450bn the same year) (Eurostat 2022). Given the EU's integration into a globalized commodity market and its position as the biggest exporter of agri-food products, applying the polluter pays principle in the EU alone would result in a potentially significant leakage of emissions to other production areas. Leakage means that the reduced production would be substituted by increased production outside the EU (see Chapter 4 policy assessment section for detailed overview of literature on the issue of carbon leakage). The corresponding increase in emissions there would, at least in part, offset the domestic emission reductions. In addition, GHG emissions intensity of products can vary by region due to climatic and agronomic differences (for example, the life cycle analysis of beef per kilo of protein demonstrates GHG emissions twice as high in Latin America than in Western Europe due to higher productivity per animal and more digestible rations in Western Europe). Therefore, improvements in efficiency in Europe to reduce emissions may even be cancelled out by increases in the trade in cheaper agricultural goods produced in areas with lower GHG efficiency, intended both for EU and non-EU consumption.

Objective 3: *a policy option applying the polluter pays principle should provide safeguards against the risk of carbon leakage.*

Problem 4: there is a lack of economic security for many farmers in the EU

Due to various economic factors, many farmers across the EU lack income security and therefore a policy applying the polluter pays principle may have negative social consequences for rural areas. Indeed, sustained emphasis on providing income support to farmers has been a major barrier to incorporating effective environmental and climate policy instruments into the CAP (Scown et al. 2020; Pe'er & Lakner 2020). The need for income support arises from the reality that farming is an exceptional and hazardous industry because it is exposed to unpredictable and unstable weather and market conditions, underlying the use of exceptional policies for agriculture (Daugbjerg & Swinbank 2009). Several regions in Europe have been subject to 'land abandonment' – a process driven by a combination of socio-economic, political and environmental factors by which formerly cultivated land is no longer economically viable under existing land use and socio-economic conditions (Ustaoglu & Collier 2018). Land abandonment particularly affects rural communities in remote regions and where local economies rely mainly on small farm holdings with limited economic prospects and low productivity. Recent estimates indicate that approximately 30% of agricultural areas in the EU are under at least a moderate risk of land abandonment (European Parliament 2021).

A polluter pays policy option could offer an opportunity for a new business model for farmers. Farmers will become more competitive if they innovate and change their production towards practices with more positive impacts on climate and environment. A polluter pays policy option needs to give the right financial incentives to farmers for the right choices in their practice and product choices, ecosystem services, and for being a steward of land. In particular, if ETS revenues are redistributed to the sector, they should be redirected to more sustainable practices. Therefore, the objective should be about moving from one equilibrium to another one with a higher welfare.

Objective 4: *a policy option applying the polluter pays principle should provide financial incentives for innovation and changes in agricultural production and support farmers in this transition*

Problem 5: applications of the polluter pays principle may face social barriers to implementation

The social acceptance of a polluter pays policy may be challenging, as agri-food stakeholders, such as farmers, have been up until this point, largely exempted from climate-based polluter pays policies, such as carbon pricing. As the above challenge indicates, agricultural producers will be concerned about their income security and may be reticent to accept a polluter pays policy. In addition, it is not only farmers who will potentially be concerned about costs, but also low-income consumers in the EU may be concerned about their food budget. EU households spent on average 12.2 % of their total expenditure on food and non-alcoholic beverages ranging from 24.8% in Romania to 8.3% in the Ireland in 2021.[13] Nevertheless, about 7.5% of the population in Europe and North America suffer from moderate to severe levels of food insecurity.[14] In 2022, it was estimated that 8.3% of people in the EU-28 were unable to access and afford a meal with meat, fish or a vegetarian equivalent every second day, with the highest share of at risk in Bulgaria (44.6%, Romania (43%) and Slovakia (40.5%), while the lowest share was recorded in Ireland (5%), Luxembourg (5.1%) and Cyprus (5.6%).[15] This is primarily due to low income levels or loss of income.

However, market-based polluter pays instruments can be designed in a manner to incentivise actors to take the most cost-effective measures to reduce emissions and revenues generated can be redistributed to alleviate the financial costs of adopting new practices as well as to support vulnerable households.

Objective 5: *a policy option applying the polluter pays principle should be designed in an inclusive and fair manner so that no stakeholders or vulnerable Europeans feel left behind.*

[13] https://ec.europa.eu/eurostat/web/products-eurostat-news/w/DDN-20230201-1
[14] https://www.fao.org/3/cc3017en/cc3017en.pdf
[15] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20230710-1#:~:text=In%202022%2C%208.3%25%20of%20the,than%20in%202021%20(17.5%25)

2. Applying the Polluter Pays Principle: Emission Trading Systems

This first part of the study should be read alongside part 2: **Linking carbon removals in the land sector to an agricultural emissions trading system (AgETS+Removals Study)**, which focuses on policy models that could serve to financially reward carbon removals from the land sector through linking with an emissions trading system for agricultural emissions ("AgETS+Removals"). Throughout Part 1, we refer to Part 2 as the "AgETS+Removals Study"

2.1. Developing a range of potential policy options applying the Polluter Pays Principle

The purpose of this study is to develop a range of five potential policy options applying the polluter pays principle towards agricultural greenhouse gas emissions. The consortium began this process by identifying potential viable policy instruments applying the PPP in a long list that was then collated into a shortlist of options. The output of this process was a review and analysis of potential polluter pays approaches in terms of their key attributes. The objective was to select promising instruments, considered to offer potential for implementation in the European agricultural sector. When identifying possible types of policy designs to be considered within the policy options, the consortium distinguished them along several dimensions:

- **Policy option to apply the polluter-pays principle:** whether emissions are addressed through a quantity-based option (e.g. sectoral quotas or sectoral targets), a price-based option (e.g. a carbon tax) mechanism, or a hybrid form (e.g. an ETS or sectoral quotas combined with a carbon tax).
- The **point of obligation:** whether the price of polluting is applied to 1) directly to GHG emissions; 2) the inputs causing emissions (i.e. fertiliser, livestock, or energy use on-farm); 3) the outputs causing emissions (i.e. meat, household consumption, waste disposal, food retail, food processing, food packaging, food transport); or 4) on-farm activities causing emissions (manure application, manure management, burning crop residues.
- **Definition of "pollution", i.e. scope:**
    - ***Scope of GHGs:*** whether the instrument focuses on long-lived emissions (N_2O and CO_2), short-lived emissions (CH_4), or both; and
    - ***Sectoral scope:*** whether they are applied to GHG emissions from livestock farms, crop-based farms (food and/or non-food), or mixed-based farms; and
- **Definition of "polluter":** whether the instrument is applied at farmgate emissions, or if it applies upstream of farms (e.g. pre-production polluters such as fertiliser producers and/or fuel suppliers) or downstream (such as processing, wholesale or retail), or a combination of these points of obligation and are therefore liable under the policy instrument;
- **The sources of emissions:** what types of on- and off-farm activities causing GHG emissions may be covered by the application of the principle at a particular point of obligation and/or a particular policy instrument

The intention of the long list was to draw out the policy options based on these variables. The options considered represent a number of different approaches that draw out the variety of specific GHG mitigation challenges in the agricultural sector. The policy options considered varied in the types of actions they intend to incentivise in order to deliver on the objective of reducing emissions, such as:

- reducing nitrogen fertiliser application
- reducing livestock numbers
- redirecting consumer demand from beef towards other types of meat
- shift consumer consumer demand towards lower emissive products
- improved manure management
- improved livestock management practices (i.e. feed efficiency)

This long list was based upon a literature review of relevant academic studies, policy evaluations, and grey literature. In addition, the consortium received input from the Commission on factors to be considered when shortlisting potential options.

The long list of potential instruments **(see Annex 1)** contains information on key variables discussed above as well as other key information that influenced the final selection of the 5 policy options. In moving from the long list to the shortlisted options, the consortium considered the range of coverage a potential instrument has on 1) the scope of GHG emissions; 2) the sources of emissions; and 3) the types of polluters (i.e. upstream or downstream the agri-food value chain). In addition to these variables, the consortium considered the following:

- Is it feasible for the instrument to be applied at the EU level?
- What is the data availability on GHG emissions for a particular policy instrument?
- Can an instrument address carbon leakage?
- Are there existing empirical examples that can be examined to better understand potential impacts?

2.2. Selection of five potential policy options

The long list represents the diversity of potential approaches and takes into account where there are **substantive opportunities for GHG emission reductions in the EU**. Once the list was developed, we collaborated with the Commission to review and determine the **five policy options** to be explored in greater detail.

In moving from the long list to the proposed shortlisted options, we based our decision-making on considerations of the ***variation in coverage*** a potential application of the polluter pays principle has on the following:

- the scope of GHG emissions: does the application of the PPP apply to one or more types of GHG gases?
- the system boundaries: the range of processes and causes of on-farm emissions that can be addressed by a particular application of the PPP; and
- incentivise change among polluters: the impact of the application of the PPP on the range of practices that might be adopted to reduce emissions farmgate emissions

In consideration of the potential range of coverage, the consortium aimed to have policy options that could be described as ‘comprehensive’ in their level of coverage of GHGs, system boundaries, and on-farm practices, but also to explore at least one policy option that is more targeted in its coverage (aimed at a particular activity, has limited system boundaries, and encourages a limited range of on-farm practices). The shortlisted options were also selected on the basis of their differentiation across other variables in the long list, including:

- variations in the point of obligation, to include options that obligate polluters not just at the farm level, but also upstream or downstream the agri-food value chain (farms, processors/vendors, retailers/wholesalers)
- variations in objects/activities where the polluter pays principle is applied (direct emissions, inputs, outputs, activities)

Based on these differences the consortium initially proposed the following policy options:

- **An on-farm emissions trading system for all greenhouse gases**: This option applies the polluter pays principle directly to farmgate emissions. It can be applied either to all GHG emissions (CO_2, CH_4, and N_2O) or to methane and nitrous oxide (excluding CO_2 emissions). The price placed on emissions could either be based on farm-level emissions data (which may be difficult to collect and monitor) or could be based upon farm-level proxy activity data (i.e. livestock numbers, or estimated fertiliser consumption). The trading system could either apply a single price to all emissions or use a split-gas approach to calculating an emission price. The option could include all farms, requiring them to register in a system, or apply a farm size threshold to capture farms that emit a certain level of CO_2e each year, so that the system could exclude small landholders. The consortium proposed this policy option based on the comprehensiveness of its coverage, especially if it is applied to all agricultural emissions. However, even if the option is limited to only CH_4 and N_2O emissions, there is a large theoretical scope of coverage of GHG emissions in the agricultural sector (applying to ~400 $MtCO_2e$). This option was also selected on the basis of having the widest range of coverage in its system boundaries and on-farm practices encouraged.
- **CAP payment deductions**: Similar to the on-farm ETS, this option also applies the polluter pays principle to on-farm activities, and has the potential to be comprehensive in its coverage of activities, system boundaries, GHG scope, and encouragement of on-farm practices that will mitigate GHG emissions. Under this option, subsidy support that is provided through the Common Agricultural Policy (CAP) will be reduced for high emission activities. Penalties placed on high emission activities could be based on farm-level emissions data. This policy option could allow for the study to examine the broader potential harmful impact of subsidies for high emissive activities, which is line with the polluter pays principle that no harmful subsidies should be provided. Penalty-based instruments already exist in some form through the Good Agri-Environmental Conditions, which, if violated, prevent farmers from receiving CAP funds (e.g. GAEC 6 that bans the burning of crop residues on arable land). To encourage emission reductions, the next CAP funding period could design new GAECs targeting emission reductions for various on-farm activities, particularly for livestock (for example, maximum livestock load). This policy option would also offer a large degree of farm coverage, as the CAP supports over 9 million farmers in the EU.
- **An upstream emissions trading system**: This option applies the polluter pays principle to agricultural inputs (fertiliser, feed purchases). The policy option can be based on proxy data estimating on-farm emissions linked to the use of these inputs. The point of obligation is for manufacturers and importers of fertilisers and feed. Under this option, producers further up the supply chain would pay for on-farm emissions based on an emissions charge applied to products manufactured in the EU or imported. An emissions price would be calculated using proxy data linked to the use of the relevant products (fertiliser and feed purchases).
- **A downstream emissions tax**: This option applies the polluter pays principle to agricultural outputs (food processing). This policy option can also be based on proxy data estimating on-

farm emissions. The point of obligation for this option is for meat and dairy processors. Under this option, processors would pay for on-farm emissions based on an emissions tax applied to products supplied to them. An emissions price would be calculated using proxy data linked to the production of the relevant products (milk, meat).

- **A peatland tax:** This option applies the polluter pays principle to agricultural activities occurring on drained peatlands. This option was proposed on the basis of being a much more targeted policy option in comparison to Policy Option 1: its system boundaries is limited to soil carbon emissions, and its impact on on-farm practices encouraged is limited to the re-wetting or management of peatlands, or the encouragement of paludiculture in place of dry-land agriculture. Nevertheless, despite being a targeted policy option, this option could promote significant GHG abatement on farms and areas with abundant peatlands: while drained peatlands only make up 3% of the agricultural land in the EU, they contribute up to 5% of total EU GHG emissions. This policy option could be easily integrated with policy options developed in Task 1b.

In light of these proposed policy options, the consortium consulted with the Commission to review the five policy options proposed, eliciting feedback on the options, and discussing alternative options to be taken into consideration. Based on this consultation, two options were adjusted, and another policy option was replaced in favour of an alternative proposal. The downstream emissions tax and the peatland tax instruments were adjusted to be emissions trading systems instead of taxation instruments. This was due to the potential legal and political challenges in implementing a taxation instrument at the EU level, because of the difficulties in achieving agreement on the necessary legislation, which requires unanimity in the Council. As a result, taxation instruments are in practice a less favoured mean at the EU level for achieving environmental protection.

The CAP penalties option was replaced in favour of an on-farm emissions trading system for livestock. The CAP option was set aside as it would change the fundamental purpose of the CAP. While the CAP has been reformed to increasingly integrate climate mitigation as one of its objectives, it is not solely a climate policy, as it has multiple environmental objectives as well as social and economic objectives beyond environmental ones. While it has been reformed for over two decades to meet multiple EU objectives, its fundamental purpose is to operate as a form of income support for farmers. Therefore, while the CAP will play an essential role in providing financial support to farmers in adapting climate-friendly practices, the focus of this study will be on a policy measure that operates as a separate climate measure.

2.3. Cross-cutting aspects of emissions trading systems for agriculture

In addressing the *balance between the cost and benefits of the system) (first objective),* an emission trading system is considered a cost-effective measure for achieving GHG emissions reductions. In a ‘cap-and-trade' system, a government sets an upper limit on emissions (the ‘cap’) and issues permits, or allowances, for each unit of emissions allowed under the cap. Every polluter covered by the system is required to obtain and subsequently surrender a permit for every unit of GHGs that they emit. Allowances can be purchased in an auctioning process coordinated by the government, received for free as part of free allocation, or purchased on the secondary market from other ETS participants.

Over time, the cap is tightened to ensure emission reductions, enforced through an increasingly limited supply of allowances. Regulated entities can trade their allowances on an open market – if they succeed in reducing emissions faster, they can sell their spare allowances to another ETS participant, or, on the other hand, if they find it costly to abate, they can buy allowances instead. Spare permits may also be saved for future compliance (the banking of allowances).

Because the EU already applies the polluter pays principle through the use of an emissions trading system, the decision was made by the Commission to focus on designing all five potential options in the form of an ETS. Given the choice of a single type of policy instrument, there are cross-cutting aspects that the Commission will need to consider for all five options, namely:

- Emission units to be measured
- Monitoring, reporting on, and verifying the emissions for which participants are responsible
- Setting a cap
- Thresholds for participation
- Allocation and mitigating the risk of carbon leakage
- Including flexibilities
- Ensuring compliance

Measuring emission units

In an ETS, a carbon unit/emission unit is generally equivalent to one metric tonne of CO_2 emissions. As established under the GHG scope, the all-GHG on-farm ETS will encompass both CO_2 and non- CO_2 agricultural emissions. Therefore, the global warming potential (GWP) of methane and nitrous oxide emissions will need to be converted into CO_2-equivalents (CO_2e), which is the number of metric tons of CO_2 emissions with the same global warming potential (GWP) as one metric ton of another GHG. GHG reporting and compliance will be conducted in units of CO_2e. The carbon dioxide equivalent for a gas is derived by multiplying the tonnes of the gas by the associated GWP. CO_2 and N_2O emissions have a GHG effect many decades after their emission, while methane remains in the atmosphere for a short period of time. However, during the time it remains in the atmosphere, its warming potential is very high. Therefore, in order to create a conversion option between long-lived and short-lived greenhouse gases for practical climate policy, the IPCC reached an agreement in its second assessment report (1995) on a comparison period of 100 years: nitrous oxide emissions have a GWP of 298 times that of CO_2, while methane emissions have a GWP of 28 times that of CO_2. These conversions of CH_4 and N_2O can be utilised to measure emission units for the non- CO_2 emissions for agricultural emissions.

How emissions are measured may encourage only a specific mitigation action rather than a range of actions. For example, measuring emissions using the amount of fertiliser used on-farm as a proxy measurement for N_2O emissions may only incentivise farmers to reduce the amount of fertiliser they use but does not necessarily incentivise the adoption of technologies which also can help lower N_2O emissions, such as nitrification inhibitors.

Establishing a system for Monitoring, Reporting, and Verification (MRV) for agricultural emissions

An emissions trading system depends on accurate and trusted data on the emissions for which each regulated entity is responsible. In light of the second objective of this study (*reliable but cost-effective MRV),* this poses a particular challenge for the agriculture sector. The existing EU ETS relies on third-party verification of emissions for each installation, airline, or other regulated entity. Regulated entities report on their emissions each year; those reports must then be verified by an accredited third-party verifier. However, the assessment is generally simple – emissions of CO_2 from combustion of fuel can be estimated reliably based on the quantity of fuel burned (emissions of other gases are more challenging, but are generally related to industrial processes with reliable data).

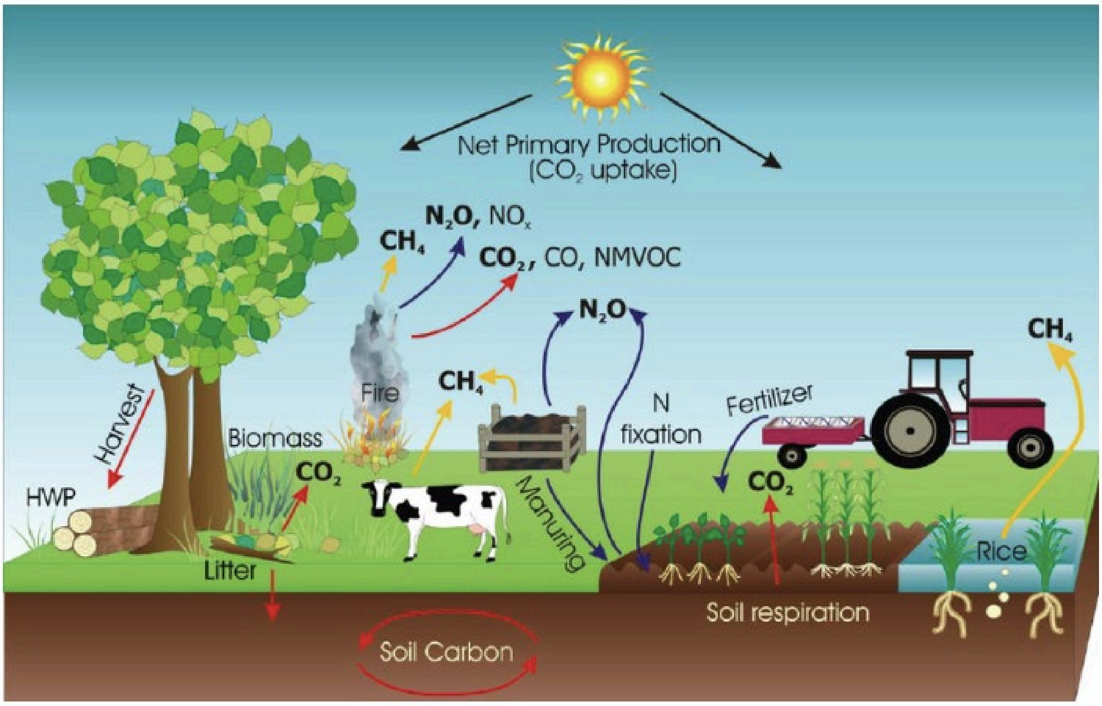
Farm emissions are more varied (particularly for mixed farms, but also for livestock and arable farms), as can be seen from the detailed description below, and less well-understood. This section describes the types of farm emissions potentially needing to be covered by an agriculture ETS; the following section outlines the MRV (monitoring, reporting and verification) approach we have adopted for the five policy options contained in this report; and we then describe in more detail some of the specific challenges in establishing an MRV system for the agriculture sector which our approach aims to address.

MRV: Agricultural emissions and measurement challenges

Farms emit (and sequester) GHGs in a range of ways, depending on their production and the land used. The complexity of some of these physical processes (in comparison with the relatively simple process of CO_2 being generated from combustion of carbon) means that GHG inventories at Member State level rely on significantly more approximate mechanisms for estimating agricultural emissions than in the case of most other sectors. Similarly approximate mechanisms are likely to be required to estimate emissions on a farm-by-farm basis.

Below, we set out a range of emissions from farms, and the measurement challenges they present.

Figure 2 Sources and sinks of GHG emissions in agriculture, forests, and other land use systems



Source: IPCC 2006, Volume 4, Chapter 1 (2)

Livestock and livestock by-product emissions

Livestock produces methane as a product of its digestive processes. These emissions are significantly greater for ruminant livestock (mainly cattle and sheep), but are present for all livestock.

In addition, urine and faeces from livestock generate methane and nitrous oxide emissions. This occurs either as a result of direct interaction with the soil (for pastured animals), or as a result of storage of the manure (for housed animals).

In general, Member State GHG inventories estimate these emissions (and those from organic fertiliser use, see below) on the basis of livestock numbers. This produces a reasonably credible estimate; but this approach means that a range of specific on-farm measures which are known to reduce emissions in practice are not captured within national inventories (except as far as they affect emissions factors used by national inventory). For example, improved storage of slurry can significantly reduce methane emissions; the use of some dietary supplements, or the addition of some elements to grazing or fodder, can lower methane emissions from ruminants; improved animal health can also lower emissions per head of livestock (as well as improving the production efficiency of livestock systems). Similarly, poor management practices which are likely to increase emissions, such as inadequate slurry storage, are not separately identified by national inventories.

Measuring on-farm emissions from livestock can be done using estimates based on livestock numbers (see MRV section below). Estimates of these numbers can be based on the Agricultural Census, the European Agriculture Statistics System (EASS), and data collected under animal health legislation.

The backbone of agricultural statistics has been the decennial Agricultural Census, as required by the FAO, and the related Farm Structure Surveys (FSS). The FSS is the only statistical source covering the widest range of farms. The legal basis for the Farm Structure Surveys (Regulation 1166/2008) expired after the survey in 2016. Following the Commission's publication of the 'Strategy for Agricultural Statistics for 2020 and beyond,' the European agricultural statistics system (EASS) is undergoing a major modernisation. The objective is to provide the most accurate statistics for the design and evaluation of the agricultural and other related EU policies (e.g. climate and environment policies), while reducing the costs and burden of data collection. The plan is to integrate existing agricultural statistics with two new framework regulations: an integrated farm statistics regulation covering data on farm structure that was adopted as Regulation EU 2018/1091 and was in place before the 2020 agricultural census; and a framework regulation on statistics on agricultural input and output (SAIO), which will enter into force as of 1 January 2025.

The EU Animal Health Law (Regulation 2016/429) requires each bovine to have a unique identification tag, and for Member State competent authorities to track information on ownership and location. Rules for sheep are less strict, as lambs destined for early slaughter don't need to be tagged. Rules for other livestock are significantly less stringent, mainly because they are less likely to be transferred between farms (e.g. pigs live and die in the same unit). Sheep data requirements were apparently very controversial and unpopular when the legislation was negotiated. The Commission could consider updating the Animal Health Law to improve data.

The Irish Animal Identification and Movement database (AIM) maintained by the Department of Agriculture, Food and the Marine (DAFM) serves as a good example of a robust animal data collection mechanism at Member State level. The system captures details of all animal movements, as well as recording information including dam type, sire type, breed, gender and age. It can also be used for veterinary certification and to assist disease prevention. The system is accompanied by a mobile app, which allows farmers to complete calf registration from their smartphones, including when they are not able to access the internet. The AIM data can be used in tandem with information collected through the Teagasc National Farm Survey and private initiatives at national level, such as the ICBF database, for the development of nationally-relevant emission factors.

Fertiliser emissions

Fertiliser application generates nitrous oxide emissions. This occurs as a result of using either synthetic fertilisers, or organic material as fertiliser. (Synthetic fertilisers also generate significant emissions in their manufacture, but these are already addressed by the existing EU ETS, and are not included in the agriculture section of GHG inventories, so are considered out of scope.) Synthetic fertiliser emissions are generally estimated from the quantity of fertiliser sold (and assumed to be applied); organic fertiliser emissions are estimated on the basis of livestock numbers. Again, this approach does not capture key measures likely to increase or decrease emissions in practice, such as the use of legume crops or catch crops, the use of anaerobic digesters, application of fertilisers to maximise nitrogen uptake and minimise run-off, and so on. Another means for estimating fertiliser emissions could come from reporting requirements under the CAP, e.g. in the case of Spain, farmers are required to track fertiliser and organic matter inputs to soil (new GAEC 10 in the Spanish CAP Strategic Plan).

Soil carbon emissions and sequestration

Soils both sequester and emit carbon dioxide. Emissions can occur on changes in use, particularly conversion of pasture land to arable (and also conversion of forestry to agricultural land), and through normal use of agricultural land (for example, carbon sequestration, particularly in grassland, and carbon losses through ploughing). A range of categories are included in the Land Use, Land Use Change and Forestry section of national inventories (and also in the LULUCF Regulation[16]), including managed cropland, managed grassland and managed wetland. Emissions are estimated on the basis of emissions factors applied to categories of land, and categories of land conversion.

In contrast to nitrous oxide and methane emissions, more detailed soil carbon measurement is possible on a land parcel by land parcel basis (or, in the case of peatland, peat depth can be measured); and a time series of such measurements can give a more accurate indication of net carbon sequestration. However, this is a relatively expensive and time-consuming process, and the land parcels chosen for measurement would need to be carefully selected in order to provide an accurate estimate across a whole farm holding.

Peatlands

Monitoring of peatland emission is regarded as problematic due to the diversity of peatland habitats, including the parameters (e.g. weather, vegetation, soil, species) that have a seasonal and yearly influence on GHG emission. While direct, on-site measurement of carbon stored and GHG emitted can provide accurate data, the cost can be excessively high (McDonald et al., 2021); Dunn & Freeman, 2014); and for larger sites, a number of locations need to be monitored to provide an accurate estimate. Conducting on-site and continuous monitoring is therefore not feasible or cost-efficient to collect primary data in real time for all indicators on a regular basis (COWI et al., 2021). Consequently,

[16] Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, as amended by Regulation (EU) 2023/839 of the European Parliament and of the Council of 19 April 2023

the assessment of GHG fluxes from peatlands as direct and precise measurements are only feasible for pilot sites (COWI et al., 2021). A further consideration is that extending a monitoring system to all peatland farm holdings would also mean that the land requiring monitoring significantly exceeds the number of soil scientists capable of making the measurements and assessing the results, even in the Member State with a high level of experience in peatland management. A system could be envisaged based on a combination of (i) emissions totals calculated on the basis of centrally-held data; (ii) scope for farms to sign up to mitigation certification schemes and deduct reduced emissions/ sequestration from their calculated totals; and (iii) a progressive roll-out of tailored carbon assessments of each holding.

Rice

Rice production in the EU is relatively minor, with Italy being the main producer (almost all in the Po Valley); other member states producing rice include Spain, Portugal, France, Bulgaria, Romania and Hungary. Rice cultivation produces methane through anaerobic processes in flooded fields. (Nitrous oxide emissions from soil fertilisation also occur, but are generally estimated alongside other emissions from fertilisation). Estimates are made by applying emissions factors to the number of hectares used for different types of rice cultivation regimes.

Our proposed approach: a mandatory ‘default method’ together with a voluntary 'certified method’

We set out below some of the key issues to be addressed in determining an appropriate approach to MRV. The proposed approach strikes a balance between the second objective of this study (*reliable but cost effective MRV*), the fourth objective (*provide incentives for innovation and changes in agricultural production*), as well as the issues outlined above. The approach can also support the first objective of this study, in *balancing the costs and benefits of an emission trading system*. Following discussion with the Commission, the approach is essentially similar for each of the 5 options, and consists of making available two methods, a mandatory 'default method’ and a voluntary 'certified method.’ The ‘default method’ would apply to all regulated entities (except where they choose the certified method – see below),

Default method

The **default method** would be a relatively simple standard calculation of emissions, performed through a centrally-managed database, and based on readily identifiable data (for example, livestock numbers, fertiliser use). Alternative mechanisms for applying this approach for the on-farm options would be (i) for member state authorities to make use of the data already available to them (supplemented where necessary, for example with data from suppliers of fertiliser), and (ii) for farm operators themselves to input the necessary data. Our recommendation is to use centrally-available data rather than to rely on individual farms inputting data.

Regardless of the mechanism adopted for data input, the calculation would be a fairly simplistic estimate of emissions based on factors like the numbers of different types of animals owned, the total use of fertiliser, etc.. Specific management techniques which could be adopted by farms to limit emissions (such as more efficient approaches to the application of fertiliser to avoid run-off and losses; dietary supplements to reduce methane emissions from livestock; soil management techniques to improve carbon) would not be reflected in these calculations.

As noted above, the approach to default calculation is to base it on data already available to public authorities; this would help to ensure consistency and would reduce bureaucratic demands on farmers – thus support objective two (cost effective MRV). Some investigation would be necessary to establish whether the necessary data is both available to, and can be used by, the competent authorities in Member States. If it is not, it would be necessary to use the 'certified approach' (see below) of requiring farms to input their own data directly to a central database which would then calculate an emissions total.

Assuming the preferred approach of a central calculation of emissions is adopted, competent authorities designated by Member States would be responsible for ensuring that the relevant information was made available by the relevant public authorities (for CAP and animal health data). Detailed rules for the data required, and the calculation of emissions based on that data, would need to be established at EU level in implementing regulations. A process for communicating the calculated emissions to farms, and allowing them to challenge the data used in the calculation, would be likely to be required, and would need to be managed by the MS competent authorities.

Certified method

However, in light of the fourth objective of this study, we propose the inclusion of a second approach which can *provide financial incentives for farms to adopt mitigation practices and innovate*. The second approach to MRV is the **certified method.** Under this approach, farms would be able to opt out of the default calculation by volunteering for a more detailed farm level calculation of net emissions at their own expense, with certification by a verified third-party assessor using methodologies approved by the Commission (similar to the approach proposed for the Carbon Removals Certification Framework). These certified emissions calculations would reflect the sorts of climate-friendly management techniques which the default calculation fails to pick up, and would state how the farm's emissions differed from the emissions implied by the default calculation. Farms could use these certified emissions reports to replace the default calculation for their emissions, in the case of the on-farm options (options 1 to 3).

This approach provides incentives for farms to adopt a more detailed farm-by-farm approach, and to adopt additional mitigation practices in so doing (since we assume that only farms which would be able to demonstrate significantly lower emissions would find this option attractive). Over time, this may lead to the development of an adequate supply of providers of on-farm assessments to consider a progressive move to requiring on-farm assessment. A further benefit, assuming that adoption of the certified approach increased over time, would be steadily improved understanding of how different management approaches affect emissions, which would be of wider global benefit, and could be enhanced by links to EU research funding. Data from the proposed Soil Monitoring Law[17] would be a valuable reference point in assessing the accuracy of the various methodologies (the default approach, and methodologies approved under the certified approach), although it is unlikely to provide data which is useable for assessing soil emissions on a farm-by-farm approach.

Given the likely cost of the certification approach, consideration should be given to encouraging collective adoption of mitigation practices and collective assessment for groups of farms, in order to

[17] Proposal for a Directive of the European Parliament and of the Council on Soil Monitoring and Resilience (COM (2023) 416 final)

ensure that smaller producers could also benefit from the voluntary approach; this could involve the use of subsidies co-funded by the Rural Development pillar of the CAP.

If the certified approach of on-farm input of data were chosen, significantly greater governance will be required to ensure accuracy of the data provided by farms. A process of random checks of a sample of farms would be necessary, implemented by the competent authority at national level. A standard approach to the calculation of emissions based on the proxy data would need to be established at EU level; however, the interface for farms to input the data is likely to be best designed at national level, allowing for a focus on the data most likely to be relevant (relevant species and breeds, etc).

The JRC carbon calculator includes mitigation options that may be suitable for farms to be assessed for under the 'certified' approach, and results from a survey found this calculator aided farmers in identifying practices that could reduce emissions. The New Zealand He Waka Eke Noa proposal for an on-farm carbon levy also recognises mitigative practices in its on-farm calculations, including practices that improve production, reduce the total feed eaten, manage effluents, and use new and future mitigation practices such as feed additives. The French voluntary carbon market certification programme Label Bas Carbone also uses a carbon audit methodology, known as CAP'2ER. Farmers, with support from farm consultants, enter approximately 150 inputs into a custom farm carbon audit tool to calculate emissions, and then emissions are recalculated when reduction measures are implemented under management change.

Table 2 provides examples of mitigative practices included in the EU Carbon Calculator, the He Waka Eke Noa proposal, and the CAP'2ER.

Table 2 Examples of mitigative practices included in farm-level GHG calculators

Mitigative practice	EU On-Farm GHG Calculator	He Waka Eke Noa On-Farm Carbon Levy Proposal	CAP2'ER
Reduce synthetic fertiliser use	✓	✓	✓
Urease inhibitors	-	✓	-
Improved manure management	✓	-	✓
Keep soils covered all year	✓	-	✓
Introduce legumes	✓	-	-
No/low tillage	✓	-	-
Agro-forestry and landscape elements	✓	✓	✓
Feed management	✓	✓	✓
Adjust livestock numbers	-	✓	✓
Improve animal housing			✓
Increase livestock performance	✓	✓	✓
Livestock gene editing	-	✓	✓
Feed additives	-	✓	-
Methane vaccines	-	✓	-
Nitrification inhibitors		✓	-

Enhanced fertiliser products	-	✓	-
Avoid burning residues	✓	-	-
Biogas production	✓	✓	-
Improved on-farm energy use	✓	-	✓

The certified approach will need to take into account the potential impacts of some CH_4 reducing techniques. Intensification of agriculture can lead to environmental problems, such as disrupted nutrient cycles, loss of biodiversity, air, water, and soil pollution (FAO 2013). Feed additives can impair animal sanitation and often only lead to short term CH_4 reductions because CH_4-forming microbes adapt quickly to the treatment (Herrero et al 2016). For CH_4 reducing feeding habits, grasslands may be converted into maize fields for animal feed cultivation and the resulting carbon loss may exceed the CH_4 savings (Vellinga and Hoving 2011).

Animal welfare problems are also of concern, as measures to reduce livestock emissions could lead to intensive livestock practices that have negative implications for animal welfare. Future discussions should focus on developing potential solutions to ensure the risk towards other environmental problems and animal welfare could be integrated into the certified approach.

Key MRV issues for the farm sector

Currently available on-farm carbon calculators unlikely to be appropriate for regulatory application

There are already a number of on-farm calculators available to estimate agricultural emissions at a farm level, further information on which is detailed below. The Commission's proposal for the certification of emissions removals envisages farm-by-farm calculations. Both approaches are based on voluntary participation by farm businesses, who have a genuine interest in identifying their climate impact. For a number of variables, a degree of estimation or subjectivity is permitted. Applying similar tools on a compulsory basis to all farm businesses would be a very different proposition; there would be a significant risk of farms supplying data in a way which ensured that they minimised their recorded emissions. Even if deliberate under-reporting were not a significant issue, farms may struggle to identify exactly what the correct input variables are. We therefore consider that applying detailed farm-level calculations to all farms regulated under the system is unlikely to be suitable, at least at the inception of the ETS.

Several on-farm carbon calculators are already in existence. The Joint Research Centre developed a methodology for an EU-wide farm-level carbon footprint calculator (2015), which quantifies GHG emissions based on international standards and technical specifications on Life Cycle Assessment. The calculator asks farmers to identify a maximum of five main products that a farmer sells to market, e.g. milk, animals (for meat), eggs, or seeds (from crops) or whole crops. The crop that is used for silage or feed is not a product but used on-farms. The livestock module takes all information on animal production including the animal intake (from grazing or from feed or feedstuffs and the manure management). The cropland module takes all information on growing crops, feed crops and pasture or grassland including the soil management (tillage, residue management) and fertilisation (mineral fertiliser, organic fertiliser and chalk as well as fertilisers and pesticides). As a consequence, livestock farmers who grow crops (including fodder) or use residues for feed need to complete the relevant parts of the crop module as well. To assess the emissions, data is supplied to the Carbon Calculator. Data should be retrieved from farm records, if available. If data cannot be retrieved from written records, then farmers are asked to flag this and provide an estimate instead.

The New Zealand He Waka Eke Noa proposal for an on-farm carbon levy includes a single centralised calculator using either a simple method, which is easier to complete but is less accurate, while a detailed method captures a wider range of on-farm efficiencies and optimised farm management, which takes more time to complete but is more accurate. Both options combine the on-farm calculations with actual farm production data.

There are also a number of on-farm carbon calculators that have been developed either by the academic sector or by businesses for consultancy-oriented purposes or by not-for-profit organisations, including:

- AgRE Calc (Agricultural Resource Efficiency Calculator): developed by the consulting division of Scotland's Rural College.
- The Cool Farm Tool: developed at the University of Aberdeen.
- The CALM Calculator: developed by the Country Land and Business Association, in partnership with Savills.

Each calculator employs a unique range of methodologies, and the scope of the assessment varies. These calculations would estimate the quantity of on-farm emissions from the sources included in Table 3.

Table 3 Emission sources included in on-farm calculator tools

Emissions sources included in calculator	JRC carbon footprint calculator for European farms	He Waka Eke Noa proposed centralised calculator - simple	He Waka Eke Noa proposed centralised calculator - detailed	The Cool Farm Tool	AgRECalc	CALM
Crop residues	*Yes*	*No*	*No*	*Yes*	*Yes*	*Yes*
Manure application	*Yes*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
Fertiliser Application	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Manure management	*Yes*	*No*	*No*	*Yes*	*Yes*	*Yes*
Enteric fermentation	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Feed stuffs	*Yes*	*No*	*Yes*	*No*	*No*	*No*

On-farm energy use	*Yes*	*No*	*No*	*Y es*	*Y es*	*Ye s*

A key aspect of the New Zealand experience in implementing a carbon pricing policy for agriculture to consider is the preparation for on-farm MRV in advance of a carbon pricing measure for agriculture by phasing-in requirements for emissions reporting with a programme entitled 'Know Your Numbers.' The goals of the programme are to ensure that farmers know their annual total emissions at the end of a two-year period (by the end of 2023), and that by January 2025, all farmers will have a plan to monitor and manage their emissions. A range of different calculators have been made available to help farmers calculate their footprint. As of date, 80% of farmers know their total annual emissions, and 40% have a plan to monitor and manage their emissions. A similar programme to help phase in an on-farm reporting MRV system could be considered for an EU ETS for agriculture.

Use of proxy data to estimate emissions

Monitoring and reporting of emissions for farms could, instead, be based on the use of proxy data already available to public authorities, from e.g. the CAP Land Parcel identification System (LPIS), and livestock data held under the Animal Health Law. However, existing data will not address a full range of GHG emissions drivers on farms, and would need to be supplemented by data collected from third parties such as fertiliser suppliers. If further assessment of the availability of such data suggests that this is not a feasible option, then estimation and reporting of emissions will initially need to be based on farms inputting data to an emissions calculator.

On the assumption that data on livestock held by each farm is readily available via animal health authorities, calculations of emissions will be relatively straightforward: emissions factors can be applied to the livestock numbers for each farm (differentiating by age and breed where possible).

The disadvantage to measuring on-farm livestock emissions is the immense effort involved in recording and monitoring the multitude of agricultural practices relevant to livestock (differing emission intensities according to species and form of livestock farming (Ekhardt et al 2018; Wirsenius et al 2011; Gerber et al 2010; Grosjean et al 2016). Even now, environmental standards in agriculture are often not complied with, and detailed inspections have limits (see explanation of enforcement of CAP GAECs and challenges associated with this in all-GHG on farm policy option). Therefore, the use of approximate values of GHG emissions from livestock may need to be used (Gerber et al 2010), which is similar to how meat taxes are measured. The quantity of the number of animals is easier to measure objectively than on-farm emissions: most of the data required for this is already collected under existing agricultural regulations and applications for subsidies under the EU Common Agricultural Policy (De Cara et al 2011).

If the Commission was to consider indirect emissions from land use for growing feed, as well as the emissions associated with the production of feed (i.e. transport and energy costs), then this would imply a life cycle analysis (LCA) of livestock emissions LCA. It is challenging to define the boundaries of such accounting systems, but it is not infeasible. However, as of date the UNFCCC has not released guidelines on emission accounting following an LCA methodology, and while this is not necessary to measure emissions that are priced, it would nevertheless be helpful to have a reliable standard upon which to rely on.

Further consideration is needed on how to ensure that the data used for assessing livestock numbers represent a farm's emissions fairly, and avoid the risk of gaming. For example, if a calculation is based on numbers at a single annual date are used, it might not reflect regular seasonal transfers of livestock between farm holdings; and, assuming there are a number of small farms excluded from the system under a de minimis threshold, farms could be able to transfer part or all of their livestock for a short period to excluded farms to reduce their emissions calculation.

General emission values can be related to various output measurements: the type of livestock animals, the number of livestock (heads), livestock units, or the kilograms of an animal product. To measure emissions for both methane and N_2O, a species-specific uniform value could be used. Under a species-specific uniform value, each animal is assigned a specific quantity of methane or nitrogen (i.e. a herd's average milk yield). Since the emission intensity of livestock farming varies between regions, emission values could be based on regional or national average values instead of EU-wide values, which are determined using standardized methods. These generalized emission values can be further differentiated by distinguishing between production methods, such as manure management or grazing or pure stable farming (Grosjean et al 2016).

The calculation can be based on the full range of emissions associated with livestock, including enteric fermentation, manure management, and the use of manure as fertilizer. The latter would create a slightly higher burden on livestock farms than on arable farms using artificial fertilizer as long as the latter will not face a carbon price on the emissions generated from fertilizer use. Livestock farms selling manure and other by-products to other farms may take the view that their calculated emissions should be reduced to reflect that the fertilizer use emissions are happening elsewhere; but a strict approach would regard them as being primarily associated with the animal rather than the application as fertilizer.

Depending on the animal type and the mode of production practices, an average value could be calculated based on cradle to gate analysis, where the total CH_4 and N_2O emissions from livestock lifespans and number of livestock are taken into account. The advantage of measuring general emission values per animal is that it will encourage farmers to reduce livestock numbers while increasing the highest possible yield of an animal to lower certificate costs. However, measuring emissions based on weight of livestock, which would be a more accurate measurement of emissions, may disincentivize increasing the performance per animal, as weight would be the basic factor for certificate estimation, not the performance of the animal.

Linking emissions to suppliers or processors

A further challenge arises for two of the policy options, the upstream option (Option 4), and the downstream option (Option 5). In both cases, the point of obligation for emissions trading is not on the farm, but at a different point on the supply chain. The use of proxy calculations of emissions, based on broad quantity information on sales to or purchases from farms would therefore be necessary. Either suppliers to farms (for Option 4) or downstream processors (for Option 5) could buy credits generated from the certified on-farm voluntary credit approach, and use them to satisfy their obligations to retire allowances to cover their emissions.

Information available to public authorities

Given the number of farms potentially covered by an ETS, and the need for consistency in reporting of emissions, the preferred approach would be for public authorities to use existing available data. This could be supplemented by data obligations on third parties, particularly suppliers of fertiliser. Much of the relevant information is already available to public authorities, particularly through the Land Parcel Identification Systems required under the Common Agricultural Policy[18], and under the Animal Health Law[19]. An assessment would be necessary of whether this information can be used for additional legislative purposes, or whether specific provisions to permit this should be included in legislation setting up an agriculture emissions trading system[20]. Given the risks of inaccurate and diverse approaches to the input of data under the on-farm option, this has significant advantages, if adequate data is available.

Challenges from on-farm input of data

If the preferred approach of a central calculation by public authorities is not available, it would be necessary for farms to provide their own data. This would be potentially complex and challenging for many farms; and would face significant risks of variation in approach, and of either deliberate minimisation of emissions, or optimism bias on the part of farmers. A number of tools exist enabling farms to estimate their GHG emissions[21], some of which are based on farms inputting their own data, and others based on an external expert assessment (see Annex X). However, enabling farms to choose which of these mechanisms they used to input data would run into the problem of gaming (with farms choosing the tool that provided the most favourable calculation for their circumstances), and would also be complex for farms to navigate. We therefore advise specifying a single calculation mechanism, either in the form of farms inputting data to a central database, or the mandatory use of a single emissions calculation mechanism. Given the challenge of covering all farm types across the EU, it may be necessary to use a single calculator for each Member State, with the Commission having a role in approving each Member State calculator.

Impact on adoption of mitigation practices

There is clearly a trade-off between the complexity of the calculations made for each farm, and the administrative simplicity of the system, both for participants and for public authorities. However, the way in which emissions are measured will have an impact on incentives for mitigating behaviours. To take an example, nitrous oxide emissions from the application of organic or inorganic fertiliser are closely linked to weather conditions: dry weather favours a high level of uptake by soil and crops, whereas wet weather leads to run off, and both water and climate pollution. A key mitigation measure is therefore to plan application of fertilisers for dry weather, and avoid periods when rain is forecast. However, recognising such good practice in an MRV system would be difficult, and may need to rely on case-by-case judgement.

[18] See Article 69, Regulation (EU) 2021/2116 of the European Parliament and of the Council of 2 December 2021 on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013

[19] Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law')

[20] Our assumption is that LPIS information will be capable of being used, since (presumably) participation in and compliance with the emissions trading system will be an element in cross-compliance in the post-2030 CAP.

[21] See for example the Farm Carbon Calculator (https://calculator.farmcarbontoolkit.org.uk), or the ClimAgri tool developed by the Agence to l'Environnement et de la Maîtrise de l'Energie (https://expertises.ademe.fr/agriculture-foret/production-agricole/passer-a-laction/dossier/levaluation-environnementale-agriculture/loutil-climagri).

Availability of trained advisors to verify emissions

A key constraint on the available MRV options is the availability of a sufficient number of experts capable of carrying out a farm-by-farm on-farm assessment of emissions. The training and development of a supply of suitably qualified and accredited assessors will take time; while a farm-by-farm approach may prove feasible over the longer term, it will not be feasible in the early years of an ETS.

Linking MRV values to national GHG inventories

National GHG inventories for the agriculture sector rely on more approximate estimates than for other sectors, for example applying an emissions factor to number of livestock units for individual species. A relatively simple approach to calculating emissions under an ETS could be expected to replicate these results with some accuracy; but a more complex system which recognises specific mitigation practices (see the application of fertiliser example above) would diverge from the results of national inventories. To the extent that the data quality of reported emissions under an ETS is better than that of inventory reporting, Member States and the EU would need to ensure that their national inventory methodologies were updated (with the necessary approval from the IPCC process) to reflect the impact of the ETS policy.

Fluidity of farm business structures

The relative fluidity of farm business structures in some regions (where farms take on or shed additional parcels, sub-divide or combine on a frequent basis, which means that the parameter of the farm business is not stable from year to year) creates challenges for monitoring, reporting and verification of emissions (MRV), as for other regulatory aspects of emissions trading. Even within a stable farm business, changes in-year as part of the normal process of agricultural production will need to be accommodated (for example, changes in the age-structure of livestock herds; decisions to rent or cease renting land from other farm holdings; sales of livestock to, or purchases from, other farm businesses).

Administrative complexity and costs related to MRV

A process for identifying the farms subject to regulation under the Emissions Trading System will be necessary; using the same approach to determining a farm holding as is used under the CAP would help to ensure coherence[22]. Some governance complexity may arise in Member States which implement the CAP on a regional, rather than a national basis (i.e. in Germany this occurs at the level of the Laender rather than at the federal level). Provided that the EU legislation creates a clear obligation on Member States to ensure that all qualifying farms are regulated, the detailed rules for identifying the qualifying farms can be determined at national or regional level.

A particular driver of administrative complexity and costs in this system is the relatively fluid nature of the entities regulated. Farm businesses are more prone to change than the static installations initially regulated by the EU ETS: although the patterns of land ownership and tenure vary from Member State to Member State, there is a tendency for farm businesses to take on new land, or release land; and to subdivide or combine. This will pose some challenges for any de minimis rule (particularly given the risk

[22] See Regulation 2021/2115, Article 3.1:

> “*(a) "farmer" means a natural or legal person, or a group of natural or legal persons, regardless of the legal status granted to such group and its members by national law, whose holding is situated within the territorial scope of the Treaties, as defined in Article 52 TEU in conjunction with Articles 349 and 355 TFEU, and who exercises an agri cultural activity;*
> *(b) "holding" means all the units used for agricultural activities and managed by a farmer situated within the territory of the same Member State*”.

This definition is unchanged from the previous CAP, and is well understand by farmers and public authorities.

that farms will see an advantage in subdividing in order to benefit from any de minimis rule), but also for assessing emissions on an annual basis, and for allocating free allowances (if any). Competent authorities may need to invest significant time and effort in dealing with complex cases. As discussed above, consideration of horizontal producer organisations that can assist farmers with the administrative efforts associated with participation in an ETS should be considered.

In addition, a number of private sector costs can also be anticipated. These include: administrative costs for system participants; potential administrative costs on private sector providers of data for system management (for example, data from suppliers of fertiliser). These costs will depend to a large extent to the choices made for monitoring, reporting and verification mechanisms (see below). In addition, system participants will face the administrative costs of ensuring that they have sufficient allowances to match their emissions, including (potentially) participation in auctions or other mechanisms for purchasing allowances. There is significant scope for reducing these costs through a collective approach – for example, cooperative mechanisms to purchase and hold allowances - which could be encouraged through Member State Rural Development Programmes.

Some estimates of potential administrative costs for a results-based carbon farming scheme were provided in a report for the Commission by COWI et al in 2021[23]; however, this is based on the assumption that farms will be demonstrating GHG mitigation on a voluntary basis. A key issue the report notes for practicality of any mechanism is the limited availability of people with the necessary skills and expertise for detailed assessment of on-farm emissions; evidence from discussion with invited experts as part of this project also suggests that experience of addressing agricultural emissions in other economies (e.g. Australia) has led to a significant increase in the need for competent consultants.

As noted in the MRV section below, some of the choices to be made on how individual farm emissions are estimated will have a significant impact on system costs. As the COWI et al (2021) report notes, nearly all of the existing carbon calculator tools rely heavily on self-assessment by farmers. While this can reduce costs, it creates significant potential for variation in accuracy of results, and incentives to manipulate data inputs to achieve more favourable results.

A key issue for consideration is the impact of any system on a sector which is largely comprised of SMEs or micro-businesses, with limited scope for additional administrative burdens (depending on the size of the benefits associated with the burden). This would also have implications for the behavioural response to emissions trading: farms may have limited scope for allowance trading, and may find price fluctuations difficult to understand or to respond to. These problems may be addressed in part by collective responses (for example, cooperative structures to hold and manage allowances).

A range of potential impacts on other EU policies will need to be addressed. There is a potential need (see the monitoring, reporting and verification section) for other data sources mandated by EU legislation (CAP, animal health) to be used to generate emissions estimates. The interaction with the CAP will be particularly important to manage: this includes the application of cross-compliance to any emissions trading system focused at the farm level, as well as the potential for CAP support for structures to deal with the administrative costs to farm businesses, information provision to enable

[23] 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, DG Climate Action

farms to understand and comply with their obligations, and for further incentives for mitigation measures.

Non-obligated parties and the generation of certified on-farm voluntary credits

In order to *enhance the financial incentives for changes in agricultural production* (objective 4), it could be envisaged to provide farms that are not regulated by an ETS option an opportunity to receive financial support in transitioning towards mitigation practices by allowing them to sell the corresponding emission reduction credits to entities covered by the ETS.

Non-obligated farms could have the opportunity to calculate and certify their emissions in a detailed and accurate way on a voluntary-basis.[24] If non-obligated farms adopt this option, they could be given tradeable credits generated through the certified approach. Part 2 of this study (AgETS+Removals) also considers the use of credits, but such credits are to financially reward LULUCF carbon removals (see policy model 4 in the AgETS+Removals part of this study). The credit models proposed in this part of the study and in the AgETS+Removals part share many similarities.

The quantity of credits generated can reflect the difference between their certified emissions, and what their calculated emissions would have been on the standard proxy calculation. These credits could be purchased by obligated parties under the ETS option (e.g. processors in the downstream option, or fertiliser producers in the upstream option). This approach, however, does not necessarily have to be limited to the downstream or upstream policy options. Non-obligated parties for each of the five policy options could include:

- All-GHG On-Farm ETS: small farms (if thresholds for participation are established)
- Livestock ETS: all arable farms; small livestock/mixed farms (if thresholds for participation are established)
- Peatlands ETS: all farms not on cultivated peatland soils
- Upstream and downstream ETS: all farm emissions not covered by the emission scope of the system

If farms are not directly regulated by the ETS themselves, and the emissions are outside the ETS scope, they could sell credits demonstrating the extent to which their emissions are lower than the default values to other regulated entities (either to suppliers or processors under options 4 and 5, or to livestock farms under option 2 in the case of emissions reductions in the arable sector, or to peatland farms under option 3 in the case of emissions reductions on non-organic soil farms). However, if the emission reductions certified under this approach overlap with the scope of the ETS in place (e.g. if livestock farmers sell credits for the reduction of livestock emissions to downstream meat or dairy processors), then the ETS cap would need to be adjusted accordingly to ensure that the policy is effective for the sector as a whole.

Regulated entities could present these certificates to help meet their obligation to surrender allowances covering the total of their emissions. If non-obligated parties participate in adopting practices to reduce emissions, such participation could help to improve the 'certified' approach system. This Certified On-Farm Voluntary Credit approach has the advantage of increasing the potential

[24] Obligated farms under the on-farm options could also potentially earn credits as long as the emissions that are reduced are not under the regulatory scope of the ETS, and as long as double counting is prevented. For example, a mixed farm under a livestock ETS could earn credits for reducing fertiliser emissions.

mitigation contributions from on-farm actions for each of the policy options by increasing the potential number of participants in mitigation options. It also provides farmers engaging in pro-mitigation behaviour with the opportunity to generate additional income under the ETS.

Setting a cap

Under an ETS, the EU will be the responsible jurisdiction for precisely defining an emission cap and change it over time. Setting an initial cap could be decided based on an assessment of the entire agricultural sector's historical emissions within the EU, its projected emissions (which depend on both anticipated improvements in emissions intensity), and mitigation costs and opportunities. It is not necessary to align a cap based on such an assessment, as setting a more stringent or more lenient cap is ultimately a political decision that will be made in combination with stakeholder consultations, as well as considerations of costs and benefits of the economic and social implications, not just historical and projected GHG emissions. A couple of the experts interviewed for this study shared the view that the existing climate ambition and emissions targets at EU level should serve as the starting point, with agriculture's overall mitigation potential vis-à-vis other sectors also being taken into consideration in the decision-making process regarding the cap.

The Commission should consider how various policy instruments that currently apply to agricultural sector GHG emissions can be complemented with an ETS – for example, the inclusion of agriculture as an ESR sector, the targets under the Farm to Fork Strategy that may be impacted by climate mitigation activities, and the inclusion of agriculture in the climate policy architecture post-2030. Emission allocations should be measured in accordance with reduction targets.

Choosing a time period for the cap is very much related to its stringency: establishing a long time-period for a cap lacks flexibility for adjustments, but provides more policy certainty. For the on-farm policy options, the process for establishing a time period should consider how farms will need a long period of time to make adjustments and for the effects of long-term investment decisions to take effect, but must also maintain flexibility to help farmers respond to evolving circumstances.

As to who sets the cap, for the first two phases of the EU ETS, cap setting was initially left to Member States, subject to approval by the Commission, and then from phase 3 onwards was set directly by the EU legislative process. The idea behind this was to allow for flexibilities to account for variations across Member States during the initial phases. However, the experience from Member States setting caps was largely negative as they lacked ambition to reduce emissions. Nevertheless, at the time it was needed politically to get Member State buy-in for an ETS. Therefore, the Commission will need to ensure legal certainty and environmental integrity and therefore it may be preferable for the cap to be set as an EU-wide legislated target.

For the EU, establishing a cap should be built on the MRV data of existing emissions. This could be based on a two-year pilot phase-in of an MRV system to allow for the collection of more precise data as well as to allow for farmers to adjust to new reporting requirements. The level of ambition of setting a cap could reflect the objectives of other relevant policy measures, including targets under the Farm to Fork Strategy, the sink target under the LULUCF Regulation, and the environmental requirements to receive funding under the Common Agricultural Policy (CAP), as well as commitments to reduce emissions under LTS and NECPs should be taken into consideration. The cap could also be inspired by the Global Methane Pledge, where participants (including the EU) have collectively committed to reducing global methane emissions by 30% by 2030. If the Commission introduces targets for the agriculture or AFOLU sector in the climate policy framework post-2030, then such a target could inform the cap set by the EU.

It should be noted that the opportunities envisaged to link non-obligated entities to the ETS through the certified approach to MRV makes it challenging to set the cap at the right 'amount' - there may be a reasonably good estimate of the emissions of the obligated parties, but not of the potential influx of credits. Therefore, it should be taken under consideration whether to limit the amount of credits that can be generated by non-obligated farms or establish a fully integrated system. In case credits covering the same emission scope as the ETS would be allowed in the system, a corresponding cap adjustment would need to be considered to ensure that the additional mitigation at farm level also translates into EU level mitigation.

Thresholds for participation

Small emitters can face relatively higher compliance costs when complying with an ETS. Thresholds are often used to help reduce compliance costs for smaller entities, as well as to lower the costs of operating an ETS. In the EU ETS, this is done by a 20 MW threshold for installations covered. As a result, there is a manageable number of installations within the energy and industrial sectors that fall under its scope (~11,000). If an ETS is designed to be applied at the farm-level, similar considerations on appropriate thresholds for participation need to be established, otherwise there could be potentially over 10 million farms included for the on-farm options for which each would have to be reporting its GHG emissions under, or the up- or downstream options would be of similar size to the current EU ETS. Therefore, with the first objective of the study in mind (*minimise the burden of implementation)*, the use of de minimis thresholds should be taken into consideration as a policy design aspect of an agricultural ETS for the purposes of reducing initial administrative costs and complexity.

The decision to implement thresholds should be based on the capacity of the farm to manage ETS compliance – for example, participation would be difficult for small-scale subsistence farms as they would have limited financial and human capacity and this could influence many small-scale farmers' decision to continue to operate, as well as the EU's capacity to enforce compliance. A potential option to overcome such a challenge could be to allow for groupings of farms, similar to horizontal producer organisations or carbon farming operators, in order to reduce administrative costs and burdens for small farmers. A further consideration for participation is whether a land *manager* or land *owner* will be the responsible unit. It is worth noting that under its proposed on-farm carbon levy, the New Zealand government has indicated that the point of obligation will be with land owners, rather than land managers.

Another key consideration of choosing thresholds can include whether there are many small sources of emissions; if so, then a lower threshold may be needed to ensure a large proportion of emissions is covered. Indeed, while the number of subsistence farmers in the EU is decreasing, their GHG emissions intensity tends to be higher due to the use of outdated agricultural practices and therefore their exclusion from an ETS may lead to much lower levels of GHG coverage.

Choosing a suitable threshold requires a balance between a low threshold with higher coverage but also higher administrative costs, versus a higher threshold with lower impacts on agricultural sector competitiveness and administrative costs, but less coverage. Another key consideration is market distortions that could be caused by thresholds, where firms make the decision to break-up production installations into smaller entities in order to avoid compliance. Firms below the threshold may curb their growth for similar reasons.

Mitigating risk of carbon leakage

Free Allocation of Allowances

In light of the third objective of this study, an agricultural ETS will need to integrate policy design measures to *reduce the risk of carbon leakage*.

In an ETS, once a cap is set, a quantity of emission allowances (also referred to as ‘rights’) can be issued by the regulator. Emission allowances allow farms to emit GHG emissions to the extent that they have emission rights. Polluters must hold allowances for every ton of CO_2 or CO_2e of greenhouse gas they emit that is within the scope of the ETS.

Allocation is the process of distributing allowances to covered entities in an emissions trading system. There are basic options for allocation: allowances can be either given away (freely allocated) or sold, often by auction. Once allocated, they can be traded between participants. In theory, the amount of allowances allocated should be consistent with the cap. The auctioning and/or trading of allowances establishes an emissions price. The total quantity of allowances would be reduced from year-to-year until a specified GHG reduction target is achieved.

Auctioning ensures that the revenues linked to the introduction of an ETS go to public authorities, rather than being captured by the polluting installations and companies, and therefore can be considered fully in line with the polluter pays principle. Requiring operators to pay for all of their allowances via auctioning also represents the most economically efficient method of allocation and provides a stronger incentive to reduce GHG emissions.

Free allocation, on the other hand, can help farmers adjust gradually to the implementation of an ETS and manage the costs of their obligations while maintaining an economic incentive to reduce emissions, thus helping to *minimise the burden of implementation* (first objective). With the proportion of free allocations likely going down over time, if ETS participants do not reduce emissions, they eventually must buy allowances if their share of free allowances is insufficient. They also lose the opportunity to be able to sell their allowances, as they will be needed for compliance. Free allocation is also a way of reducing the cost of permits compared to auctioning the full stream of emissions, which can serve to improve the acceptability of the system among regulated operators, thus *ensuring stakeholders do not feel left behind* (fifth objective).

There are different potential rules for distributing free allocations. How it is done can alter the distribution of costs across individual emitters, the incentives emitters have to reduce emissions, and how emitters are supported through change. For rules on distributing allocations, in its proposal to include agriculture in the New Zealand ETS, the government examined five methods of allocation (see ICCC 2019):

- Grandparenting: allocation is determined by historic data, such as emissions, stock numbers or production. An emitter would receive the same amount of allocations every year as long as the allocation rate remains the same
- Proportional: allocation is a proportion of annual emissions, and therefore the volume of allocations would change every year, depending on actual emissions on-farm.
- Output-based: allocation is based on annual output (i.e. milk solids or livestock numbers). If the annual output increases, then the amount of allocation increases. If output decreases, then allocation decreases.
- Land-based: allocation is determined by land area. The amount of allocation would vary per hectare, based on land characteristics. Emitters would receive the same amount of allocation each year unless they decrease or increase the size of the land holding. Allocation would be based on the productive capacity of land.
- Hybrid of land and output-based: this would be a combination of the output- and land-based methods. For example, half of free allocation could be done through the land-based method and the other half through the output-based method.

Free allocation comes with the risk that industry actors show significant reluctance to support sufficiently swift phase-out timelines, especially if free allocation is used to accrue considerable profits, as has been the case for EU ETS. The lead time between announcing a policy involving free allocation and its implementation must also be carefully considered, given the perverse incentive to postpone emissions reduction to receive a more favourable allocation by the regulated entities.

The Commission will need to decide whether to freely allocate allowances and what proportion of allowances to freely allocate. Since the start of phase 3 of the EU ETS (2013-2020), free allocation has been based on benchmarks expressed as GHG emission intensity (tonnes of GHG emitted per tonne of product produced). Benchmarks should represent the performance of the 10% best installations covered by the EU ETS producing a product. The use of benchmarks to determine free allocation has the advantage that all installations receive the same number of free allowance per tonne of product produced. Currently, in principle, 57% of allowances are auctioned, and up to 43% are freely allocated based on benchmarks. While free allocation is designated as an exception from the default option of auctioning in the EU ETS, it is envisioned that the majority of free allocations will be phased out by 2030, and for industries at risk of carbon leakage by 2034.

Emissions trading systems in California and Quebec provide an example of a tiered approach to free allocation, with sectors classified under high, medium, and low risk of carbon leakage. By comparison, all sectors on the EU ETS leakage list receive free allocation based on 100% of the relevant benchmark for the 10% most efficient installations, and with the latest ETS revision with conditionalities related to implementing recommendations from energy audits. An improved targeting of sectors based on their exposure to risks of carbon leakage was one of the recommendations made as part of the review of the EU ETS conducted by the European Court of Auditors (2020c).

However, the main purpose of free allocation is to provide transitional assistance (objective 1). Therefore, if it opts for the use of free allocations in an AgETS, the EU must decide how it will provide a well-signalled phase-out. To help farmers adjust, the New Zealand government proposed in its proposal to integrate the agricultural sector into its ETS by 2016[25] (which was later scrapped due to political opposition from the sector), a linear phase-out for agricultural free allocation planned at 8.3 per cent per year over 2019–2030, resulting in no further free allocation being provided after 2029 (see Box 2). The EU could consider a similar approach to establishing an initial high proportion of free allowances to be linearly phased out over a long period from the introduction of the on-farm ETS in the EU.

It must be politically determined who is allowed to benefit from emission allocations, which creates winners and losers. Because of these issues, there is a serious disadvantage of free allocations if they are to be used permanently. Therefore, allocations will need to eventually be phased out.

Box 2 Consideration of free allocation of allowances for agriculture in the New Zealand ETS

In its 2019 proposal for an on-farm ETS, the New Zealand government ultimately decided against free allocation using these rules as they could not get stakeholder agreement, as output and land-based rules created vastly different winners/losers. However, in its review of the various potential allocation methods, the New Zealand Climate Commission found that while the proportional rule provided the lowest cost across from farmers, the negative impact that this rule would have on farms that currently have lower emissions led against the decision to go with this rule. Meanwhile, the hybrid option avoided the more extreme outcomes when either land- or output-based options were used alone.

In the end, in its consultative process, the 2022 He Waka Noa option for an on-farm carbon levy in New Zealand proposed two rebate options, similar to the rules proposed for the ETS option: 1) a land-based rebate, where farms receive assistance based on the land area, adjusted for the average emissions associated with the carrying capacity of the land; 2) an output-based rebate, which applies only to livestock emissions, where farmers receive assistance based on the efficiency per unit of product. This decision was based on the assessment that these rebates can reward farmers for adopting practices that can help to reduce emissions while also providing the needed financial assistance to adopt such practices, as well as provide strong rewards for farmers who improve emissions intensity and not punish those who have already worked towards reducing emissions. This hybrid option could therefore provide a balanced approach to the free allocation of allowances.

It should be noted that the New Zealand Climate Committee emphasised that the ratio of these methods (proportion of output-based allocations versus proportion of land-based allocations) will influence incentives to reduce production, and how costs will be distributed across farms, in particular for livestock farms. Concerns were raised both for incentivising the intensification of livestock practices, as output-based allocations are based on emissions efficiency, as well as the implications for land-based allocations received by livestock farmers. Therefore, the EU will need to consider the ratio of allocations provided between dairy and cattle farms if it opts for a hybrid-based rule.

Free allocation is regarded as a strategy for addressing risks to the competitiveness of the regulated sectors by helping to reduce the pressure to shift production outside the EU, thus potentially addressing objective 3 (*reduce the risk of carbon leakage*). In the EU ETS, firms facing the highest risk of carbon

[25] Another failed attempt to integrate the agricultural sector into the New Zealand ETS in 2019 proposed 95% free allocations with an indefinite period of phasing-out free allowances.

leakage are given priority for free allowances. Where regulated industries are deemed to be under relatively little competitive pressure from outside of the EU, the introduction of an ETS may not require any free allocation of allowances, as in the case of buildings and road transport in the newly-created ETS 2, where the entire allocation will be subject to auctioning. Ultimately, the risk of carbon leakage depends on the ability of industry actors to pass the carbon cost through to consumers.

Excessive free allocation can, however, weaken the incentive to reduce emissions in a timely manner, reduce the efficiency of a carbon market and the amount of revenue that can be used towards other objectives. A review of the EU ETS by the European Court of Auditors (2020) recommended that the role of free allowances should be re-examined, particularly with regards to targeting sectors at risk of carbon leakage and consistency of approach. Amongst others, the review found that excessive free allocation in the power sector in Phase III of the EU ETS resulted in a slower pace of decarbonization. Where sectors received free allowances despite their high cost pass-through capacity[26] (and therefore lower risk of carbon leakage), costs would still be passed through to consumers, resulting in windfall profits for economic operators. The review also concluded that better targeting of free allowances would have had benefits for public finances through increasing the share of allowances auctioned.

Where sectors are considered to be at risk of carbon leakage or political feasibility of introducing an ETS is seen as a challenge, alternative options may also be considered. One example for addressing concerns of a small subsector of an ETS is the phase-in approach adopted for including the maritime transport sector in the EU ETS. The provisions set out during the recent revision of the EU ETS require shipping companies to pay for 40% of their emissions in 2024, 70% in 2025 and 100% in the following years, while withdrawing the corresponding amount from auctioning in the next year, creating a price signal in line with the polluter-pays principle and ensuring a smooth transition for the newly included sector without introducing free allocation.

Carbon Border Adjustment Mechanism (CBAM)

An alternative measure to address the risk of carbon leakage (objective 3) is the imposition of a carbon levy on imported goods. In the case of the EU ETS, this is being realised through the Carbon Border Adjustment Mechanism adopted in 2023 in anticipation of the leakage risks resulting from the increased climate ambition in the Fit for 55 package. It is expected to both mitigate the impact on the competitiveness of EU producers and encourage exporters in other countries to reduce their emissions. Once fully operational, it will require importers in selected EU ETS sectors to purchase CBAM certificates at a price set by the Commission based on weekly average EUA prices, and subsequently surrender a volume of certificates corresponding to the emissions embedded in the imported goods. Importers will also be required to submit annual CBAM declarations validated by an accredited verifier and containing information on embedded emissions, CBAM certificates purchased and surrendered, and any carbon costs incurred abroad. Before the full phase-in of the CBAM, a transitional two-year period is envisioned during which importers will be required to report on GHG emissions embedded in their imports, without any associated financial obligations.

[26] It should be noted that many empirical investigations have found a lack of an economically and statistically significant pass-through between international food commodity prices and final consumer prices for the euro area. This lack of a pass-through has been attributed to price distortions caused by the CAP, or that pass-through is non-linear (Ferrucci et al 2018).

Overall, the implementation of a CBAM relies on the feasibility of calculating carbon footprint of the imported products, which is likely to be exceptionally challenging in the case of agri-food imports. While the recently signed CBAM regulation covers bulk commodities with short and easily traceable value chains, accounting for GHG emissions embedded in agri-food products is particularly difficult given the complexity of agricultural supply chains, often spanning several countries in the case of a single product. Matthews (2022) illustrates how the practical difficulties apply both to simple products, such as e.g. a beef steak, in the case of which information would be needed on the cattle rearing practices, feeding regime, age at slaughter etc., and more complex, processed foods such as e.g. pizza where information would be required for each of the inputs, potentially supplied by different countries.

Where information on embedded emissions is not possible to obtain, the current CBAM regulation allows for the use of either country- and product-specific emission factors or default values based on the carbon intensity of the 10% least efficient producers in the EU. While such flexibility would likely be needed in the case of a CBAM for agri-food imports, it would require that the Commission develops default emission values for a significantly larger number of food products, set separately for each exporting country.

In the existing CBAM, importers are also allowed to deduct carbon costs incurred through levies imposed on their imports before reaching the EU. Enforcing such a rule would further contribute to the complexity of a CBAM on food commodities, as it would require the importer to obtain detailed origin information, including the value added in each country involved in the supply chain, as well as specific information on the applicable climate policies in each country. It should also be noted that mitigating the complexity associated with the availability of emissions data by imposing a CBAM levy on basic agricultural commodities only, while excluding processed foods, is likely to result in distorted incentives for tradable goods (Matthews 2022).

The effectiveness of a CBAM in addressing carbon leakage in the EU agricultural sector may be substantially diminished given the highly export-oriented nature of EU agricultural production, compounded by a relatively high price elasticity of food exports. A CBAM only applicable to food imports would not address the replacement of EU exports by commodities produced in regions with higher carbon intensity of production, resulting in potentially very limited reductions in carbon leakage overall (Nordin et al. 2019). This could theoretically be mitigated through the introduction of a rebate to relieve the burden of carbon pricing on exports – however, export subsidies are not WTO compatible and such rebates could lead to an unfair advantage in global markets. One possible scenario is also that EU exports receiving a rebate may displace products that are less carbon intensive, potentially increasing overall global emissions. In the context of the EU ETS, Marcu et al. (2022) have proposed benchmark-based export adjustment as the approach offering the most favourable balance of environmental effectiveness, practical feasibility and limited legal risk. Such an approach would rely on the issuance of non-transferable export adjustment certificates corresponding to the average emissions intensity of the 10% least carbon-intensive producers in the EU, which can subsequently be surrendered for compliance instead of EUAs. This option would allow for maintaining a dynamic incentive for exporters to reduce the carbon intensity associated with their products.

Other potential approaches to carbon leakage

There are a number of other trade policy measures which can be deployed to minimise leakage. One of them is the use of mechanisms and commitments under multilateral agreements to stimulate increased climate ambition in other countries. Examples include mechanisms established by the Paris Agreement, such as the Financial and Technology Mechanism, which could be relevant in the context of trade in agri-food products. The use of these mechanisms would involve the EU providing financial assistance targeting climate mitigation in the agricultural sector or facilitating sector-specific technology transfer and development. Modelling indicates that the risk of carbon leakage declines significantly as the number of countries implementing carbon pricing mechanisms grows (Henderson & Verma 2021), further highlighting the role of climate diplomacy in this context.

Encouraging more progressive climate policy on agricultural emissions in other countries could be accompanied by additional incentives in the shape of tariff-based measures. Lower or zero tariffs could be applied to imports of selected products from countries that have agreed to implement more ambitious policy measures aimed to reduce the carbon intensity of production. Matthews (2022) notes that while such measures may normally be difficult to justify under the WTO rules, the WTO does allow the possibility of more favourable treatment vis-à-vis developing countries compared to other WTO members.

There is also a variety of non-trade measures, which can be implemented to mitigate the risk of carbon leakage. These can include demand side measures, compensating farmers, or investments in support of transformative technologies (especially those with high capital and low operational costs).

Regulatory flexibilities within an ETS

Within carbon markets, large price variations may occur as a result of exogenous shocks, regulatory uncertainty, or market fluctuations. The negative impacts of such instability in a carbon price can be alleviated through the use of flexibilities – thus supporting the first objective of the study (*balancing the costs and benefits of the system*).

Temporal flexibility provisions include the banking and borrowing of emission allowances – banking allows for the reserving of allocations in the current time period for future use, while borrowing allows participants to use allowances from future allocations. Banking can be positive for early adopters of mitigation practices, as it encourages earlier reductions, while borrowing carries risks of delaying mitigating actions.

A smooth roll-out of an ETS can be supported by auctioning a higher volume of allowances early on. The front-loading of allowances allows regulated firms to hedge by buying allowances ahead of schedule to mitigate price risk and is intended to provide additional liquidity to the market. This measure is planned for the introduction of EU ETS 2, with auction volumes planned to be 30% higher in the first year of the operation of the ETS (2027) than the total number of allowances for that year (i.e. 130% of the cap). The frontloaded allowances will be subsequently deducted from auctioning volumes in the following years. While front-loading enhances liquidity, it is likely to put downward pressure on the carbon price and postpone emissions reductions.

Banking can also create negative impacts by baking in early errors through overly generous allocation. This has been observed in the case of the EU ETS, where the banking of allowances between Phases II and III contributed to the continued surplus of allowances on the market and low permit price levels through the third phase. This was partially a result of an initial overallocation of allowances due to the poor quality of the data used for the first established benchmarks, which contributed to the emergence of the surplus in Phase II (European Court of Auditors 2021c). Similarly, the level of complexity of GHG data required for determining appropriate level of allocation in the case of an agricultural ETS may affect the potential for error in the initial phases. The risk of carrying over potential negative effects to the next trading periods through the banking of allowances will need to be taken into account. A mechanism similar to the Market Stability Reserve introduced in 2019, which would adjust the number of allowances made available to the market in the near term, could be considered to allow for course correction and price regulation in such a scenario.

The benefits of allowance banking relating to emissions abatement being encouraged in the early stages and smoothing the effects of potential shocks will also depend on the forward-looking behaviour of the regulated actors. It is likely that the heterogeneity of agricultural holdings across the EU, their different planning horizons, and the ability, or the lack of thereof, to accelerate emissions reductions to capture gains from allowance banking will affect the practices in this respect and their impact on the permit market.

While banking and borrowing relate to the validity of allowances for compliance and are features of a high-level system design, other forms of flexibilities, such as free allocation of allowances, offer a form of cost mitigation and their design will be more closely linked to a specific ETS option.

Another option that can provide additional flexibility for entities covered by an ETS to comply with the system is the use of credits. Until 2020, participants in the EU ETS could use international credits from the Clean Development Mechanism and the Joint Implementation under the Kyoto Protocol[27] towards fulfilling part of their obligations under the EU ETS, subject to qualitative and quantitative restrictions. Such credits, however, have been phased out due to credit quality problems and the carbon price distortion effects. Credits are no longer allowed to be used as compliance units within the EU ETS.

There is precedent for the use of credits in the EU ETS as well as in other jurisdictions (i.e. California, New Zealand). In addition, the proposed on-farm carbon levy for agriculture in New Zealand has integrated payments or credits for carbon sequestration. A comprehensive discussion regarding possible options for offsetting, including by using certificates generated under the Commission's proposed Carbon Removal Certification Framework, is the subject of the second part of this study (AgETS+Removals).

Another flexibility could be linking a ETS for agriculture with other emission trading systems. Theoretically, connecting emission trading systems can lead to efficiency gains resulting from a larger carbon market and a broader range of more cost-effective mitigation options available to ETS participants. However, linking ETSs is associated with complex design and governance issues which may undermine the environmental integrity of the system. It also involves effectively ceding a degree of control over the domestic ETS and weakening the link between the ETS and domestic climate policy objectives.

[27] Two mechanisms for international credits set up under the Kyoto Protocol were the Clean Development Mechanism (CDM), which allowed industrialised countries with a greenhouse gas reduction commitment (Annex 1 countries) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emissions reductions in their own countries; and the Joint Implementation (JI), which allowed industrialised countries to meet part of their required cuts in greenhouse gas emissions by paying for projects that reduce emissions in other industrialised countries.

ETS auctioning revenue use

One of the benefits of a market-based polluter pays instrument is the generation of revenues, which can be utilised to address multiple issues. Depending on the price, the auctioning of allowances can generate significant income for the administering governments. In light of the fifth objective of this study (*ensure no stakeholders or vulnerable Europeans feel left behind),* careful contemplation will be needed of how to utilise revenues generated under an agricultural ETS.

Under the EU ETS, the rules governing the use of ETS revenue have become stricter and more targeted over time. The newly revised Directive requires Member States to spend all national revenues from auctioning on climate-related activities, with defined allowances budget dedicated to investment in innovative climate mitigation technologies (via the Innovation Fund) and to supporting energy transition in lower-income Member States (via the Modernisation Fund). In addition, the EU institutions agreed to create a Social Climate Fund to accompany the roll-out of ETS 2 for buildings and road transport. The Fund, financed through auctioning allowances up to an amount of EUR 65 bn, will be used for investments that benefit vulnerable households, transport users and micro-enterprises, in particular those affected by energy and transport poverty.

Similarly, the establishment of an ETS for agriculture could be accompanied by specific provisions that redirect a portion of auctioning revenues to support innovation in the sector, as well as to finance other ecosystem services, such as biodiversity, and to promote equitable outcomes both across Member States and for affected social groups, ensuring a just transition. To avoid undermining climate mitigation goals in the long run, a requirement for ETS revenues to finance only activities that respect the principle of ‘do no significant harm’ or result in a net benefit with regards to other sustainability objectives should also be taken into consideration.

A Social Climate Fund would be especially relevant for the livestock sector, particularly cattle farmers. Livestock farmers receive heavy subsidization in order to stabilise the sector, both in terms of € amount and as a % of farm income (see Table 4).[28]

Table 4 Total subsidies granted to European farms according to production type

Farm specialty	Farms (#)	Subsidies per farm (€)	Subsidies as a % of total income (subsidies/income + subsidies)
Dairy	438 600	20 600	57%
Sheep and goats	328 000	14 400	85%
Cattle	356 900	22 800	133%
Pig and poultry	111 200	16 900	30%
Mixed crops	180 400	7 100	44%
Mixed livestock	100 400	6 800	76%
Mixed crops and livestock	545 100	8 100	107%

Source: FADN 2018

[28] Note for Cattle and mixed crops and livestock, the subsidies as a % of total income are above 100% because the average income balance for cattle and mixed farmers are negative.

Several of the interviewed experts emphasized the importance of using the revenues generated via a potential agricultural ETS to support climate action in the farming sector (as opposed to climate mitigation more broadly), with stakeholder acceptance as one of the key factors that should inform decision-making in this respect.

One of the options that could increase social acceptance could be the use of revenues for incentivising LULUCF removals. For example, a model that allows carbon removal credits to be surrendered as part of compliance obligations could redirect revenue streams to carbon removers outside of the ETS. In other cases, ETS revenues could be used by the government in its role as an intermediary to pay for carbon removals by procuring removal certificates from voluntary participants. A detailed exploration of the options for using revenues to incentivise LULUCF removals is the subject of the acccompanying report AgETS+Removals.

Carbon price management

A key choice in the design of an agricultural ETS concerns carbon price management. Price containment mechanisms can be implemented to introduce more certainty into the market, or to mitigate the economic impacts of a surging carbon price, thus supporting the first objective of this study (*balance the costs and benefits of the system*). A surplus of allowances in an ETS can pose a threat to its functioning, as its resultant low price could disincentivize obligated parties from engaging in mitigation actions.

Under the EU ETS, the problem of excess allowances is being addressed through the Market Stability Reserve (MSR), a rule-based mechanism which aims to provide a long-term solution to supply-demand imbalances in the market by controlling the number of allowances available at auctions. If the total number of allowances in circulation is above a pre-defined threshold, a percentage of those allowances are removed from the market and placed in a reserve. Conversely, if the total number of allowances in circulation falls below a certain level, additional allowances are released from the reserve to be auctioned.

While the MSR assumes supply interventions based on quantity of allowances, a minimum carbon price could potentially also be enforced through setting an auction reserve price. When the market price falls below the reserve price, a portion of allowances auctioned at the reserve price will remain unsold. The resulting reduction in the supply of allowances puts an upward pressure on the market price, restoring it to or above the minimum level (assuming that a significant share of allowances is auctioned). This mechanism allows the market price to dip below the minimum price for a limited period of time, meaning that the reserve price is not an absolute floor.

Alternatively, a floor price can be created nationally through the use of carbon taxes that effectively top up the carbon price to a predefined level. This system has been introduced, among others, in the Netherlands, where industrial emitters covered by the EU ETS are required to pay the difference between the EUA price and the minimum price defined by the Dutch government in tax. It is unlikely that such a system could be introduced EU-wide, given the requirement for unanimity in the Council in the case of fiscal measures.

Similarly, a carbon price ceiling can be introduced in the form of both a hard and a soft ceiling. A soft price ceiling entails increasing the supply of allowances by a predefined amount when an upper market price threshold is hit, allowing the price to rise above the ceiling if demand is sufficiently high. A hard price ceiling assumes an unlimited supply of allowances that can be made available when the market price hits the maximum level. Most existing emissions trading systems assume a gradual ratcheting up of price floor and ceiling levels.

The nature of food production and types of enterprises that may be regulated under an agricultural ETS are among the key factors that would need to be taken into account in this context. Some of the experts interviewed for this study emphasised the issue of price volatility as being particularly problematic for farmers and potentially putting into question the appropriateness of an emissions trading system as an effective polluter-pays policy in the absence of a price containment mechanism. One interviewee expressed a strong preference for a fixed price with a possible ratcheting-up mechanism, given the need for certainty stemming from the nature of agricultural production planning.

The EU ETS has seen a gradual introduction of measures intended to stabilize the market and indirectly impact price formation, notably the Market Stability Reserve. For ETS2, in addition to a Market Stability Reserve a soft price ceiling has been included for the first three years. Both systems also include price containment mechanisms, as described in Art 29a (EU ETS) and Art 30h (ETS 2), triggered by potential doubling or tripling of the allowance price. When certain conditions are fulfilled, these mechanisms result in the release of additional allowances from the MSR.

There is some concern that the character of the more restrictive measures needed to e.g. enforce a price floor through an auction reserve price bears too much resemblance to fiscal instruments, and would therefore require unanimous support in the Council. However, some have argued that this concern is unsubstantiated, suggesting that based on legal analysis an auction reserve price is not considered a “provision primarily of fiscal nature”, and pointing to a strong economic case for introducing this mechanism into the EU ETS (Fischer et al. 2019).

Governance

Administrative actors

Oversight

The Commission will be responsible for exercising the Commission’s role of oversight and ensuring implementation of the legislation for an agricultural ETS. This will include developing implementing legislation, disseminating guidance, and making any decisions at EU level required by the legislation, such as approval of Member States plans for allocation of allowances (if required). The legislation is likely to include requirements for reporting to Parliament and Council on the implementation and results of the Emissions Trading System, for which the Commission will also take responsibility.

For the on-farm options, the Commission will also need to be involved, including:

- Managing the interface with the Common Agricultural Policy, including:
    - any use of CAP data (LPIS, etc) for implementation
    - incorporation of relevant provisions into the next CAP legislation (cross-compliance, any amendments necessary to enable CAP rural development mechanisms to assist farmers with implementation) and
    - assessment of the impact on the agriculture industry.

- Use of information derived from the Animal Health Law, and pursuing potential co-benefits in terms of incentives for improved animal health and welfare;
- A specific role in respect of the overlap with the IED's application to agricultural businesses, and a general role in terms of the impact on biodiversity, water quality, air quality, and other environmental objectives.

Monitoring, reporting, and verification

As outlined above, there are potentially two systems for monitoring emissions – the default approach would use proxies, while the certified approach would involve on-farm reporting of emissions. Under both systems, a process for identifying the farms subject to regulation under the ETS will be necessary; using the same approach to determining a farm holding as is used under the CAP would help to ensure coherence[29]. Some governance complexity may arise in Member States which implement the CAP on a regional basis. Provided that the EU legislation creates a clear obligation on Member States to ensure that all qualifying farms are regulated, the detailed rules for identifying the qualifying farms can be determined at national or regional level.

Governance arrangements for the 'certified' approach will be necessary. There is an argument that, given the range of agricultural conditions and practices across the EU, Member States should have a role in order to reflect the specificities of farming in their area; however, there is a risk that Member States would design systems in order to make it easier for their farms to report emissions reductions, so some level of control at EU level is therefore likely to be required. One approach would be for the Commission to have powers to set out detailed rules for specific types of emissions reduction practice in implementing regulations; but for Member States to be able to propose additional emissions reduction certification schemes to the Commission, with approval by the Commission necessary before those schemes can be used to reduce farms' reported emissions. Ideally, Member States' GHG emissions inventories would reflect the emissions reductions certified by these schemes, although this may require further time before the IPCC process can approve the necessary methodological changes.

Mechanisms for challenging results

Regardless of the approach adopted to estimating emissions, it is likely that there will be disputes about the estimates made for individual farm holdings. Farms themselves may believe that calculations (either on the basis of their own inputting of data, or on the basis of the estimation by public authorities foreseen in the default approach), over-estimate their emissions (particularly if they have made use of farm emissions tools in the past), or fail to recognise specific mitigation measures they have put in place (which is likely, given that the emissions factors used will be based on an assumption of average performance, and will therefore not recognise individual emissions-reduction measures). In the case of farm input under the certified approach, it would be necessary for public authorities to be able to query anomalous results. Any such mechanisms are likely to add to the cost, complexity, and time required for introduction and operation of an emissions trading system.

[29] See Regulation 2021/2115, Article 3.1:
"(a) "farmer" means a natural or legal person, or a group of natural or legal persons, regardless of the legal status granted to such group and its members by national law, whose holding is situated within the territorial scope of the Treaties, as defined in Article 52 TEU in conjunction with Articles 349 and 355 TFEU, and who exercises an agri cultural activity;
(b) "holding" means all the units used for agricultural activities and managed by a farmer situated within the territory of the same Member State".
This definition is unchanged from the previous CAP, and is well understand by farmers and public authorities.

Administrative costs

The detailed design of the option, including the extent to which Member States will have flexibility over implementation, and the level of flexibility allowed to emissions trading system participants, will determine the extent of administrative costs. Public sector costs could include the following:

- Costs on Member States of developing relevant implementation measures
- Costs for regulated entities to surrender allowances and participate in emission trading
- Regulatory oversight of emissions data
- Costs associated with allocation of allowances (including both through auctioning and any free allocation of allowances)
- Information campaigns to ensure system participants are fully informed of their obligations, and of the options available to them
- Registry administration
- Operation of appeals mechanisms – for example, appeals over system participation (assuming there are exemptions for small farms, or for other categories), over allocation of allowances, over assessment of emissions (if this is determined by public authorities on the basis of available data, rather than reported by system participants).

Operationalising an ETS

Operationalising an ETS for agricultural emissions will require the development of appropriate infrastructure to facilitate the auctioning, trading and surrender of permits. In designing such infrastructure, important insights can be drawn from the existing mechanisms under the EU ETS.

In the EU ETS, all information regarding the ownership of allowances is recorded in the Union Registry, a centralised electronic database. It tracks data relating to national implementation measures (free allocations), account holders, transactions, annual verified CO_2 emissions, and annual reconciliation of allowances and verified emissions. A key part of the Registry is the European Union Transaction Log (EUTL) which automatically checks, records, and authorises all transactions between accounts, ensuring that all transfers comply with EU ETS rules. Several types of accounts can be created in the registry: operator holding accounts (used by compliance entities to fulfil their obligations), trading accounts (used by both compliance and non-compliance entities), and omnibus accounts (used by financial entities, notably banks, trading on behalf of their clients who are compliance entities) (Cludius et al. 2022). In its report on the EU carbon market, the European Securities and Markets Authority (ESMA) (2022) pointed out the current challenges with identifying omnibus account holders, and distinguishing between omnibus and own accounts, and recommended measures to improve visibility around the activities of market participants. Cludius and Betz (2020) also observed that transparency has been negatively affected by the three-year delay with which physical transfers of allowances are published, as well as by the issues with the consistency and user-friendliness of the publicly available data.

It should be noted that while the registry keeps track of the physical transfer of allowances, it does not record the financial information relating to market transactions. Trading on secondary markets (as opposed to auctions, considered to be the “primary market”) is typically performed via trading venues such as the Intercontinental Exchange, the German EEX, and Nasdaq Oslo, or as part of privately negotiated contracts (over-the-counter) outside of organised exchanges. Early trading activity in EUAs initially took place mostly through OTC transactions, however the share of exchange trading increased quickly and currently constitutes ca. 70% of all trading activity (Oxera 2022). It’s worth noting that trading via exchanges entails higher transaction and administrative costs and is therefore only profitable for companies with higher transaction volumes (Görlach et al. 2022). The high entry costs impacting the ability to access exchange trading would be a particularly relevant consideration in an agricultural ETS which sets the point of obligation at the farm level, given the broad range of heterogenous actors, including potentially a lot of smaller trading entities that would come under the scope of the ETS. The differentiated ability and competence of agricultural actors to e.g. hedge and take positions on the futures market may result in only the larger businesses being able to access gains of trading and speculation, potentially with the risk of non-equitable outcomes unless the smaller actors task their banks as intermediaries. These considerations may warrant taking into account when designing a trading mechanism for an agricultural ETS.

The auctioning of EUAs is governed by a dedicated regulation (1031/2010) which sets rules for the timing, administration, and other aspects. This includes the provisions for the appointment of a common auction platform, which performs the auctions, post-trade payment of the auction proceeds, the transfer of allowances to successful bidders, reporting on transactions and auction surveillance. It is nominated for up to 5 years by a joint procurement between the Commission and the participating countries.

For an agricultural ETS, the registry should probably be geographically explicit, in which emissions reductions can be traced back to a specific land parcel. This will allow for links to the LPIS of the CAP and eventually national GHG inventories based on land parcel data. A single data registry should provide the data for the ETS, CAP, as well as the scope-3 reporting of the food processors.

Ensuring compliance

An approach to compliance will need to balance costs to regulators and regulated entities against potential risks of non-compliance.

An important policy design characteristic for compliance concerns who is legally responsible for complying with the ETS regulation, or for surrendering to the regulator an allowance for each ton of emissions. The choice depends on which entities can be held legally liable and where data is available and auditable. Often, these factors depend on existing regulatory structures. In some ETS', this may be a company, or in some it is a particular installation. In the EU, existing environmental permitting, licensing, and regulations are already focused on individual installations (i.e. in the IED, pigs and poultry installations are already included as installations required to comply with permitting rules set out in BREF documents), and so is the EU ETS.

A compliance system will also need to ensure the enforcement of penalties in the event of non-compliance. In an ETS, there are usually three categories of non-compliance that carry penalties: emitting in excess of the number of allowances; misreporting or not reporting emissions and other data; and failing to provide, or falsifying, information to the regulator. In an ETS, penalties usually take the form of a combination of naming and shaming, fines, and 'make good' requirements. The EU ETS currently uses a combination of naming and shaming and fines.

In the existing ETS, operators which fail to surrender sufficient allowances to cover their emissions are required to pay an excess emissions penalty of €100 per tonne (rising in line with inflation); and still have to acquire and surrender the necessary allowances[30]. A similar approach could be applied for the

[30] Directive 2003/87, Article 16 (3) – (4).

agricultural ETS, although the exact level of the penalty per tonne should be set in the light of the additional compliance tools available from conditionality rules under the CAP.

For the three on-farm options, compliance incentives could be further reinforced through the compliance system used for CAP conditionality, which applies to all farms receiving CAP payments (around 6.2 million beneficiaries per year) across the EU. It requires farms to comply with both (i) a list of Statutory Management Requirements covering EU legislation on animal and plant health, animal welfare, and the environment; and (ii) Good Agricultural and Environmental Conditions, defined at Member State level. The new ETS mechanism could be added to the list of Statutory Management Requirements; thus, farms would face progressive reductions of their CAP payments if they failed to meet their obligations to surrender allowances.

Various bodies protect CAP financing from fraud at the EU and national level. In this system, authorities perform compliance controls at the Member State, or even regional level. Within the Commission, DG AGRI shares CAP's management with accredited paying agencies in the Member States while remaining ultimately responsible for the policy. DG AGRI obtains assurance on the operation of the Member States' management and control systems. The European Anti-fraud Office carries out administrative investigations into illegal activities adversely affecting the EU. Certification bodies annually review the paying agencies' control systems, and their compliance with accreditation criteria. Member States report to the Commission the amount of fraud they detect in CAP spending.

EU regulation stipulates that 1% of all beneficiaries have to be selected for a full inspection on cross-compliance. The selection of exploitations is based on a risk-analysis that accounts for the characteristics of the exploitation and the risk of non-compliance. Approximately 20-25% of cases are randomly selected. Farmers that are found non-compliant receive a fine based on the total amount received (ranging from 5-100% depending on the recurrence and intentionality). In the case of an on-farm ETS, a similar penalty system could, in addition to administering fines, reduce rebates or deductions (if introduced into the regulatory framework).

There is a risk that some highly profitable intensive farm businesses would choose not to receive CAP payments if the potential cost of cross compliance requirements, as reinforced by the inclusion of the ETS, outweighed the benefit of the payments. Those farms would still face a per tonne penalty for failure to comply, and the continuing requirement to acquire and surrender allowances to meet their shortfall; and in these cases, given that the additional compliance tools of CAP conditionality would not apply, it seems appropriate to apply the standard €100 per tonne penalty applicable under the main EU ETS.

In addition, for livestock, we recommend the EU consider using existing frameworks for animal welfare audits to reinforce the compliance structure. Within EU legislation on the welfare of farm animals, the Commission has developed a system of regular audits performed by experts from the Food and Veterinary Office (FVO) of the Commission's Health and Food Safety Directorate General. The FVO audits cover various areas of EU legislation, mainly related to food safety, animal and plant health. The purpose of the audits is to verify that Member States have planned and applied the necessary measures to implement EU rules. The role of the Commission's experts is therefore to check that the competent authorities are able to detect and identify non-compliance and take the appropriate remedial action. They have no legal competence to directly inspect individual establishments or sanction them. Their audits include visits of establishments but not to judge an individual case but to use it as a sample that could reflect a general situation. For this purpose, the FVO has a particular team of experts dedicated to EU animal welfare legislation which performs around one audit a month. In addition, other FVO expert teams also check some animal welfare rules in the context of other audits (like audits on food safety in slaughterhouses will also check the stunning of animals). The FVO reports are publicly available on the Internet. When the Commission's experts find failures in the inspection system of a Member State, there are a series of follow up actions in order to address the issues through a continuous dialogue. In case there is a persistent failure of the Member State to address certain issues, the Commission may decide to trigger a legal procedure. Such a system could be utilised to audit farms to substantiate reported livestock statistics and data on-farm.

Legislative changes needed

For all of the cross-cutting issues outlined in this chapter, the Commission will need to determine what will be set out in primary legislation, what will be set out in the implementing legislation, and what can be left to Member States, as well as what can be carried out by private actors.

A proposed ETS would be a novel system that could be introduced as part of the Emission Trading Directive, as has been done in the example of the second emission trading system for road transport, buildings and additional sectors. The speed of implementation will most likely be determined by the time required to draft the legislation and reach political agreement through the co-decision process.

A separate ETS for agricultural emissions can exist alongside other important EU regulations. If emissions trading is used as an instrument for the entire agricultural sector, possibly within a sector-specific reduction target for agricultural emissions, it is conceivable that there could be a combination of different points of obligation (upstream, farm-level and/or downstream).[31] In such case, potential overlap in agricultural emission sources covered by the different points of obligation need to be carefully considered. Furthermore, the parallel existence of emission trading systems and the Effort Sharing Regulation raises the question which of the two should be regarded as the main compliance instrument and how overlapping commitments create misaligned incentives to introduce mitigation policies other than carbon pricing (this question has extensively been discussed in relation to the proposed ETS for road transport and buildings – see Goerlach et al. Ariadne report).

Other key legislation to consider include CAP and the most relevant pieces of FF55 legislation, including Effort Sharing Regulation (ESR), Land Use and Land Use Change and Forestry (LULUCF) Regulation, Farm to Fork Strategy (Sustainable use of pesticides, implications for fertiliser use – impacts on arable sector), and the Industrial Emissions Directive (IED) for the livestock sector. There will also be likely interactions with the Nitrates Directive, the proposed Carbon Removal Certification Framework, as well as Carbon Border Adjustment Mechanism (CBAM), animal health and welfare regulations (risk of animal disease outbreaks), and the proposed targets relevant to the agriculture sector under the Nature Restoration Law (NRL).Other legislation that may need to be reviewed for compatibility, for any requirement for consequential amendments, and for potential synergies includes food labelling (particularly the Food Information to Consumers Regulation 1169/2011), and traceability requirements in the General Food Law (Regulation 178/2002).

[31] In the GermanZero proposal (2022) for a land-based ETS, different combinations of point of obligations are proposed, each covering different agricultural emission sources. In the report, the authors propose an ETS where the compliance entities are downstream slaughterhouses combined with upstream fertiliser manufacturers and importers as a way to capture major sources of agricultural emissions.

3. Policy option descriptions

3.1. Policy option 1: All Greenhouse Gases ETS

ETS option	All-GHGs ETS
GHG scope	CH_4 emissions from enteric fermentation; N_2O and CH_4 emissions from manure management; N_2O emissions from soils; CO_2 emissions from mineral soils and grasslands; N_2O, CH_4 and CO_2 emissions from organic soils; CO_2 emissions from liming and urea application; CH_4 and CO_2 emissions from rice farming; N_2O and CH_4 emissions from burning crop residues
Point of obligation	Arable farms, Mixed Farms, Livestock Farms
De Minimis threshold	Arable Farms: based on size of farm by ha (e.g.>50ha) Livestock Farms: based on number of livestock units (e.g. 150 LSUs) Mixed Farms: based on size of farm by ha (e.g.>50ha) threshold for arable farms; for farms smaller than the ha threshold, based on livestock units threshold for livestock farms

Policy option description

This on-farm ETS will set an overall limit on emissions occurring from on-farm activities. The ETS will set a cap on the total allowable emissions, will require farms regulated under the system to surrender enough allowances to cover their emissions, thereby ensuring emissions reductions. It will allow farms to buy and sell emission allowances (and therefore transfer responsibility for achieving emission reductions), leading to an effective price on emissions. This option will also impose a regulatory requirement on farmers to keep track of their emissions, in order to ensure that they hold enough allowances.

GHG emissions scope

Table 5 provides an overview of the sources of greenhouse gases from agriculture, the types of gases emitted, the amount[32] of $MtCO_2e$ emitted per annum from activities that would be covered under an on-farm (all-GHG) ETS.

Table 5 Agricultural GHG sources and activities included in the on-farm (all-GHG) ETS

GHG Source/ Activity	GHG			Included in on-farm GHG calculation?	Net emissions/annum
	CH_4	N_2O	CO_2		
Enteric fermentation	✓			Yes	182.5 $MtCO_2e$
N_2O emissions from managed agricultural soils		✓		Yes	118 $MtCO_2e$

[32] The data on the amount of emissions per annum for soil carbon emissions from organic soils and mineral soils, as well as the CO_2 emissions from grasslands is sourced from the data visualiser for LULUCF emissions on the EEA website (source: https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-land#:~:text=The%20land%20use%2C%20land%20use,EU's%20annual%20greenhouse%20gas%20emissions). The data on the amount of emissions for N_2O emissions from agricultural soils, manure management, and enteric fermentation is sourced from the data visualizer for agricultural emissions on the EEA website (source: https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-agriculture). Data on greenhouse gas emissions and removals are sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States). This data set reflects the GHG inventory data for 2020 as reported under the United Nations Framework Convention for Climate Change. Data on emission estimates from urea application, burning crop residues and liming are sourced from Mielcarek-Bochnska & Rzeznik (2019)

Manure management	✓	✓		Yes	62.9 $MtCO_2e$
Grasslands			✓	Yes	25 $MtCO_2e$
Croplands			✓	Yes	22.6 $MtCO_2e$
Liming			✓	Yes	5.6 $MtCO_2e$
Urea application			✓	Yes	3.5 $MtCO_2e$
Rice farming	✓		✓	Yes	2.7 $MtCO_2e$
Other agricultural emissions[33]	✓	✓		Yes	1.7 $MtCO_2e$
Burning crop residues	✓	✓		Yes	0.7 $MtCO_2e$
Other carbon-containing fertilisers			✓	Yes	0.7 $MtCO_2e$
On-farm energy use	✓	✓	✓	No	*unknown*

GHGs: This policy option includes methane, nitrous oxide, and carbon dioxide emissions in its scope, including agricultural non-CO_2 emissions accounted for under the Effort Sharing Regulation (ESR) and CO_2 emissions from croplands and grasslands accounted for under the Land Use and Land Use Change and Forestry Regulation (LULUCF Regulation). The scope of this option includes various farmgate emissions sources and activities (see Table 5 above).

As with all policy options discussed in this chapter, there is the potential to reward farmers for removals, which could be integrated with the All-GHG policy option since it includes LULUCF emissions from croplands and grasslands. Elaborations on how payments for removals can be integrated into an agricultural ETS policy option can be found in the description of the AgETS+Removals study (see Chapter 4).

Excluded from this option is on-farm energy use. There are sources of on-farm energy use of that currently fall under the EU ETS, and other sources of energy use that could potentially be included in the ETS 2. It would ease the administrative burden if the scope of ETS 2 was expanded to address CO2 emissions from fuel used on farms, rather than covering them under a new ETS. Fuel use for agricultural activities is currently excluded from the ETS for road transport and buildings (ETS 2). However, compliance entities in ETS 2 (i.e., fuel suppliers or distributors) still have to monitor the quantity of fuel going to agricultural activities to determine the fuel that is exempted. Expanding ETS 2 to fuels for on-farm use could also lower the administrative burden under ETS 2 for covered entities as fuel for agriculture activities would not have to be monitored separately.

Point of obligation

The point of obligation is on-farm, in which farmers will face a legal obligation to pay a price for emissions. The simplest approach to determining who is regarded as the responsible person for each farm holding would be that the same person benefiting from CAP payments (i.e. the “active farmer”) is liable. The objective should be to ensure that the obligation rests with the person most capable of making changes to farm practices to deliver climate mitigation. Where CAP payments are not currently received by a farm (for example, some intensive livestock units), the land owner of the relevant installation should be liable.

[33] The only EU Member State reporting emissions under CRF 3.J “Other agricultural emissions” category in 2021 was Germany, which includes CH4 and N2O from digestion of energy crops (digesters and systems for storage of digestates) in the scope of the category.

De Minimis threshold

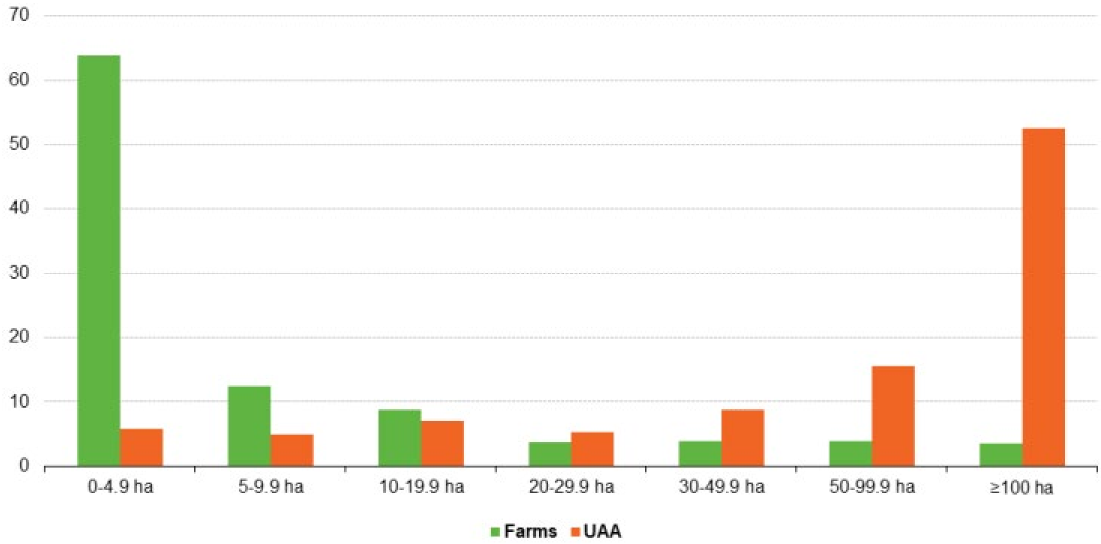
Farms in Europe can be classified in three groups: semi-subsistence farms, small and medium sized farms (usually family run farms), and large agricultural enterprises. From Eurostat: The overwhelming majority (94.8 % in 2020) of the EU's farms are classed as being family farms, defined as being farms on which 50 % or more of the regular agricultural labour force is provided by family members. Family farms were the dominant farm type in all Member States. Almost two-thirds of the EU's farms were less than 5 hectares (ha) in size in 2020 (see Figure 3 below). These small farms (~5.8 million farms totalling ~64% of total EU farms) play an important role in providing income and food to areas with higher rates of rural poverty. At the other end of the production scale, 7.5 % (~680,000 farms) of the EU's farms were of 50 ha or more in size and worked two-thirds (68.2 %) of the EU's utilised agricultural area (UAA).

Romania has the highest number of small farms (over 90% are small farms), while 1% of farms are over 50 ha – however, the 1% with over 50 ha account for 54% of the total utilised agricultural area (UAA) in Romania. Small farms under 5 ha are also common in Malta, Cyprus, Greece, Portugal, Croatia, Hungary, and Bulgaria. Around 3.3 million farms have a standard output below 2000 EUR per year. Small farms have a very small economic output (approximately 2-8,000 EUR per year).

To support the first objective of this study (*minimise the burden of implementation and balance the costs and benefits of the system*), a potential threshold of excluding farms smaller than 50ha of land would exclude small farms, in particular semi-subsistence farms for which the administration would be potentially overly burdensome and potentially have a high negative impact on their livelihood. However, the use of thresholds could create perverse incentives in which larger farms divide themselves into smaller land parcels in order to avoid obligation. One option that could be considered is to allow for groups of operators to represent and act on behalf of small farms, which will be allowed under the Carbon Removal Certification Framework. An economic actor, such as a cooperative or a private entity would take over the responsibilities of MRV for a group of smaller farmers. Such a group could benefit from simpler MRV – for example, soil sampling based on the group and not the individual farm.

Larger farms (>50 ha) are more common in France, Germany, Finland, and Denmark. In most Member States, a majority of the UAA is concentrated on farms > 50 ha – for example, farms > 50 ha in Czechia account for 93% of the total UAA. These farms tend to have a standard output of more than 250,000 EUR per year.

Figure 3 Distribution of EU farms and Utilised Agricultural Area according to farm size (%)[34]



Source: Eurostat (2021)

However, there are some intensive livestock units with potentially significant emissions, but with land holdings of less than 5ha. To ensure that these businesses are included, an additional test of 150 or more livestock units (LSU) could be considered. This is the proposed threshold for the application of Best Available Techniques (BATs) under the proposed revisions to the Industrial Emissions Directive for cattle, pig, and poultry installations *(see Livestock ETS policy option for further explanation*).

For mixed farms, there will need to be a combination of thresholds to determine obligation. A default approach could use the size of farm by ha (e.g.>50ha) threshold that is used for arable, with a caveat that farms which are below such an area size containing livestock units above the threshold for livestock farms also being obligated under the option. For example, a farm that is smaller than a 50ha threshold for arable farms, but has LSUs greater than 150, would be obligated.

Several of the experts interviewed for the study emphasised that, while environmental and social objectives needed to be carefully balanced, ensuring the largest possible GHG emissions coverage was essential.[35] A number of interviewees indicated that the more farms are included, the fairer and more effective the system, as well as suggesting that potential social impacts could be mitigated through adequate social safety net policies, free allowances, and other forms of targeted support, rather than by leaving a significant number of farms outside of the scope of the system. One expert suggested that a fairly effective system could be designed based on a threshold determined on the basis of the principle of bringing a minimum of 80% of emissions in the sector within the scope of the policy. They also proposed that farms below the threshold could be given the option of voluntary participation.

Any proposed thresholds should be kept under review, particularly with regard to the final decision on threshold in the IED, and to any changes in the CAP process for determining what qualifies as a “small

[34] Note: There are some differences in the threshold applied by some Member States, often to exclude the very smallest agricultural holdings which together contribute 2% or less to the total UAA excluding common land, and 2% or less to the total number of farm livestock units

35 It should be noted that presumably under this option, all farms on peatlands would be excluded from farm size thresholds, as is justified under the Peatlands ETS option.

farm"; alignment with these approaches is not essential, but would help to reduce complexity and confusion for farm businesses.

3.2. Policy Option 2: Livestock ETS

ETS option	Livestock ETS
GHG coverage	CH_4 emissions from enteric fermentation, N_2O and CH_4 emissions from manure management
Point of obligation	Livestock farms, Mixed Farms
De Minimis threshold	Based on number of livestock on-farm using livestock units (LSUs) as the measurement

Policy option description

This ETS sets an overall limit on emissions from livestock, but allows the entities covered by the system to buy and sell emission allowances (and therefore transfer responsibility for achieving emission reductions), leading to an effective price on emissions. However, similar to the on-farm ETS for all greenhouse gas emissions policy option, the on-farm livestock option can distribute free allowances to reduce emission leakage and the risk of livestock farmers losing income due to competition from their counterparts outside the EU, who may not face an effective carbon price. Alternatively, a Carbon Border Adjustment Mechanism could be introduced.

Box 3 Alternative policy options to a Livestock ETS

Another approach to regulating on-farm livestock emissions could involve a broader introduction of a livestock-to-land ratio, which is currently one of the criteria in the EU Organic Agriculture Regulation. According to Weishaupt et al. (2020), a wider application of this rule to all livestock farms could result in significant reductions in agricultural emissions, as well as minimising other negative externalities associated with livestock farming. Verschuuren (2022) observes that regulating stock density in the EU is not unprecedented, as shown by Regulation (EEC) No 2066/92 on the common organization of the market in beef and veal, which was in force between 1992-1999. There is at present no instrument where such an approach could be integrated, so broadening this rule to all livestock farming would likely require a new legal instrument to be adopted (ibid.).

Alternatively, an extension of existing policy instruments, such as the Industrial Emissions Directive (IED) and the National Emission reduction Commitments (NEC) Directive could serve as an effective approach to reducing livestock emissions. The NEC Directive does not currently cover GHG emissions, but the European Commission has indicated that it is open to including methane in the Directive at a later stage. Doing so would create an overall reduction target for the EU, which could be combined with emission standards in individual permits under an expanded IED (Verschuuren 2022).

GHG emissions scope

Table 6 provides an overview of the sources of greenhouse gases from agriculture, the types of gases emitted, the amount of $MtCO_2e$ emitted per annum from activities that would be covered under an on-farm (livestock) ETS.

Table 6 Agricultural GHG sources and activities Included in on-farm (livestock) ETS

GHG Source/ Activity	GHG			Role of livestock: Direct or indirect?	Included in scope? (Y/N)	Net emissions/ annum
	CH_4	N_2O	CO_2			
Enteric fermentation	✓			Direct	Yes	182.5 $MtCO_2e$
N_2O emissions from managed agricultural soils		✓		Indirect	No	118 $MtCO_2e$
Manure management	✓	✓		Direct	Yes	62.9 $MtCO_2e$
Grasslands			✓	Indirect	No	25 $MtCO_2e$
Croplands			✓	Indirect	No	22.6 $MtCO_2e$
Liming			✓	Indirect	No	5.6 $MtCO_2e$
Urea application			✓	Indirect	No	3.5 $MtCO_2e$
Other agricultural emissions[36]	✓	✓		Indirect	No	1.7 $MtCO_2e$
Burning crop residues	✓	✓		Indirect	No	0.7 $MtCO_2e$
Other carbon-containing fertilisers			✓	Indirect	No	0.7 $MtCO_2e$
On-farm energy use	✓	✓	✓	Indirect	No	*unknown*

This policy option includes both methane and nitrous oxide emissions in its scope, the agricultural non-CO_2 emissions accounted for under the Effort Sharing Regulation (ESR). The scope of this option includes emissions sources and activities that are directly attributable to livestock farming (see Table 4 above). Emissions that are directly attributable to livestock production include CH_4 from enteric fermentation of ruminants and CH_4 and N_2O emissions from manure. If the scope is limited to direct emissions from livestock, then it would be limited to methane emissions from enteric fermentation, which are responsible for 76% of agricultural CH_4 emissions the rest of which come from manure management. Manure management can also emit nitrous oxide emissions during the storage and treatment of animal wastes.

The inclusion of N_2O emissions from the application of manure to soils in place of synthetic fertilisers would also be an indirect source of emissions from livestock. The use of manure from livestock as an organic fertiliser and the potential to reduce emissions using organic fertilisers was taken into consideration, as manure has a relatively lower N_2O emission factor compared to synthetic N fertiliser (Hu et al 2013; Bouwman et al 2002; Stalenga & Kawalec 2008). Thus, the application of manure has been recommended as an effective strategy to mitigate climate change. However, the magnitude of greenhouse gases emission derived by application of manure to agricultural soils across environmental conditions still remains unclear, as they are highly dependent on soil and climate conditions (Zhang et al 2017). Although the application of manure is not an activity associated with livestock production, it is a direct *output* from livestock production, and therefore would be within the scope of the ETS.

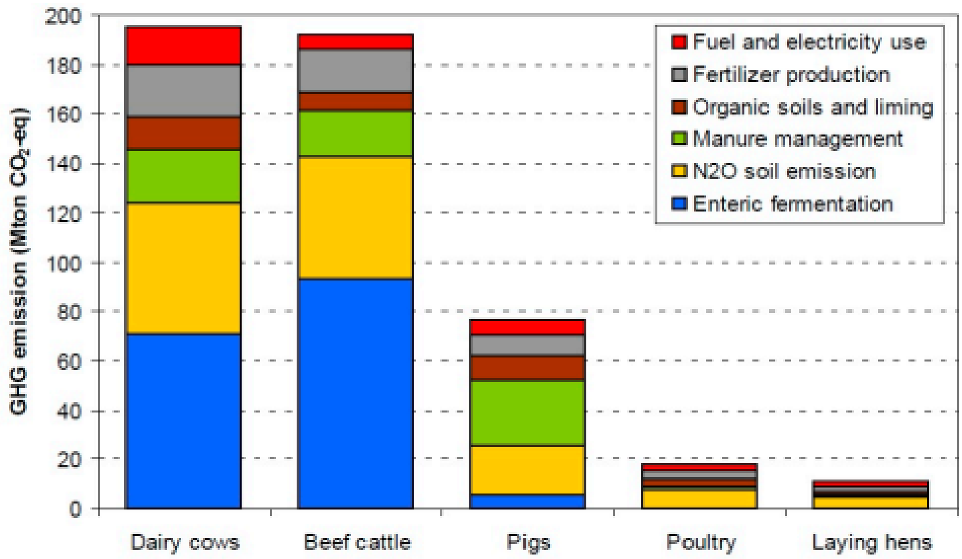
The production of livestock relies on feedstuff production and significant levels of energy use, leading to indirect GHG emissions, especially from land use changes and fertiliser use in the context of the

[36] The only EU Member State reporting emissions under CRF 3.J “Other agricultural emissions” category in 2021 was Germany, which includes CH4 and N2O from digestion of energy crops (digesters and systems for storage of digestates) in the scope of the category.

production of protein feed. Feed is often produced in monocultures or close crop rotations far away from animal husbandry, which requires the intensive use of mineral fertiliser. Furthermore, importing animal feed leads to a nutrient surplus in areas with intensive animal husbandry because in those areas more nutrients are applied through the liquid manure than plants can absorb. Surpluses are released into the air as nitrous oxide (N_2O). When the entire production chain is accounted for, animal husbandry is responsible for between 81-86% of agricultural emissions (Peyraud & MacLeod 2020) and between 12-17% of overall GHG emissions in Europe (Bellarby et al 2012).

In principle the EU ETS is designed for regulating direct emissions i.e. those occurring directly at the installation. If the existing EU ETS principles are applied to an on-farm ETS, then only those emissions occurring on a farm (rather than indirect emissions occurring due to feed production and use) should be included within the scope. However, due to the high amount of emissions associated with the production of feed (see Figure 4), the Commission will need to consider whether these emissions should be integrated into the scope of an on-farm ETS for livestock.

Figure 4 Total GHG emissions from livestock farming in the EU 27 by source of emissions



Source: Lesschen et al (2011), p. 25

Point of obligation

If the EU's ETS logic of regulating GHGs at their source were to be followed, then all livestock farms would need to be regulated (Bragadottir et al 2015). There are approximately 6.2 million farms with livestock in the EU out of a total of 10.5 million total farms. The average size for a livestock farm in Europe is 34 hectares, with a herd size of 47 livestock units (LSUs[37]) (Eurostat 2021). Many of these farms are semi-subsistence farms with a very small number of livestock, and MRV will be particularly difficult for these very small emitters (Heindl et al 2018). However, even if small farms were to be excluded from the ETS, there would still be a large number of units to be regulated (see Table 7 – for example, a threshold of 50 LSUs would include 330,000 cattle farms, 91,000 pig farms, and 95,800 poultry farms.

[37] The LSU is a reference unit for the EU executive that facilitates livestock aggregation from various species and ages. For example, one LSU unit consists of the grazing equivalent of one adult dairy cow producing 3,000 kilograms of milk annually.

However, it should be noted that utilising livestock units as a threshold may not be an adequate proxy for the quantity of GHG emissions – for example, one LSU of pigs or poultry emits much less than 1 LSU of cattle. Thus, due to the overwhelming contribution of beef cattle and dairy farms, it could be taken into consideration to apply the point of obligation to these types of farms only. Alternatively, due to the relatively very small contribution of poultry towards GHGs, an exemption could be considered for it as well. In order to simplify further, we suggest focusing on the three species – cows, sheep and pigs – which generate the overwhelming majority of emissions. There is a further argument for excluding pigs: as non-ruminants, their enteric fermentation emissions are significantly lower; however, emissions from manure management for pigs are comparable to those from cow and sheep farming, and there are potential co-benefits in terms of reduced water pollution. Emissions from other species, particularly ruminants (eg goats, deer) should be kept under review, in case there is a significant increase driven in part by a lower carbon price caused by their exclusion from the ETS and regulatory burden.

De Minimis threshold

As with the "on-farm all-GHG emissions" option, to support the first objective of this study (*minimise the burden of implementation and balance the costs and benefits of the system*) there is a strong argument for a de minimis threshold to exclude the smallest operators from the administrative costs of participation. Given the livestock focus of this option, it makes sense to focus on livestock numbers per farm holding as the criterion for a de minimis threshold.

Establishing thresholds for the application of the polluter pays principle towards livestock farmers is not without precedent in EU policy, as proposed updates to the Industrial Emissions Directive set a minimum threshold for livestock units (LSUs). The IED is the main EU legislation regulating the environmental impacts of industrial production, including those of large agro-industrial sources. The IED aims to lower emissions by regulating the conditions under which an industrial installation can operate. All installations conducting activities listed in IED Annex I must operate in accordance with certain requirements to receive a permit from the competent authority in the relevant Member State. The requirements cover all environmental aspects of an installation's operating activities, including emissions of pollutants to air, water and soil, waste generation, resource use, noise, odour, prevention of accidents and restoration of the site upon closure. Permit conditions must be based on best available techniques (BATs), which are the most environmentally effective of the economically viable techniques available. In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organises an exchange of information with experts from Member States, industry and environmental organisations. This process results in BAT Reference Documents (BREFs). The IED requires that these BAT conclusions are the reference for setting permit conditions. Large-sized pig and poultry agro-industrial are currently regulated under the IED, which has proposed to expand to include cattle.

In the Commission's proposal to update the IED, the Directive will cover all industrial farms with more than 150 livestock units (LSUs). According to these calculations, 150 livestock units are equivalent to 150 adult cows, or 375 calves, or 10,000 laying hens, or 500 pigs, or 300 sows.

Table 7 LSU thresholds and expected number of farms

Threshold (LSU)	Approximate # of cattle farms above threshold (% coverage)	Approximate # of pig farms above threshold (% coverage)	Approximate # of poultry farms above threshold (% coverage)	Approximate Number of Mixed farms (% coverage)
50	330 000 (39%)	91 000	95 800	unavailable
100	163 000 (20%)	58 500	59 700	unavailable
150	67 700 (12.5%)	37 200 (61%)	20 400 (58%)	9 300 (27%)
300	16 400 (3%)	24 900 (41%)	12 000 (34%)	4 600 (13%)
500	5 500 (1%)	15 300 (25%)	7 000 (20%)	1 700 (5%)

Source: 50 through 100 LSUs sourced from Eurostat (2017); 150 through 500 LSUs sourced from DG ENV 2023

From a study that was utilised as an input into the impact assessment for the IED (Ricardo 2021), the potential coverage of including installations with cattle and lowering the threshold for livestock units for pig and poultry farms was evaluated for both its potential costs and benefits, as well as the potential for addressing methane emissions. Tables 6 and 7 demonstrate the coverage of both farms (%) and animal heads for thresholds of LSUs: while coverage for the number pig and poultry heads does not change substantially between thresholds between 50 to 150 LSUs, the coverage of animal heads for cattle increases substantially when lowered from 150 LSUs (40% of cattle heads) to 50 LSUs (80% of cattle heads). The potential coverage of cattle is particularly relevant, as 86% of emissions from enteric fermentation come from cattle, while 2.5% comes from pigs, and the rest is mainly from sheep.

Table 8 Coverage of animal heads (%) based on LSU Thresholds

	>50 LSU	>100 LSU	>150 LSU	>300 LSU	>500 LSU
Cattle: number of heads (%)	80%	62%	40%	23%	12%
Pig: number of heads (%)	94%	92%	91%	80%	66%
Poultry: number of heads (%)	98%	95%	89%	73%	59%

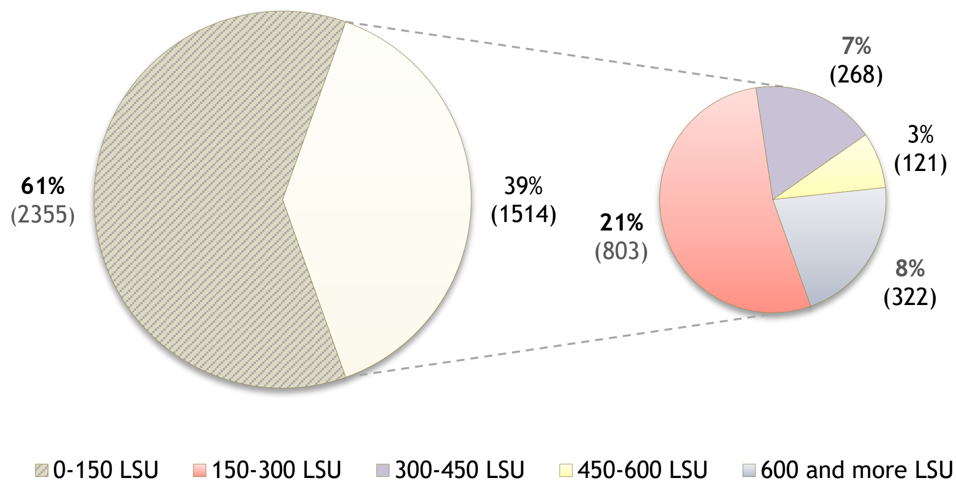
Source: 50 to 100 LSU sourced from Eurostat (2017); 150 through 500 LSU sourced from DG ENV 2023

The degree of coverage for LSU thresholds was also assessed for the methane emissions that could be brought under the IED from livestock farms – see figure 5, although this was assessed only for thresholds above 150 LSUs. Nevertheless, the assessment indicates that approximately 43% of methane emissions would be brought into the policy with a threshold of 150 LSUs.

The costs increased linearly as the threshold was lowered, and therefore it can be assumed that costs for thresholds lower than 150 LSUs will increase linearly as well. Due to limitations with the modelling, it should be noted that the analysis of both potential methane reductions and of the costs and benefits only assumed a limited adoption of techniques to reduce methane emissions from enteric fermentation, with only those from manure management considered.

Thus, in the interests of aligning an on-farm ETS with the existing policy framework, the outcomes of thresholds established in the IED will inevitably influence the threshold level for an on-farm ETS for livestock.

Figure 5 CH_4 emissions (ktonnes per annum) that can potentially be included under an on-farm ETS, based on a 150 LSU threshold



Source: Ricardo 2021

3.3. Policy Option 3: Peatland ETS

ETS option	On-Farm ETS – peatland only
GHG coverage	Emissions from agricultural production on organic soils (CH_4, CO_2, N_2O)
Point of obligation	Arable, livestock, and mixed farms on peatland soils
De Minimis threshold	None

Policy option description

This option applies the polluter pays principle to emissions of GHGs from drained peatland used on agricultural land. It will involve setting a cap on net emissions from such soils; those managing farms using such soils will, if they have net emissions, need to surrender sufficient allowances to cover their net emissions, and will be able to buy and sell allowances to achieve this. Other emissions from such farms (e.g. from livestock or the use of fertilisers) will not be covered, and will need to be addressed by other policy options at EU or national level.

Box 4 Alternative policy option to an on-farm ETS on peatland emissions

Given the problems with GHG measurements and baseline definition, some have disputed the suitability of a cap-and-trade approach as a primary instrument for peatland conservation (Ekardt 2020). Emissions trading systems are considered to work well when linked to easily comprehensible control variables, as in the case of e.g. fossil fuels or livestock products. The uncertainties and multitude of factors that affect emissions from drained peatlands and their mitigation potential make command-and-control instruments potentially a more appropriate tool for addressing the problem of agricultural emissions from peatlands (ibid.).

The strong correlation between increased water level and emissions avoidance opens the possibility of designing a command-and-control policy which would be based around a requirement to maintain an elevated water table. Other provisions, such as bans on the use of peatlands as arable land or ploughing up grassland, could complement this requirement to support both long-term rewetting and prevent the draining of new areas of peatland. This type of legislation would internalise pollution costs by ensuring that farmers take measures to maintain water levels within legal limits and would not require precise knowledge of the emissions from peatland use as the baseline.

In exploring potential policy options to incentivise peatland re-wetting Danish Council on Climate Change (2020) considered the potential of a drainage ban to ensure that all peat soils are rewetted. The assessment determined that such a measure would not be cost effective, namely due to potential lawsuits over claims of expropriation and claims for compensation amounts. Such a scenario would prevent the determination of compensation through political negotiations instead. Such lawsuits could also delay the process of re-wetting peat soils.

An alternative approach would be to introduce a tax on the use of peatland for agriculture. This could either be based on a simple hectarage tax for any agricultural use, or on net emissions from agricultural holdings on organic soils (using a similar approach to the ETS option for calculating emissions). Isermeyer et al. (2019) observe that the introduction of a carbon tax with immediate effect would not be considered expedient, as landowners would be likely to contest the resulting devaluation of their land, potentially leading to long-term legal disputes.

This issue could be addressed by introducing a bonus-malus system which involves both a carbon levy and a climate protection premium (Schafer et al. 2022). It assumes the payment of a premium to farms that want to rewet their land or switch production from drainage-based peatland use to paludiculture. This would provide an incentive for farmers to convert their land to a more sustainable use, while also providing them with compensation for the loss of income that they may experience as a result. The introduction of a bonus-malus system would be staggered, with the climate protection premium introduced with immediate effect and the carbon tax coming into force a few years later. This would allow early movers to be rewarded and create certainty enabling landowners to action the long-term measures required.

Schafer et al (2022) emphasise that the system would need to be carefully designed, particularly with respect to the point of obligation. They recommend that the carbon tax should be levied on the landowners, given their rights of disposal over the land and ultimate decision-making power. While the premium should be paid to farmers who carry out the necessary changes, it is noted that the payment of protection premiums increases basic rent, and the benefit is likely to be passed on from the famer leasing the land to the landowner. The potential impacts would need to be carefully assessed to ensure adequate incentives exist to stimulate emissions reductions.

As with any measures envisioning payments for ecosystem services by the state, the premiums would have to be set at levels affordable for the government. This may be challenging in the context of peatland rewetting given potentially high opportunity costs associated with continued drainage-based peatland use. Similarly, high tariffs would likely be required with the introduction of a carbon tax.

In principle, the introduction of command-and-control measures, taxes and financial incentives may be associated with a higher degree of uncertainty around the expected mitigation outcomes when compared with a cap-and-trade system, where the cap defines the desired reduction. On the other hand, these measures are associated with higher price certainty, which may be more desirable for farmers.

A significant drawback of fiscal policy solutions is the potential difficulty of securing agreement to any EU proposals in this area. In addition to the usual challenges in securing agreement (by unanimity in Council) to tax measures under the Environment title of the TFEU, Article 192 also requires unanimity to measures affecting "land use, with the exception of waste management[38]", which would appear to apply here. Member States have widely differing approaches to and systems for land taxation, and finance ministries will consider this as being clearly a national prerogative. The ongoing and future developments related to the Energy Taxation Directive may provide some insight into the appetite for introducing EU-wide fiscal measures and the likelihood of achieving unanimity in the Council.

Finally, a redesign of the relevant aspects of the Common Agricultural Policy is a clear opportunity to reduce emissions from peatlands and should be prioritized to ensure coherence with any further policy measures. While changes made as part of the most recent revision of the CAP aim to introduce minimum standards for the protection of peatlands and eligibility for paludiculture activities, implementation at Member States level appears to be lacking the necessary ambition (see Box 13 for further detail). Overall, the issue of subsidization of continued drainage-based peatland use has remained unaddressed. This suggests that minimum standards relating to the protection of peatlands need to be defined at EU level to set in motion the necessary land use changes. Currently, CAP subsidies to drainage-based peatland use artificially inflate the opportunity costs of rewetting or changing practices to paludiculture. Removing subsidies would eliminate the distortive effect on the market and enable other policy measures, whether based on incentives or penalties, to work as intended.

GHG emissions scope

Drained peatlands are a source of CO_2, N_2O and CH_4 emissions, all of which are covered within the scope of this policy option. Functioning and undisturbed peatlands always emit CH_4 due to the decomposition of plants, while drained peatlands usually emit negligible amounts of CH_4. However, large amounts of CH_4 are released from drainage ditches (Greifswald Mire Centre 2022a). In addition, grazing by ruminant animals, which is typical on drained peatlands in Germany, can contribute significantly to the atmospheric CH_4 fluxes of the ecosystem. Methane emissions from rewetted peatlands are usually comparable to those from natural, undrained peatlands (Greifswald Mire Centre 2022b)..

Peatlands are particularly rich in organic matter. Peat accumulates in areas where the decomposition of plants is slowed due to wet conditions, storing large amounts of carbon accumulated over thousands of years. Healthy peatlands are the most space efficient long-term carbon store and sink in our planet's biosphere (idem.). Peatlands have been drained for agriculture purposes, usually either converted into land utilised for growing arable crops, grasslands for the purposes of livestock rearing, or they are drained for the purposes of peat extraction, or for commercial forestry activities.

Drainage of peatlands causes significant releases of greenhouse gas emissions: drainage allows oxygen to enter the soil, leading to microbial decomposition of the peat and thereby breakdown of the stored

[38] TFEU, Article 192 (2) (b) third indent

carbon leading to substantial amounts of CO_2 and N_2O emissions. Around 40% of EU peatlands have been drained, and this large-scale drainage and overexploitation of peatlands account for roughly 5% of the total EU GHG emissions, making the European Union the second largest emitter of GHGs from drained peatlands globally (Birdlife & European Environmental Bureau, 2022), emitting up to 220 Mt CO_2 per year (Greifswald Mire Centre, 2019).

Because of the substantial contribution to GHG emissions from the draining of peatlands, and because of the potential of peatlands as a global carbon sink, peatland re-wetting will be a key factor in mitigating climate change and limiting the increase of the global mean temperature to well-below 2 degrees (Guenther et al 2020).

In the EU, carbon farming activities for the management of peatlands, such as re-wetting, or restoring previously degraded peatlands used for agriculture, or paludiculture, have the potential to mitigate up to 54 $MtCO_2e$ per year (McDonald et al 2021). Paludiculture is the productive land use of wet and rewetted peatlands that preserves the peat soil and thereby minimizes CO_2 emissions and subsidence. According to the EU Peatlands and CAP Network (2021), '(w)ith paludiculture, peatlands are kept productive under permanently wet, peat-conserving and potentially peat-forming conditions. Thus, it is a blueprint for peatland carbon farming while still producing food, feed and energy' (p.1).

For most areas, there is a possibility of using the rewetted areas for sustainable peatland practices, which will need to be defined depending on the local site conditions. Farmers could be allowed to use the rewetted area for economic purposes as long as such economic activities are carried out according to a framework of "sustainable peatland management practices." It should be noted that not every drained peatland can be re-wetted, as several factors (such as water availability) will influence the land's suitability. If the area is not suitable for re-wetting, then farmers should not be penalized for the emissions.

While full restoration and renaturation of peatlands could be pursued by those farming on peatlands, there are other mitigative practices that have the potential to reduce greenhouse gas emissions, to varying degrees (see Table 9 for the mitigative potential of various practices) that could be incorporated into the certified approach to MRV.

Table 9 Potential mitigation activities on peatlands and their mitigation potential

Mitigation	Mitigation Potential
Re-wetting or renaturation of drained peatlands	Highest level of mitigation potential
Paludiculture	Moderate to very high
Raising water table on grassland	Moderate
Conversion of arable land to grassland	Low
Grassland extensification	Low
Submerged drains	Low-moderate
Afforestation[39]	Low-high

Source: Adopted from Chen et al 2021

[39] Afforestation on drained peatlands may lead to increases in emissions from the soil, while removals would be above-ground. Therefore, introducing this as a potential measure should be carefully considered and analysed for potential negative impacts.

The EU will need to clarify which mitigation is best suited to the location and which innovations could be applied in order to receive deductions from the price of emission certificates.

On some of the peatland areas, however, potential uses of the land will be very limited by nature conservation objectives. How this particular situation should be regulated financially should be determined in nature conservation policy.

Globally, inventories for peatland emissions have up until recently been unsatisfactory and most countries have insufficient information about their peatland resource (Joosten 2009). This is because the presence of peat cannot be observed directly by remote sensing. Often, data ranges presented in literature are compilations of different estimates. EU Member State emissions from organic soils such as peatlands are still underexposed in the National Inventory Submissions (NIS), and are often insufficiently reported (Barthelmes et al 2015; Houghton et al 2012; Tubiello et al 2015). Obstacles for reporting include: *"… undifferentiated presentation of the total land use sector, in which organic soil sources are obscured by forest biomass sinks, and the split reporting of agricultural emissions over the two sectors Agriculture and LULUCF." (Greifswald Mire Centre, 2018, p. 6)*. While the IPCC (2014) provides guidance for reporting and accounting emissions from drained and rewetted organic soils, many EU countries fragmentarily and inconsistently report CO_2 emissions from cropland and grassland under LULUCF emissions and N_2O emissions under Agriculture (ibid). It is thus difficult to determine the quantity of peatland emissions attributable to agriculture.

Scientists from the Greifswald Mire centre have been developing and refining proxies to estimate emissions from large peatland areas, and establishing the Global Peatland Database, which contains data on distribution, status, and emissions of peatlands worldwide. It is also worth noting the efforts being made as part of the Joint Research Centre's SEPLA project ("Satellite-based mapping and monitoring of European peatland and wetland for LULUCF and agriculture"). The project's key objective is to enable the development of a comprehensive inventory of wetlands and peatland and enhance monitoring in this area through remote sensing and regularly updated, geographically explicit datasets. The planned outputs include a methodology for identification and mapping of "candidate" peatland/wetland areas for the achievement of the LULUCF carbon sink ambition and a prototype for EO-based monitoring of these areas.

Joostens (2009) does provide an estimate of both emissions from agriculture, which can be compared with the total emissions from degraded peatlands based on inventories reported to the UNFCCC.[40] The table below has extracted the emission estimates for EU Member States for total emissions for all degrading peatlands (from drained peatlands used for forestry, agriculture, and peat extraction), as well as emissions from drained peatland used for agriculture only.

Table 10 Estimates of emissions from drained peatlands by Member State

Member State	Emissions from peatland drained for agriculture ($MtCO_2e$)	Total emissions from degrading peatland ($MtCO_2e$)
Germany	30	32

[40] Note the estimates from Joostens (2009) are from 2008 and therefore do not match the Greifswald Mire Centre's 2020 estimates from the Global Peatland Database of total emissions from peatlands

Poland	17.5	23.5
Finland	7.5	49.9
Sweden	7.5	14.6
Estonia	7.5	9.5
Ireland	6.35	8.2
Netherlands	5.75	5.8
Lithuania	3.25	6.1
France	2.5	2.7
Latvia	2.25	4.22
Denmark	1.5	3
Romania	1	1.03
Hungary	0.68	0.71
Italy	0.35	0.35
Austria	0.25	0.29
Belgium	0.24	0.34
Slovenia	0.17	0.17
Greece	0.13	0.14
Spain	0.04	0.13
Croatia	0.00	0.00
TOTAL	**94.5**	**162.7**

Emissions from peatlands converted to forestry use will not be covered under this option since this study is focused on agricultural emissions. Some consideration may be needed of whether existing controls on conversion (such as requirements for an environmental impact assessment) need to be reinforced, given the risk of perverse incentives for afforestation.

Point of obligation

The point of obligation for this policy will be at the farm level and will include all farms in the EU utilising drained peatlands for the purposes of agricultural production.

A factor of consideration is that farms with the obligation to participate within this policy option will be unevenly distributed across Member States given the strong imbalance in peatland distribution in Europe. Overall, peatlands cover 5.7% of the EU-27 land surface. They are mainly concentrated in Northern, Eastern and Central Europe where they cover up to 25% of the land surface (Tanneberger et al., 2017). Even between countries with a high share of peatlands, the number of farms with the obligation to participate will vary depending on how the peatlands are used. For example, in Finland more than half of the peatlands drained are utilised for forestry while a small proportion (11%) is utilised as arable land; while in Germany, more than 95% of peatlands are drained and 80% of the total are used intensively for agriculture (Trepel et al 2017).

Overall, 3% of the utilised agricultural area in EU-27 is located on organic soils (Martin & Couwenberg 2021). Emissions from peatlands used for agricultural activity are highly concentrated, with 57% occurring in just three Member States: Germany, Poland and Romania. Seventeen EU countries are responsible for 99% of agricultural emissions from peatlands. In each of the remaining ten Member

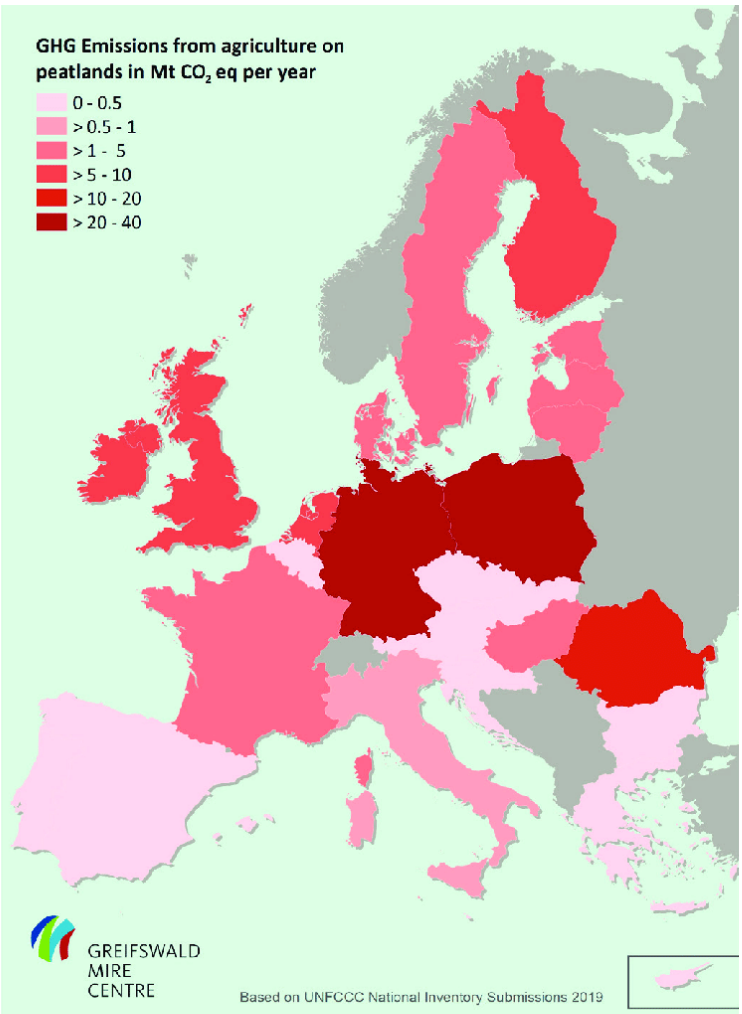
States, emissions and area of agricultural land located on organic soils are negligible, staying below 450 kt CO_2eq and 20kha respectively.

Table 11 GHG emissions from drained peatlands used for agricultural purposes in EU-27 - Cumulative %

EU27 Member States	% of EU emissions from drainage-based agriculture	Cumulative % of EU emissions from drainage-based agriculture
Germany, Poland, Romania	57%	57%
Netherlands, Finland, Lithuania, Ireland, Denmark	24%	81%
Estonia, Latvia, France, Sweden, Austria	15%	96%
Hungary, Bulgaria, Portugal, Italy	3%	99%

Source: Adapted from Martin & Couwenberg (2021)

Figure 6 EU GHG Emissions from agriculture on peatlands



Source: O'Brolchain et al 2020

There are currently no official estimates of the number of agricultural holdings which conduct farming on organic soils in the EU. To arrive at a preliminary estimate, the authors of this paper used the analysis conducted by Martin & Couwenberg (2021), which compiles and validates data on agricultural area located on peatlands in each Member State. The percentage of total UAA on organic soils in each Member State was applied over its total number of agricultural holdings as recorded by Eurostat (2020), and the resulting numbers were added to estimate the total number of farms in the EU which farm on organic soils. This estimation suggests that around 26,900 farms could be expected to fall within the scope of this policy option. However, this figure should be interpreted as an indicative estimate only, as it does not take into account variations in the distribution of farms on organic and mineral soils. Relative to the other on-farm options (all-GHGs, Livestock), this option would have significantly fewer farms within its scope, and therefore could minimise the burden of implementation (objective 1).

Holders of peatland which are either public authorities or NGOs not actively farming the land could be excluded on the basis that they are not "agricultural holdings" as defined under CAP legislation. Alternatively, they could be integrated in the ETS so as to receive allowances that can be sold, thus providing revenue for the maintenance of re-wetted peatlands, thus rewarding "early re-wetters."

De Minimis threshold

A permanent preservation of the CO_2 and N_2O storage is only possible if the peat soils are completely rewetted. Conventional agricultural use as arable land may no longer be possible, although paludiculture offers the option of re-wetting and using the land at the same time for agricultural purposes. However, all farms on peatland would have to be integrated (see EU Peatlands and CAP Network 2021). Effective agri-environmental management of peatlands will require co-ordinated implementation action beyond an individual farm due to the ecological functioning of the water system at the watershed level: this is because raising the groundwater level cannot necessarily be brought about by individual farmers. Therefore, re-wetting efforts may require concerted and collective action (Haefner & Piorr 2021).

Therefore, because of the collective nature of peatland re-wetting, the European Commission will need to explore the potential impacts of integrating all farms on drained peatlands across the EU into emissions trading, with no thresholds of farm size or area for obligation to participate.

Unique Policy Design Aspects

Administrative Oversight

The possibility of establishing an intergovernmental organisation that would be responsible for collecting and managing the necessary data on peatlands in Europe could be considered. Such an organisation could have the main responsibility of implementing an ETS. This could be an option to give the ETS into ''neutral'' hands after the implementation of ETS legislation.

The Commission will also be involved in the management of the interface with the Common Agricultural Policy, including (a) any use of CAP data (LPIS, etc) for implementation (b) incorporation of relevant provisions into the next CAP 2028 legislation (cross-compliance, any amendments necessary to enable CAP rural development mechanisms to assist farmers with implementation). There will also be a need for careful scrutiny of the potential impact on protected areas and species under biodiversity legislation (ensuring positive synergies wherever possible).

MRV

Establishing rules for **Monitoring, Reporting and Verification** of emissions (and sequestration) is likely to be more complex than in the other on-farm options, with a likely greater need for on-farm assessment, and in particular to require careful coordination with the bodies responsible for GHG inventories. The overarching framework would be set in implementing regulations at European level, but with detailed emissions factors set at Member State level (with proposals subject to approval by the Commission). A similar approach could be adopted for the certified approach; the Commission could have the power to establish or endorse EU-wide certification of some practices through implementing regulations, but Member States could also be given the option to put forward detailed rules for the certification of additional practices relevant to their agricultural industry, subject to Commission approval. It should be noted that peatland rewetting is currently included as a carbon farming activity in the Carbon Removal Certification Framework proposal; therefore any ETS policy could build on the MRV methodology and verification process that may be developed in the near future to estimate and verify emissions in that context.

Member States will be responsible for identifying ETS participants, essentially by determining which agricultural holdings (using LPIS data) contain land identified in the EEA EUNIS classification system under categories D1, D2, D3, D4[41]. Processes for farm holdings to challenge designation could be envisaged, since some may not be aware of their land's designation as peatland, or may dispute the data used.

Certification of bodies and individuals which can (i) carry out a tailored emissions assessment of farm holdings or (ii) certify a farm's adoption of the specified emissions reduction practices will need to be carried out at Member State level, on the basis of broad guidelines established at European level. Alternatively, this could be done by an intergovernmental organisation that could be responsible for the implementation and management of the ETS. In this scenario, Member States would only need to report data on land use and farms.

To introduce a more cost-effective MRV (objective 3), proxies could be used for emissions and sequestration of GHGs, for instance using water levels, vegetation and subsidence. To make the monitoring system practical and verifiable, the input parameters must be straightforward (COWI et al., 2021). The baseline is of importance as emissions avoidance is regarded as prime objective for peatland re-wetting and conservation. For this reason, a clear baseline is required (Joosten, 2009).

Emission factors for each land category should be determined. Emission factors could be determined by using proxies or reference data and supplemented by direct measurements (COWI et al., 2021). Ideally, factors should also reflect the state of peatland within each land category, but given the difficulty in assessing peatland state accurately for all relevant holdings, some simplification may be needed (e.g. focusing on farm input of information on ploughing, drainage, land use etc.).

As with the other on-farm options, an on-farm assessment of emissions, which accounts for mitigation practices and therefore incentivising the adoption of mitigation measures by facilitating emissions savings from calculated total emissions can be introduced. This provides an incentive for adopting mitigation measures. However, care will be needed to ensure that there is no double-counting between

[41] This is the approach adopted by the Commission in its proposal for a Nature Restoration Law (22 June 2022) - see Annex VI, p 293 of the accompanying impact assessment.

the emissions factors used for calculating total emissions, and the certified reductions (e.g. an emissions factor based on re-wetting or moisture content could reward re-wetting practices, and a certified emissions reduction scheme would provide an unnecessary additional reward for the same behaviour).

Over time, and as experience in the system is developed, and as the numbers of soil scientists with sufficient expertise increases, it may be possible to move towards a more accurate and targeted approach, based on tailored assessments of each holding. One possible approach would be to apply a rolling multi-annual system for soil carbon estimates, with each holding being assessed once every (say) five years. This would even out the cost, reduce the level of demand for limited skills in each year, and would arguably be a more appropriate method for assessing a gradual process subject to weather variations. In the meantime, it may be possible to allow holdings to volunteer for a tailored assessment, at their own cost, in order to challenge or verify the total calculated on the basis of emissions factors.

A key point to note with this option is that Member State administrative costs will be highly unevenly distributed (as organic soils are unevenly distributed throughout Europe), with most facing little or no cost, and some facing significant cost. This may lead to a situation where participants in the legislative process both in Council and in Parliament have little incentive to ensure that administrative costs are manageable.

There are additional challenges involved in measuring emissions from peatland. The approach outlined would require (i) an obligation on Member States to provide a calculation of emissions for all peatland agricultural holdings; (ii) accreditation of project mechanisms for assessing measures to reduce emissions or sequester carbon; and (iii) in due course, roll-out of targeted farm assessments, which would require accreditation of the assessors.

The calculation of emissions for each holding would be based on data held on the Land Parcel Identification System, and the application of standard emissions factors, in line with those used for each Member State's GHG inventory. In order to ensure consistency of the data across Member States (and thus equal stringency of the system), a process of approval by the Commission of Member State proposals for calculation systems would be needed. A process allowing farm holdings to challenge their calculated emissions would also be needed.

The accreditation of project mechanisms could involve both EU-level approval by the Commission of broad systems of relevance to a number of Member States, and Member State level approval of mechanisms tailored to specific geographical opportunities. Ensuring integration of these project mechanisms in national GHG inventories could be challenging, and may take significant time to achieve through the IPCC process; in the meantime, there could be a disconnect between emissions recorded under the peatland ETS and emissions recorded in national inventories.

Particularly high costs will apply to MRV requirements, if these include a gradual roll-out of targeted farm assessments. These would require site visits and detailed measurements by accredited experts, at a cost potentially exceeding the carbon costs of the holding's emissions. While a multi-annual process of assessment could ease this burden, this approach still seems likely to involve a very high ratio of administrative cost to carbon saved. Focusing targeted assessments on the peatland holdings with the highest emissions, or highest potential for mitigation, would only partly address this issue.

Establishing a cap

A specific challenge associated with establishing a cap for a peatland-only ETS is estimating the level of net emissions reduction which can be demanded from the farm holdings covered, and ensuring that the cap is sufficiently challenging so that re-wetting is encouraged. A short period (i.e. two years) for assessing the total net emissions of the holdings covered by the ETS could be considered, with a cap set on the basis of a profile aiming at a faster reduction than the average across the EU economy.

In principle, it would be possible to allow Member States themselves to set national caps for their peatland farm holdings, if they also have the duty to make good any shortfall in mitigation through their action under the Effort Sharing Regulation. This would allow them to tailor their ambition to their understanding of the mitigation potential, and the competitive and other pressures on the farm businesses concerned. This is, broadly, the system that operated under the first two phases of the main EU ETS. However, experience from phases one and two is not encouraging; Member States generally set loose caps, in part because the emissions price impact of setting ambitious caps was distributed across the rest of the EU system; and hence the increased value of allowances or credits, either as held by participants through free allocation or auctioned by the Member State, did not accrue to the Member State setting a tight cap.

Allocation of Allowances

To ensure that vulnerable farmers do not feel left behind (objective 5) due to the high costs and substantial changes in land management practices associated with re-wetting, the EU could consider distributing emission allocations for peatlands free of charge over a longer period of time, including loss of revenues from decreasing production output. Such strong financial support would assure farmers that they will be provided with emission rights annually free of charge for their (currently agriculturally used) peatland area up to a certain year (e.g. 2040), or to incentivize farmers to start re-wetting part of their land. These rights can be used to continue agricultural production or, in the event of re-wetting, be sold annually in an auction. This would allow for such farmers to engage in long-term planning having a higher degree of predictability and certainty.

According to Isermeyer et al (2019), if farm operators on peatlands are given the opportunity to sell emission rights in auction, they are likely to make use of this option when the price of certificates are high. The authors propose that the EU should offer the prospect of ensuring a basic minimum price when certificate prices are low. The EU could manage a peatlands ETS in a way that will guarantee farmers the total number of emission rights for which they receive this minimum price in auction every year (e.g. rising steadily from its introduction to the endpoint of when free allocation of allowances are phased out, say by 2040) (ibid). In the event that the price of emission certificates for auction does not meet this minimum price, Isermeyer et al (2019) propose that the EU could compensate farmers for the difference. The minimum auction price must be high enough for a long period of time to provide an incentive for farmers on drained organic soils to decide jointly to rewet and should also be higher earlier in the stipulated time-period to ensure more money is given to those who participate in re-wetting earlier (ibid).

An alternative approach to this could be that the Commission buys up credits to stabilize the price for the credits. The Commission could run an EU-wide eco-scheme for all the different types of emissions-reductions, carbon removal, or biodiversity credits. The Commission would be an additional buyer of credits (those which are based on verified on-farm monitoring) and could manage the market (similar to a central bank or with the Market Stability Reserve in the ETS).

The EU will have to determine until which target year farmers receive free allocation of allowances in the event of re-wetting and how this can be contractually guaranteed. An “eternal” provision of free allocation is not feasible, as this would negate the polluter-pays principle. However, a too short period of time could be perceived as (in effect) a form of expropriation by the EU (Isermeyer et al 2019).

In deciding the rules for free allocation, grandparenting, in which allocation is determined by historic data, could be considered. Because this policy option is designed to solely address emissions from land use rather than emissions from on-farm practices, it would be logical to base this on historical emissions rather than based on output. Under grandparenting, farmers receive the same amount of allocations every year as long as emissions are the same – thus, allocations for farmers will only go down as the cap is slowly implemented.

The benefit of grandparenting is that it is designed to incentivise those with historically high emissions to reduce their emissions. Therefore, the idea is to incentivise particularly large farms to consider peatland re-wetting as they will have the highest level of allocations. According to the New Zealand ICCC (2019), grandparenting helps assist farmers with stranded farm assets, both with loss of land value and material investments needed for sustainable practices. Farmers already engaged in more sustainable peatland practices, such as paludiculture, will be disadvantaged under grandparenting rules. However, as discussed above, such farmers could be rewarded through allocation of allowances they can sell in the market, thus rewarding early re-wetters.

A Legal Framework for Re-wetting

Farmers may not always be able to conduct re-wetting themselves, since they may need the collective participation of other landowners in neighbouring areas, as well as the consent and cooperation of the local authorities. For farmers who are leasing their land, termination of agreements will need to be negotiated. In addition, not every drained peatland area is suitable for re-wetting due to water availability. A legal framework needs to take this into consideration, as farmers should not be penalized for emissions they cannot avoid/reduce due to external circumstances. Therefore, frameworks for organising regional landowners will need to be formed to promote re-wetting efforts.

The EU will need to take into consideration whether a legal framework will be necessary to stipulate how to proceed if the majority of farmers affected agree to the re-wetting, but some individuals reject it. In addition, legal entities (e.g. cooperatives) that are suitable for joint decision-making and for peatland-friendly activities of farmers should also be integrated into such a framework.

Approaches to the risk of carbon leakage

Our assessment is that the risks of carbon leakage for this option are relatively limited for the meat and dairy sectors (since peatland used as pasture is usually relatively marginal in terms of production). If the carbon price signal is sufficient to drive a significant reduction in the use of drained peatland for arable production, this will lead to a reduction in production which will (assuming unchanged global consumption) need to be compensated by increased yields or more land coming into agricultural production elsewhere, which could negate some of the emissions reduction from the peatlands no longer being utilised. However, this shift would be in line with the policy objectives; there is no obvious reason to expect a risk of peatland specifically being brought into production in other economies. Another factor limiting the risk of carbon leakage is the fact that with paludiculture, it is still possible to continue producing, albeit non-food outputs, but rather biomass used for bioeconomy purposes.

Box 5 The Peatland Code – The UK market-based instrument for peatland restoration

The IUCN Peatland Code is a voluntary certification standard, designed to make peatland restoration projects in the UK a viable and attractive source of carbon credits to voluntary carbon market participants. It sets out a series of requirements for the restoration process and a standard method for quantifying GHG impacts, while at the same time providing a mechanism for independent monitoring and validation over the lifetime of the project. In this way, it is intended to provide clarity and assurance to buyers of carbon units in terms of the volume, permanence and additionality of the associated emissions reductions.

The uptake of the Peatland Code is considered to have been slow since its launch in 2015 (Moxey et al 2021). One of the main challenges has been the lack of awareness of the benefits and need for peatland restoration, as well as lack of familiarity with the Peatland Code itself among land managers and restoration practitioners (ibid.). The issue of peatland restoration lacking resonance with the general public was identified as part of the Peatland Code pilot research project (DEFRA 2013) and has remained relevant, suggesting that additional effort is needed to publicise the case for restoration (Moxey et al 2021).

Opportunity costs are also considered to have played a role in the slow uptake of the Peatland Code. The prospect of potential income losses resulting both from reduced productivity and ineligibility for support payments or tax relief disincentivises land managers from pursuing restoration projects, particularly given the uncertainty over carbon prices and future support arrangements (Moxey et al 2021). This is reflected in the fact that most peatland restoration projects are carried out on upland blanket bogs, typically used for light grazing or seasonal hunting, as opposed to lowland peats where restoration is relatively uncommon due to competition with income from crop production (Brown 2020). This highlights the need to align existing agricultural support policies with the ultimate ambition of any new instruments designed to promote peatland restoration. It also suggests that the inclusion of paludiculture, currently not within the scope of the Peatland Code, may help accelerate peatland restoration efforts given the economic benefits associated with continued agricultural production (Evans et al 2022).

While the website of the initiative provides indicative prices of its carbon units (GBP 15-25), the actual price is agreed between the buyer and the project developer on a case-by-case basis. The costs of peatland restoration projects also vary greatly, depending on the methods used, the type of damage, site characteristics, location and other factors. A recent analysis of data collected as part of the Scottish Peatland Action Programme estimates median restoration cost per hectare to be GBP 1026 in the region[42] (Glenk et al. 2022). Similarly, the estimates of abatement potential are

[42] Glenk et al. (2022) suggest that referring to the mean value is less informative given the distorting impact of a small number of sites with a relatively high cost on the average cost. An earlier study conducted in the UK context also found the data to be dispersed, with a difference of GBP 3707 between the minimum and the maximum costs, and a median cost of GBP 1009 per ha (Okumah et al. 2019).

context-dependent and vary across literature. Assuming annual emission avoidance of 3.5 tCO_2e/ha (Moxey 2011), emission savings over a 20-year period could amount to approximately 70 tCO_2e/ha. At the end of this period, costs could be fully recovered assuming a restoration cost of GBP 1026 per ha and a credit price of minimum GBP 15 or more. Theoretically, a stable carbon price of GBP 100 would allow for full cost recovery within three years of continuous near-natural site maintenance.

Accurate and cost-effective monitoring and verification, in particular, is seen as key to the successful implementation of the objectives of the Peatland Code. The current MRV approach uses empirically-based emission factors developed for a restricted range of peatland conditions (which do not currently include heavily modified habitats such as agricultural land). Verification takes place 5 years after the start date of the project and at least every 10 years thereafter, with monitoring expected to be conducted max.12 months prior to each verification. The current monitoring practice is primarily based around measuring peat depth and qualitative assignment of each monitoring location to a Peatland Code condition category (Evans et al. 2022).

Projects are expected to identify potential risks to the maintenance of improved condition category and mitigate those where possible. The Code requires a minimum 30-year monitoring period as a safeguard against the reversal of carbon storage, however concerns over project permanence remain valid beyond this period (Qazilbash 2021). To further manage the risk to project permanence, each project must contribute 15% of net GHG emissions reductions over its duration to the Peatland Code Risk Buffer.

Operating on the basis of a limited range of condition classes can have several negative consequences for the effectiveness of the peatland restoration effort. For example, intensive and expensive restoration techniques are likely to appear less economically favourable than more 'basic' interventions despite their greater potential for emissions abatement, as long as the two lead to the same shift between EF categories (e.g. from 'Modified Bog' to 'Rewetted Modified Bog'). Conversely, interventions leading to potentially significant emissions abatement without resulting in a transition between EF categories would not be accounted for at all (Evans et al 2022).

A 2022 study commissioned by the UK Department for Environment Food and Rural Affairs investigated the potential for greater disaggregation of existing categories and inclusion of new ones, with a view to achieving higher accuracy and reflecting variations in site conditions. It found that this would largely be impossible given the continued lack of sufficient measurements from representative locations, indicating the need for concerted and coordinated investment in GHG flux measurements. Authors of the study proposed an alternative approach which would help to partly overcome the identified data limitations based on peat elevation and water table depth measurements, suggesting a set of low-cost monitoring techniques to support ongoing assessment (Evans et al 2022). Opportunities for using remote sensing and airborne imagery may also be explored (Qazilbash 2021).

Based on the lessons learnt from the implementation of the Peatland Code, the introduction of an ETS covering emissions from organic soils would require significant upfront costs associated with establishing an emission factor classification and determining baseline emissions to ensure fair allocation of allowances. In addition, given the specialist knowledge, equipment, and skills required as part of restoration efforts, significant resources will be needed to increase capacity, including through subsidised advice and training (Moxey et al 2021). However, the inclusion of peatland re-wetting in the proposed Carbon Removal Certification Framework could provide a foundation for investments needed for a peatlands ETS.

3.4. Policy Option 4: Upstream ETS

ETS option	Upstream ETS
GHG coverage	Emissions from enteric fermentation (CH_4); emissions from urine and dung deposited by grazing animals; emissions from fertiliser volatilization (N_2O); and CO_2 emissions from urea application
Point of obligation	Manufacturers and importers of farm animal feed and synthetic fertiliser
De Minimis threshold	Exemption for small businesses • Feed: based on the production capacity of farm animal feed manufacturer in volume of feed • Fertilisers: based on the production capacity of synthetic fertilisers in volume, or (specifically for synthetic nitrogen fertilisers) the production capacity in terms of nitrogen content

Policy option description

An upstream ETS would cover products that lead to on-farm emissions when consumed. The point of obligation lies with entities that supply the products that are purchased by farmers. These entities will have a compliance obligation to surrender an equal amount of emission allowances to the GHG emissions that their products would cause on farms, while GHGs emitted during the manufacturing of the product would not be covered by this policy option. The PPP is not applied directly to the emitter of agricultural GHG emissions (farms), but relies on upstream entities to pass on the cost of GHG emissions to the emitters.

Box 6 Alternative policy options to an upstream ETS: GHG emissions tax on farm inputs

A tax on GHG-emitting products used on farms could serve as an alternative policy option to an upstream ETS. The tax base would ideally be based on the GHG emissions released when the products are used, with the tax rate expressed as Euro per unit of product. The most prominent example of such a tax is a nitrogen fertilizer tax. EU Member States that had fertiliser taxes in place include Austria, Denmark, Finland, the Netherlands and Sweden.[43] In none of these countries is a fertiliser tax in place anymore, except in Denmark where there are broad exemptions from the tax for the agricultural sector. The lessons learnt from some of these fertiliser taxes are presented in the Section 4.3.

GHG Emissions Scope

The upstream ETS policy option could cover **up to about 57% of GHG emissions** from the agriculture sector (approximately 220 MtCO2 eq.). These are GHG emissions stemming from sources and activities that entities upstream of farms, i.e. suppliers of goods that upon consumption on the farm directly lead

[43] https://greenfiscalpolicy.org/wp-content/uploads/2020/09/Study-on-the-Effects-of-Pesticide-and-Fertilizer-Subsidies-and-Taxes-Final-17.7.2020.pdf

to GHG emissions, could influence. The agricultural GHG emissions addressed can be broadly categorised as follows based on the type of goods supplied to farms:

- **Farm animal feed:** methane (CH_4) emitted during enteric fermentation (up to 45% of agricultural GHG emissions); and
- **Fertilisers:** nitrous oxide (N_2O) stemming from the application of manufactured nitrogen fertiliser, which are primarily synthetic (11% of agricultural GHG emissions), and CO_2 emissions from applying manufactured urea (1%).

Table 12 Agricultural GHG sources and activities covered under an upstream ETS

GHG Source/ Activity	GHG			Covered in an upstream ETS?	Net emissions/annum
	CH_4	N_2O	CO_2		
Enteric fermentation	✓			Yes	182.5 $MtCO_2e$
N_2O emissions from managed agricultural soils		✓		Yes (partially)	118 $MtCO_2e$
Manure management	✓	✓		No	62.9 $MtCO_2e$
Grasslands			✓	No	25 $MtCO_2e$
Croplands			✓	No	22.6 $MtCO_2e$
Liming			✓	No	5.6 $MtCO_2e$
Urea application			✓	Yes	3.5 $MtCO_2e$
Rice farming	✓		✓	No	2.7 $MtCO_2e$
Other agricultural emissions	✓	✓		No	1.7 $MtCO_2e$
Burning crop residues	✓	✓		No	0.7 $MtCO_2e$
Other carbon-containing fertilisers			✓	Yes	0.7 $MtCO_2e$
On-farm energy use	✓	✓	✓	No	*unknown*

Farm animal feed

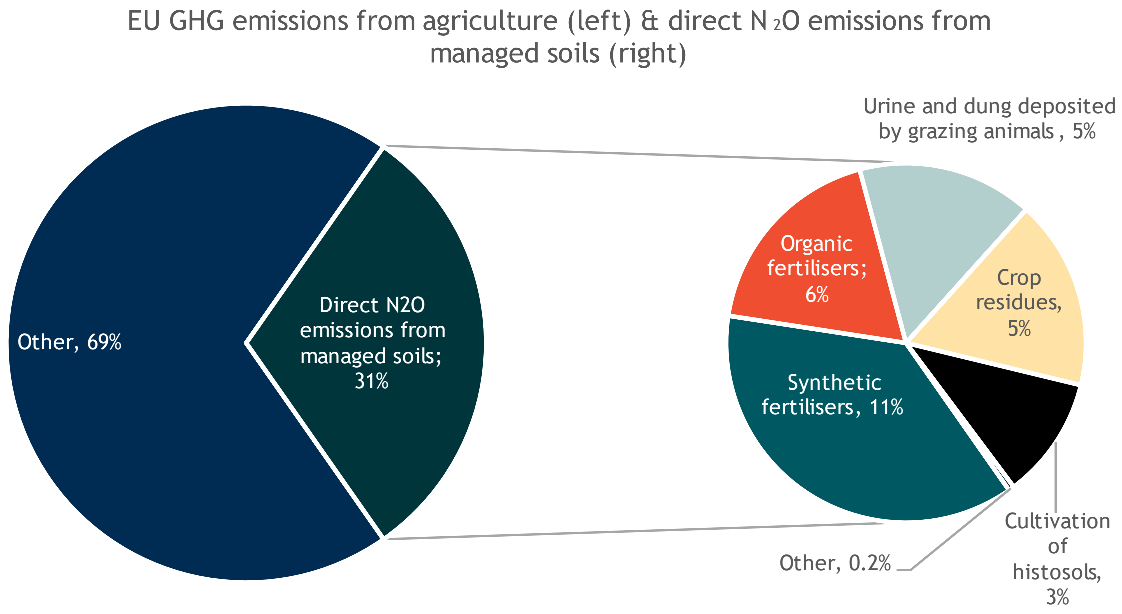
One of the key factors affecting the GHG emissions from enteric fermentation is the feed that the livestock consumes (other factors include the breed of the livestock and long-term management changes). Farms can choose to cultivate their own feed (including grassland) or purchase the feed from external suppliers. Suppliers of feed would therefore only be able to affect the GHG emissions from enteric fermentation from farms that purchase their feed. The upstream ETS therefore only covers enteric fermentation emissions resulting from purchased feed. No public data was found on what portion of feed is purchased from external suppliers compared to feed cultivated on-farm.

In addition, feed influences to a small extent N_2O emissions from urine and dung deposited by grazing animals on field, manure management and the use of manure as organic fertiliser. These emissions were not included in the scope of this policy option as the mitigation of these emissions can mostly be done at farm-level. Moreover, the price signal effect could already be achieved through pricing the enteric fermentation emissions into feed, whereas adding the manure/urine emissions to that would make it more complex.

Fertilisers

Direct N_2O emissions from managed soil represent about 31% of the EU agricultural emissions. The main contributor were emissions from fertilisers (synthetic and organic) as shown in Figure 7. Of the 31% represented by fertiliser emissions, 11% derive from synthetic fertiliser, which are all manufactured in industrial plants and purchased by farmers. Organic fertilisers represent about 6% of agricultural EU GHG emissions. However, organic fertilisers are overwhelmingly composed of collected manure,[44] which cannot be influenced by upstream suppliers. Only a very small proportion of organic fertiliser consumed on farms are manufactured by upstream suppliers.[45] For this reason, this policy option only focuses on synthetic fertilisers.

Figure 7 Emissions from the agricultural sector and Direct N2O Emissions from managed soils in 2020



Own elaboration based on Annual European Union greenhouse gas inventory 1990-2020 and inventory report 2022 submission to the UNFCCC Secretariat[46]

Other GHG emissions stemming from sources and activities that upstream suppliers could influence but are not analysed further in this policy option include the following:

- **On-farm energy use:** CO_2 emissions from on-farm energy use primarily relate to fuel use in machinery (e.g. tractors) and heating of greenhouses and animal shelters.[47] These CO_2 emissions are not further considered for inclusion in an upstream ETS as doing so would add a lot of complexity considering the very small percentage of GHG emissions they represent. A small portion of these emissions are also already addressed by the existing EU ETS (e.g. CO_2 emissions from large greenhouses in the Netherlands). Instead, it would be administratively simpler to expand the scope of the ETS for road transport and buildings (ETS 2) to address CO_2

[44] About 315 million tonnes of manure is applied to soils annually in the EU compared to about 47.5 million tonnes of compost and digestate. Moreover, out of the total of compost, part is manufactured (e.g. turned into granules) whereas part is produced on-farm. Sources: https://www.researchgate.net/publication/354449584_Manure_management_and_soil_biodiversity_Towards_more_sustainable_food_systems_in_the_EU ; https://www.compostnetwork.info/policy/biowaste-in-europe/

[45] Only 1% of nitrogen input comes from organic fertilisers that are not manure. Source: https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/ensuring-availability-and-affordability-fertilisers_en#fertiliser-production.

[46] https://www.eea.europa.eu/publications/annual-european-union-greenhouse-gas-1 (page 631)

[47] https://essd.copernicus.org/articles/14/811/2022/

emissions from fuel used on farms, rather than covering them under a new upstream ETS. Fuel use for agricultural activities is currently excluded from ETS 2. However, compliance entities in ETS 2 still have to monitor the quantity of fuel going to agricultural activities to determine the fuel that is exempted. Expanding ETS 2 to fuels for on-farm use could therefore actually lower the administrative burden under ETS 2 for covered entities as fuel for agriculture activities would not have to be monitored separately.

- **Liming:** the CO_2 emissions from liming are a result of applying calcium- and magnesium-rich materials to soil to reduce its acidity, which have a positive impact on crop yield and contribute to reducing N_2O emissions.[48] Covering suppliers providing liming products may discourage liming and lead to an overall increase of GHG emissions.

Other sources and activities resulting in on-farm GHG emissions in Table 12 cannot be directly influenced by entities upstream of farms and are therefore not considered further in this policy option.

Point of obligation

There are various stages in the supply chain upstream of farm animal feed and fertilisers with different entities involved in each stage. For choosing the point of obligation, the entities can be categorised as follows based on the incentive an upstream ETS can have on options for reducing GHG emissions:

- **Manufacturers and importers**, i.e. entities that first place the farm animal feed or fertiliser on the EU market;
- **Distributors and/or vendors**, e.g. wholesale merchants.

Manufacturers and importers

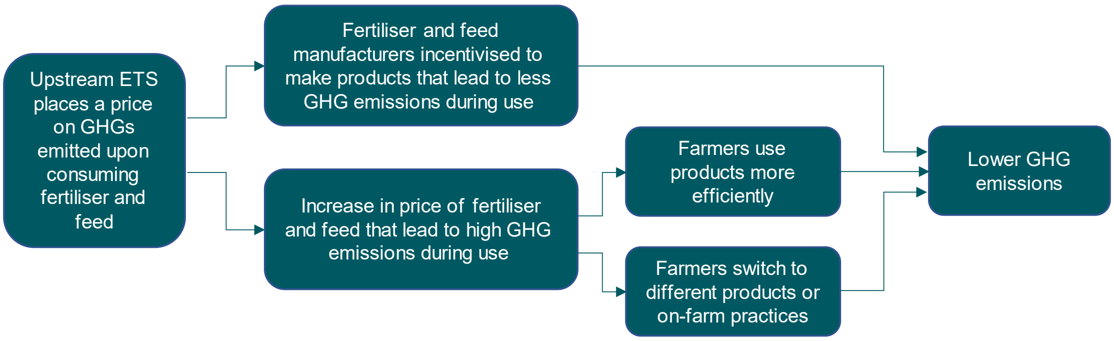
The point of obligation could be set at the stage that a product with GHG emissions covered under the upstream ETS is first placed on the EU market. This would require not only covering EU manufacturers, but also importers to prevent emission leakage and ensure a level playing field within the EU market for the covered products.

Putting the point of obligation when a product first enters the EU market could result in lower on-farm GHG emissions through two main impacts as shown in Figure 8:

1. Obligations under an upstream ETS could incentivise EU manufacturers to re-orient their production towards products which lead to less on-farm GHG emissions, or to develop such products. The upstream manufacturers would see an increase in the cost for products that lead to on-farm emissions, with products leading to higher on-farm emissions becoming more expensive to produce than low-emitting ones. For importers, an upstream ETS could incentivise them to focus their import business on more low-emitting products.
2. Upstream manufacturers and importers may pass on the increased costs due to the upstream ETS, which could ultimately increase the prices that farmers pay. As a result, this creates a price incentive for farmers to use the purchased product more efficiently, adapt their purchasing decisions by switching to products which are cheaper (by virtue of being less polluting), or look for other approaches to improving yields. To incentivise the purchase of lower-emission products, the ETS would need to be set up in a way that the price incentive is sufficiently strong to make these products cheaper overall than the high-emitting ones.

[48] https://www.teagasc.ie/publications/2020/liming-reduces-greenhouse-gas-emissions-and-increases-grassland-productivity.php ; https://www.mdpi.com/2075-1729/12/3/439

Figure 8 Diagram of the desired outcomes on GHG emission reduction under the upstream ETS



The entities that could potentially be covered are up to ~5300 companies across the EU based on the number of enterprises reporting under the NACE codes related to farm animal feed (10.91) and fertiliser (20.15) production in Eurostat for 2020 as shown in Table 13.

Table 13 Number of enterprises reporting under NACE 10.91 and 20.15 in the EU in 2020

NACE code	Description	Number of enterprises in the EU in 2020
10.91	Manufacture of prepared feeds for farm animals	3,786
20.15	Manufacture of fertilisers and nitrogen compounds	1,509

Source: Eurostat Structural Business Statistics

Importers already have reporting obligations on the type of products that they import into the EU for custom purposes. EU manufacturers also keep track of the products that they sell and report this for statistical purposes to Member State authorities. In addition, some EU manufacturers already participate in the EU ETS for their direct emissions, so an MRV system for the upstream ETS could build on that. To what degree the already available data is sufficiently robust and detailed for compliance purposes under an ETS will depend on the MRV requirements.

There is a lack of EU "self-sufficiency"[49] in protein crops for feed due to high demand from the livestock sector. While the majority of EU proteins come from forage, the EU imports a substantial amount from third countries, particularly Argentina, Brasil, and the United States. Table 14 provides the quantity of feed use that is of non-EU origin and the level of EU self-sufficiency for each type of feed product.

Table 14 Quantity of feed use that is of non-EU origin and the level of EU self-sufficiency for each type of feed product

Product	Feed use non-EU origin (million tonnes)	EU self-sufficiency (%)
Soybean meal	26.2	3%
Rapeseed meal	3.7	69%
Maize	13.1	79%
Common wheat	2	95%

[49] According to the FAO (2016), 'self sufficiency' is defined as the ability of a region or country to produce enough food (especially staple crops) without needing to buy or import additional food.

Barley	0	100%
Fodder legumes	0	100%
Silage maize	0	100%

Source: EU protein balance sheet (2022)

The EU is largely dependent on imports for most of mineral fertilisers. Over time, nitrogen-based fertilisers have been the most traded products between the EU and third countries. More than 3 million t are imported annually into the EU (DG Agri 2019). The level of imports reaches 6 million t of nitrogen-based products per annum when ammonia is included. Phosphate fertilisers (as mono/di-ammonium phosphate) are around 1 million t annually, while imports of potassium fertilisers are around 2 million t.

Possible downsides to putting the point of obligation with entities that first bring the product onto the market are:

- **Uncertainty about the final usage:** there is no absolute certainty that the final consumers of the fertilisers and feed put on the market by manufacturers and importers will be farmers. This risk is likely low since the fertilisers and feed have limited alternative use than for agriculture when sold in bulk.
- **Potential negative competitiveness impacts for exports:** a portion of the fertilisers and feed manufactured in the EU is exported to countries outside the EU. In these extra-EU markets, they would compete with producers that do not face an equivalent carbon price, putting the EU products at a competitive disadvantage.
- **ETS price signal unclear to the farmer:** the ETS costs to manufacturers and importers will be one of many components in their price setting strategy. Furthermore, the fertiliser and feed will often go through several stages in the supply chain before it reaches the farmer, where in each supply chain stage strategic decisions on pricing could also be made. The price signal from the ETS could therefore be distorted by the time it reaches farmers. To ensure awareness among farmers on the ETS price signal, the ETS price component would need to be shown separate in the pricing of the products.

Distributors and/or vendors

Another option for the point of obligation is with distributors of fertilisers and feed. The point of obligation could also be put at entities that are the final point of sales of the fertiliser and feed to farmers, which would be wholesale and retail vendors. In all cases, distributors and vendors could only pass on the price signal further down the value chain (bottom part of Figure 8) as they do not have any means to affect the GHG-emitting properties of the products that they sell, other than by focusing their business on selling more low-emitting products, if they are available on the market.

For distributors and vendors of farm animal feed and fertilisers, there are no specific statistical classifications such as NACE codes assigned. As a first estimate of the number of entities that could potentially be covered, statistics on the number of wholesale companies of farm animal feed (46.21) and fertilisers (46.75) have therefore been used. Table 15 shows that these could be up to ~53000 companies across the EU based on the number of enterprises reporting under the relevant NACE codes in Eurostat for 2020. This number is an upper estimate, since the relevant NACE codes also cover wholesale of products other than feed and fertilisers.

Table 15 Number of enterprises reporting under NACE 46.21 and 46.75 in the EU in 2020

NACE code	Description	Number of enterprises in the EU in 2020
46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds	26,896
46.75	Wholesale of chemical products	26,358

Source: Eurostat Structural Business Statistics

To minimise the administrative burden, the point of obligation should ideally be with distributors and vendors that already have reporting obligations on fertilisers and feed that they sell or store. In the new ETS for road transport and buildings, the point of obligation is therefore set at tax warehouses if the fuel passes through a tax warehouse.[50] Tax warehouses are distributors and/or storage premises of fuels that already have reporting obligations for the purpose of excise duties and could therefore build on the existing MRV system. However, there are no excise duties on fertilisers and feed, and therefore no MRV systems that could be built on exist in most Member States. Distributors and vendors of fertilisers[51] and feed also do not have any other systems with reporting obligations that could be built on.

Compared to putting the point of obligation with manufacturers and importers, some of the downsides are reduced or mitigated as distributors are closer to the farmers in the supply chain. This provides more certainty about the end users of fertiliser and feed being farmers. With distributors and final suppliers being closer to the farmers in the supply chain, there would be less distortion of the ETS price signal that is being passed on. Finally, if the point of obligation is put on distributors and vendors that only supply the EU market, negative competitiveness impacts for exports can be mitigated without the need for special rules.

Choice of the point of obligation

Table 16 summarises the considerations on the two main options on the point of obligation. Given the presence of existing MRV procedures and infrastructure that can be built upon, more ways to incentivise GHG emission reduction and fewer potential covered entities, putting the point of obligation with the manufacturers and importers would be the more logical choice in an upstream ETS. In the rest of this policy option, the considerations therefore focus on manufacturers and importers of farm animal feed and fertilisers as the point of obligation.

Table 16 Summary of considerations on the different points of obligation

	Manufacturers and importers	Distributors and/or vendors
GHG emission reduction incentives	Develop low-emitting products More efficient use by farms Use lower-emitting products by farms	More efficient use by farms Use lower-emitting products by farms

[50] https://commission.europa.eu/system/files/2021-07/revision-eu-ets_with-annex_en_0.pdf
[51] Fertiliser distributors only have the obligation under the EU Fertilising Product Regulation (EU 2019/1009) to submit information to national authorities, upon request, to demonstrate the conformity of the EU fertilising product they sell.

Existing MRV procedures to build on	Yes	No
Potential number of entities covered	Up to ~5300 manufacturers Unclear on importers	Potentially up to ~53 thousand companies
Certainty on intended target group (farms)	Some uncertainty	No uncertainty
Negative impacts on extra-EU exports	Exemptions for exports could mitigate negative impacts	Exports not affected

De Minimis threshold

Up to 5300 companies, ~3800 manufacturers for farm animal feed and ~1500 for fertilisers, could be covered under an upstream ETS as identified in Table 13. However, these include small companies with a limited contribution to agricultural GHG emissions. By exempting small companies, the costs of operating the ETS could be lowered and excessive administrative can be avoided (objective 1). However, the criteria for exempting small companies need to be carefully designed to minimise the risk of fraud and avoid companies circumventing the ETS. The threshold should also be set in such a way to minimise unfair competition between companies that operate in the same market where some will fall under the ETS and others will not.

The de minimis threshold for an upstream ETS should be ideally set based on their potential contribution to agricultural GHG emissions:

- **Feed:** this could be based on the production capacity of farm animal feed manufacturer in volume of feed. This could be similar as in the current EU ETS, where e.g. only manufacturers of glass with a melting capacity of more than 20 tonnes per day have to participate in the EU ETS, and smaller glass manufacturers are exempted.
- **Fertilisers:** this could also be based on the production capacity of synthetic fertilisers in volume, or (specifically for synthetic nitrogen fertilisers) the production capacity in terms of nitrogen content.

Public information on the production capacity of feed and fertiliser manufacturers is not available to determine whether an inclusion threshold would make sense and if so, to inform what an appropriate de minimis threshold could be. Instead, distribution of company size of feed and fertiliser manufacturers could give an indication whether mainly large companies are contributing to agricultural GHG emissions, or whether responsibility for emissions is evenly distributed among small and large companies.

However, Eurostat statistics on turnover and enterprise size are only disaggregated to "10.9 Manufacture of prepared animal feeds”, i.e. broader than farm animal feed only. Similarly, for fertilisers data is only available for “20.1 Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms”. For farm animal feed, the data may be a good proxy as 70% (3786 of 5400) of the companies in NACE 10.9 fall under 10.91 as can be deduced from Table 17. However, for fertilisers, only 19% (1509 of 8000) of companies in the broader category

NACE 20.1 report under 20.15. NACE 20.1 can therefore not be assumed to be representative for fertiliser manufacturers, but it could inform the potential need for setting a de minimis threshold.

Table 17 Number of enterprises reporting under NACE 10.91 and 20.15 and the 3-digit NACE code they fall under, for the EU in 2020

NACE code	Description	Number of enterprises in the EU in 2020
10.9	***Manufacture of prepared animal feeds***	***5,400***
10.91	Manufacture of prepared feeds for farm animals	3,786
20.1	***Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms***	***8,000***
20.15	Manufacture of fertilisers and nitrogen compounds	1,509

Source: Eurostat Structural Business Statistics

Table 18 shows that there are many small companies in NACE 10.9 and 20.1, but these only represent a small portion of the turnover and (by implication) production. Most of the turnover is in companies with at least 50 employees, or in the case of NACE 20.1, even companies with more than 250 employees. Establishing a de minimis threshold to exempt small companies may therefore only have a limited impact on the environmental integrity of the system and warrants further consideration in an upstream ETS.

Table 18 Share of enterprises reporting under NACE 10.9 and 20.1 and their share of total turnover of the NACE code for the EU in 2020, by company size

Size of the company (number of employees)	10.9 Manufacture of prepared animal feeds		20.1 Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	
	Enterprises	*% turnover*	Enterprises	*% turnover*
Total	***5,400***		***8,000***	
From 0 to 9 persons employed	70%	*4%*	68%	*1%*
From 10 to 19 persons employed	10%	*5%*	10%	*1%*
From 20 to 49 persons employed	11%	*14%*	10%	*3%*
From 50 to 249 persons employed	7%	*34%*	11%	*16%*
250 persons employed or more	1%	*44%*	4%	*79%*

Own elaboration based on Eurostat Structural Business Statistics[52]

Unique policy design aspects

Administrative actors

Administrative actors for an upstream ETS will be similar to what is described in the other policy options, particularly in *Policy option 1: On-farm ETS (all GHGs)*. This section only describes the differences in terms of administrative actors compared to the other policy options.

Oversight

The oversight for the upstream policy option will be similar to the other policy options with the Commission exercising the role of oversight and ensuring implementation of the legislation. However,

[52] Enterprise statistics by size class and NACE Rev.2 activity (from 2021 onwards) [SBS_SC_OVW__custom_4372212]

the Commission will also oversee the availability and affordability of fertilisers, ensure compliance with laws on animal nutrition and use of feed additives for GHG emission reduction, monitor the impact of GHG mitigation measures resulting from the upstream ETS on biodiversity, water quality, air quality, and other environmental objectives.

Monitoring, reporting and verification (MRV)

As this policy option applies to entities upstream of farms, i.e. before the GHG-emitting products is used, the monitoring and reporting of emissions cannot be based on direct measurements and will always have to be based on the default approach. The estimations could be determined based on one of two options from a governance perspective:

1. One option is that the entities subject to the upstream ETS will be responsible for monitoring and reporting the GHG emissions associated with their compliance obligation. The compliance entities would need to calculate the GHG emissions associated with the products they either manufacture or import based on established methodologies and guidelines. The compliance entities would be responsible for arranging third-party verification of their emission reporting and submit the verified emissions to the national competent authority. This option places the burden of emission reporting fully on the compliance entities. This would be similar as under the EU ETS and could therefore build on the same procedures. However, the risk of inaccurate reporting of emissions, and the complexity for competent authorities in challenging estimates may be significantly greater when entity-specific emission factors are used. Farm animal feed and fertilisers covers a complex system with a diffuse population of uses and various conditions affecting their GHG emissions during use, for which setting coherent rules will be challenging (see also *Administration: MRV requirements*)
2. A second option would be that entities send data on the production sold and products import to the competent authority, which subsequently calculates the associated GHG emissions based on default emission factors. This would lower the administrative burden on the companies as they could build on the statistical reporting of sold production to Member State authorities. Companies would only need to arrange for additional third-party verification of the production data, which is not required in the current reporting procedure for statistical purposes. The competent authorities would then indicate what the compliance obligation of the companies are. Companies selling products that lead to lower emissions than the default value could provide verified evidence to the competent authority to lower their compliance obligation. The rules for such a process would need to be set by the European Commission to ensure deviations to the default values are applied consistently in all MS. Assumptions will have to be made for the conditions under which the default emission factors are determined. This option lowers the administrative burden on compliance entities and reduces the risk of errors and fraud, but increases the initial burden on the competent authorities.

For third-party verifiers, the effort required under the first option will be larger as the emission factors used need to be verified in addition to the production sold. In the second option, verifiers only need to check the data on sold production.

In both approaches, default emission factors will need to be established. Setting reliable emission factors associated with the consumption of feed and fertilisers comes with various challenges. This is because the emissions are not solely dependent on the feed or fertiliser itself but also the circumstances it is being used under. Taking the example of fertiliser, the composition of products is only one amongst many factors influencing on-farm GHG emissions associated with the use of the product. Setting emission factors would have to be based on conservative assumptions regarding the method of application, type of soil on which it is applied, soil moisture level at the time of application, crop on which it is applied, etc. A literature review by Walling and Vaneeckhaute (2020) on GHG emission calculation from fertiliser use found high variability in GHG emissions based on on-farm practices, which trickles to high uncertainty related to emission factors.[53] The study concluded that GHG emissions from generalised emission factors is not accurately reflecting actual emissions. This would call for an extensive study to set emission factors for fertiliser and feed products in the scope of the ETS.

As a starting point, default emission factors from the IPCC guidelines or country-specific emission factors could be used where this is available. This would also ensure alignment with the GHG inventory reporting as done under the ESR and internationally to the UNFCCC.

- For fertilisers, the emission factors for fertiliser use could be directly used, which is based on the nitrogen volume and for urea application on tonnes of urea.[54]
- For feed, the default emission factors for enteric fermentation emissions are based on the number of livestock and can therefore not be directly used for an upstream ETS.[55] The default emission factors are based on the gross energy intake per type of livestock and methane conversion factor. By making assumptions on the typical type of feed per livestock unit and the energy content of the feed per volume, it may be possible to convert the IPCC default emission factors to ones based on quantity of farm animal feed.

Nevertheless, to ensure that emissions are more accurately measured – and therefore that the incentives associated with manufacturing and consuming certain products work better in the ETS – more accurate emission factors should ideally be defined (e.g. taking into account the effect of nitrification inhibitors in fertilisers or specific dietary additives in feed).

As discussed in Chapter 2, farm operators should have the opportunity to generate the certified on-farm voluntary credits that can be sold in ETS auctioning to upstream producers. Farmers or group of farmers could have the option of verified on-farm monitoring of how efficiently they use fertilisers and feed, and be rewarded by the sale of credits for their additional mitigation efforts. This way, an upstream ETS can facilitate the uptake of on-farm mitigations and allow for farmers to increase their relative position in agri-food value chains by increasing their income as well as having off-farm businesses pay for the necessary investments to reduce emissions.

Regulatory requirements

Requirements for measuring emissions

The reporting of production sold to determine the emissions could be built on technical elements, such as product classifications, from Regulation 2019/2152 and Commission Implementing Regulation 2022/2552 for European business statistics. However, using the collected data under these regulations to determine the compliance obligation of regulated entities will require a change of legislation. The

[53] https://www.researchgate.net/publication/344417276_Greenhouse_gas_emissions_from_inorganic_and_organic_fertiliser_production_and_use_A_review_of_emission_factors_and_their_variability

[54] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf

[55] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch10_Livestock.pdf

abovementioned regulations indicate that data collected under the regulations may only be exclusively used for statistical purposes.

Allocation of allowances

The most logical choice for the allocation of allowances under an upstream ETS is full auctioning, which would be similar to ETS 2 that is also an upstream ETS.

One of the intended drivers for GHG emission reductions in an upstream ETS is the pass through of compliance costs to farmers as illustrated in **Figure 8**. Free allocation may lead to the manufacturers passing on fewer costs, particularly if the market share of fertiliser products identified as being lower-emitting remains small; this is turn would reduce the price incentive for farmers to find ways to reduce their on-farm emissions. For manufacturers that could pass on their costs, free allocation would provide them with windfall profits. Full auctioning of allowances therefore enables the full ETS price signal to incentivise cost-effective emission reduction measures while avoiding the risk of windfall profits.[56]

However, free allocation may be challenging for importers, particularly the administration aspects, and high risks of fraud.

Approaches to the risk of carbon leakage

To support the third objective of this study (reduce carbon leakage risks), carbon leakage risks would be addressed by including extra-EU imports within the scope of the ETS, while ideally also excluding exports. Doing so would ensure that farmers within the EU do not switch their consumption to imported products, and that EU products are not placed at a competitive disadvantage on the international market. Rules would therefore need to be included on ensuring that EU manufacturers do not face cost from the upstream ETS when exporting their product outside the EU.

Box 7 The National Fertiliser Database in Ireland

A noteworthy example of a dedicated MRV system at Member State level is the Irish National Fertiliser Database, due to be launched in 2023. The database is being established to support compliance with water quality and environmental goals, provide data for monitoring climate targets, and support farmers in securing derogations from the Nitrates Directive and evidencing compliance with voluntary sustainability schemes. It is also expected to benefit farmers planning to participate in relevant Eco-Scheme actions from 2024 onwards.

Under new legislation, all fertiliser economic operators (i.e. manufacturers, authorised representatives, importers and distributors of fertilisers) will have to register with the Department of Agriculture, Food and the Marine in order to be able to sell their product in the country. The same rule will apply to all professional end users (mostly farmers) wanting to purchase fertilisers.

It will require data inputs along the value chain, with all fertiliser quantities being recorded, whether dispatched between merchants' or storage premises and farms, moving between farms, or imported directly by a farmer. Fertiliser economic operators will be required to record comprehensive information, including on the quantities produced and sold, the nutrient content, inhibitor used, liming material characteristics, and unique identification number of the farmer they

[56] This is the same argumentation for full auctioning under ETS 2. Source: https://op.europa.eu/en/publication-detail/-/publication/f496ee25-353a-11ec-bd8e-01aa75ed71a1

are selling their product to. The end users will be expected to enter details of any closing stock annually, at the end of the fertiliser spreading season. The system will allow farmers to access information on their fertiliser purchases through an online system once it's recorded by the merchant (which must be done within a specified timeframe after the end of the month when the fertiliser is dispatched).

Ensuring compliance

EU manufacturers of feed and fertilisers have to meet various environmental regulations before they are allowed to operate. The most relevant ones being:

- The Industrial Emissions Directive (IED), under which all fertiliser manufacturers and large farm animal feed producers[57] are covered. Installations under the IED are already subject to environmental inspections to ensure that they are compliant with the environmental requirements in their permit to operate. MS can determine the sanctions that they impose on installations for non-compliance.
- The current EU ETS, which already covers large feed and fertiliser manufacturers for the GHG emissions related to the manufacturing processes. Installations under the EU ETS are subject to annual reporting of their direct GHG emissions. These emission reports have to be verified by a third-party verifier before submission to the competent authorities. In addition, the competent authorities can carry out inspections based on irregularities and risks of or non-compliance.[58] The EU ETS Directive specifies a penalty of 100 €/tCO_2e for each tonne of emissions for which no allowances are surrendered, on top of the requirement to still surrender allowances for these emissions.

The system for ensuring compliance among EU manufacturers of feed and fertilisers could build on the one in place for the IED and/or current EU ETS, since an upstream ETS would overlap in covered installations. For importers, further compliance mechanisms could build on the one that is still being developed under the Carbon Border Adjustment Mechanism.

3.5. Policy Option 5: Downstream ETS

ETS Option	Downstream ETS – livestock only
GHG Coverage	CH_4 emissions from enteric fermentation, CH_4 and N_2O emissions from manure management
Point of obligation	Processors of meat and dairy product
De minimis threshold	Businesses with > 50 employees

Policy option description

This option applies the polluter pays principle to agricultural outputs. A downstream ETS would cover products that lead to on-farm emissions when produced. The point of obligation lies with entities that receive the products that are sold by farmers, specifically meat and dairy processors. These entities will have a compliance obligation to surrender an equal amount of emission allowances to the GHG emissions that their products would cause on farms, while GHGs emitted during the processing of the

[57] Installations with a total rated thermal input of 50 MW or more, and installations that treat and process animal and/or vegetable raw materials for the production of feed over a certain production capacity as specified in Annex I of the IED.
[58] https://climate.ec.europa.eu/system/files/2022-01/gd8_mrr_inspections_en.pdf

product would not be covered by this policy option. The amount required to be surrendered would be calculated using proxy data linked to the production of the relevant products (milk, meat). The PPP is not applied directly to the emitter of agricultural GHG emissions (farms), but relies on downstream entities to pass on the cost of GHG emissions to the emitters.

GHG emissions scope

Table 19 provides an overview of the sources of greenhouse gases from agriculture, the types of gases emitted, the amount of $MtCO_2e$ emitted per annum from activities that would be covered under a downstream ETS.

Table 19 Agricultural GHG sources and activities covered under an downstream ETS

GHG Source/ Activity	GHG			Included in processor GHG calculation?	Net emissions/annum
	CH_4	N_2O	CO_2		
Enteric fermentation	✓			Yes	182.5 $MtCO_2e$
N_2O emissions from managed agricultural soils	✓	✓		No	118 $MtCO_2e$
Manure management		✓		Yes	62.9 $MtCO_2e$
Grasslands			✓	No	25 $MtCO_2e$
Croplands			✓	No	22.6 $MtCO_2e$
Liming		✓		No	5.6 $MtCO_2e$
Urea application	✓	✓		No	3.5 $MtCO_2e$
Rice farming	✓	✓	✓	No	2.7 $MtCO_2e$
Other agricultural emissions	✓	✓		No	1.7 $MtCO_2e$
Crop residues		✓		No	0.7 $MtCO_2e$
Other carbon-containing fertilisers			✓	No	0.7 $MtCO_2e$
On-farm energy use	✓			No	*unknown*

The downstream ETS could cover direct emissions from livestock (CH_4) and manure management (N_2O). For these sources, emissions can be relatively well determined by the quantity of output and some information on the animals it was produced from, their feedstock, manure management practices and whether mitigation technologies to capture emissions were applied. Including other emissions, e.g. from crops, in a downstream system would pose substantial challenges to take into account the many aspects that determine the associated emissions (e.g. land use change and fertilizer use). LULUCF emissions, which occur upstream to meat and dairy production (e.g. related to feedstock), are excluded from this option to reflect the scope of the Livestock ETS. Excluding such emissions would be similar the approach in the New Zealand proposed processor-level levy [59]. However, similar to the Livestock ETS option, including such emissions within the scope of the option could be taken into consideration by the Commission.

[59] See NZ processor description in text box below.

Both the *default approach* and the *certified approach* to MRV would have the same GHG emissions scope, capturing CH_4 (from enteric fermentation and manure management) and N_2O emissions (from manure management). However, they assume different calculation methods, using, respectively, IPCC tier 1 approaches and on-farm measurements, and thus would capture and incentivise different mitigation options. The two MRV approaches are discussed in more detail in Chapter 2.

Point of Obligation

The downstream ETS would place the point of obligation at meat and dairy processors, and thus the reporting of emissions would need to be undertaken by processors. Emissions can be estimated based on the quantity of livestock processed. If farmers choose to opt in for the *certified approach* to demonstrate that emissions are below the default emission factors, farms may need to assume MRV requirements but would not become points of obligation or participants; their involvement would be mediated by the participants – the processors.

The policy option presented in this study focuses on the most upstream processors to reduce participant numbers (with the emission price being passed on to downstream processors and eventually to final consumers): only those processors that directly source inputs from farms would be required to surrender emission permits; those who only process animal products several stages down the value chain will not be participants, in order to avoid double-counting. Dairy processors would be understood to include any enterprise that purchase milk from farms (any sort of milk, including cow, goat, sheep, etc.).[60] Meat processors would include any enterprise that purchases and processes live animals, including for meat, leather, or other animal-related products that require slaughter.[61]

While the focus of this study is on more direct up- and downstream actors in relation to farmgate emissions, the consortium for this study considered further downstream food processors who sell products to the final consumers. Having such actors responsible for emissions could be effective in terms of administrative costs due to a smaller number of large actors (i.e. Nestle, Danone) and placing the price on actors with a high share of agri-food value chain added value. However, placing the obligation further downstream would also be administratively complex, due to verification challenges associated with traceability and size of portfolios. In addition, it would be challenging to delineate the categories of further downstream actors that could be obligated under such an ETS. This, in turn, could lead to increased complexity in preventing the double-counting of emissions, with processors participating in supply chains of varying lengths and distributing their products to both retailers and other processors potentially within the scope of the same ETS. However, we feel exploring such an option is warranted and should be done in a follow-up study.

The choice of the point of obligation in a downstream ETS is associated with a range of possible outcomes contingent on the type of supply chain, bargaining power, degree of vertical integration, business model, and, consequently, the range of mitigation approaches that are available to the regulated entities. Depending on the selected point of obligation and the MRV approach, this option could incentivize ETS participants to work towards reducing their emissions obligations through a variety of measures, including:

- Waste reduction and other efficiency improvements allowing for reduced purchases of raw materials.

[60] See e.g. NACE code C1051: Operation of dairies and cheese making
[61] See e.g. NACE code C1011Processing and preserving of meat and C1012 Processing and preserving of poultry meat

- Production shift towards animal types typically associated with lower emissions intensity (e.g. from beef to pork or chicken), or between intensity sub-categories (e.g. shift towards processing younger, faster growing animals, associated with lower lifetime emissions).
- Diversifying product portfolio. This tactic may be more readily employed by downstream processors, retailers and the food service industry. However, there is also evidence of large upstream processors with diversified operations investing in meat and dairy alternatives in response to changing consumer preferences. Examples include the Bel Group, a major dairy processor, announcing its ambition to "provide a plant-based offer" for each one of its core brands (JustFood 2020), or Tyson Foods, the world's second largest meat processor, rolling out a brand combining plant-based products and so-called 'blended' food (JustFood 2019). This option may not be attractive or available to smaller upstream processors, particularly meat industry actors with specialised slaughterhouse operations.
- Product reformulation. This option may be predominantly available to downstream processors, including e.g. ready-to-eat food manufacturers or FMCG companies. It can involve lowering products' meat or dairy content, or substituting ingredients of animal origin with plant-based alternatives (e.g. replacing dairy milk with oat milk in iced coffee drinks or tweaking ready meal recipes). Depending on the future regulatory framework and potential adoption of laws that stimulate the production and demand for cultured meat and dairy, a process integrating cell-based inputs with conventional raw inputs to produce blended products could also be envisioned (Verschuuren 2023).
- Steering consumer choices towards less GHG intensive products through marketing. Depending on the level of brand recognition and the ETS' participants' position in the supply chain, a shift in marketing strategies towards plant-based and lower GHG intensive products is likely to facilitate a swifter transition in terms of consumer awareness and attitudes. This would, in turn, accelerate the sales of reformulated products and help establish new product ranges competing with conventional meat and dairy-based offerings.

Supplier incentive programs. Processors could also engage and support supplier farms in implementing mitigation measures that decrease their average unique emissions factor, for example through price premiums associated with specific manure management practices. This mechanism requires that a certified MRV approach is followed, involving on-farm emissions measurement and reporting. For an example of this type of processor scheme, see Box 8 describing Arla Foods' Sustainability Incentive model.

Box 8 Arla Foods' Sustainability Incentive Model

Arla is a farmer-owned cooperative comprising over 8,900 farmers from Belgium, Denmark, Germany, Luxembourg, Sweden, the Netherlands and the United Kingdom, with ownership of over 1.5 million dairy cattle.

In 2020, the company began annual data collection under its Climate Check tool, which serves to assist farmers in measuring and reducing GHG emissions from dairy farming. The initiative features over 200 questions on subjects such as feed, energy use and manure management, and allows for the calculation of the carbon footprint of milk production on Arla farms. Participation in the scheme is voluntary for conventional producers and mandatory for organic producers, with farmer owners paid an incentive on their milk price to complete the Climate Check survey.

Building on the Climate Check tool, Arla has introduced a point-based Sustainability Incentive model to help fund and motivate actions required to hit its 30% emissions reduction target by 2030 against a 2015 baseline. Within this model, farmers can collect points based on past and future environmental sustainability activities under 19 different levers. The levers with the biggest potential to reduce a farm's carbon footprint (including e.g. feed efficiency, fertiliser use, land use, protein efficiency and animal health) are associated with a higher total amount of points available. Other areas of action relate to sustainable feed, renewable energy usage and biogas production. Not all levers have a direct influence on the farm's carbon footprint, but pertain to other factors such as feed monitoring or knowledge-building between farmer owners.

The model currently allows farmers to score a maximum of 80 points, but more options for sustainable actions will be built into the scheme over time, increasing to a total number of 100 points to be made available in the future. Farmers will receive 1 eurocent per kilo of milk delivered to Arla for submitting Climate Check data, which is the prerequisite for receiving the sustainability incentive. In addition, they will receive 0.03 eurocent for each kilo of milk per point awarded in the Sustainability Incentive model. Once the Sustainability Incentive model has been developed to comprise a total of 100 points, farmers can eventually be granted 4 eurocents per kilo of milk (including 1 eurocent for each kilo of milk by participating in the Climate Checks). This means that up to 500 million euros may be allocated to farmers to reward sustainable farming practices. In the first full year, at least 270 million euro is expected to be distributed through the monthly milk price with an estimated average of 39 points scored.

De Minimis threshold

To support the first objective of this study (*minimise the burden of implementation and balance costs and benefits of the system*), a processor size cut-off could be utilised in order to minimise the number of participants (and associated transaction costs and administrative costs) whilst still covering as high a proportion of EU animal emissions as possible. The Commissions has laid down criteria for the conditions under which firms can be considered micro, small and medium-sized enterprises micro, small and medium-sized enterprises that can be subjected to simplified procedures to lower their administrative burden. Under this definition, small enterprises are those with a staff of fewer than 50 people, including employees, persons working for the enterprise being subordinated to it, owner-managers and partners engaging in a regular activity in the enterprise. and partners engaging in a regular activity in the enterprise. As these provisions aim to confer some kind of advantages or reduce administrative burden, there is a risk of circumvention and fraud. This problem is not, however, specific to the proposed policy solution and mechanisms to monitor firms' status as a small enterprise are already in place, which will enable regulators to directly determine whether a processor is required to surrender emission permits.

EUROSTAT Structural Business Statistics[62] give a breakdown on number of enterprises by size of enterprise (measured by number of employees), and their share of total category turnover. This shows that 2614 medium-large enterprises (50+ employees) make up 82% of turnover in the meat processing & production category, while 900 medium-large enterprises make up 91% of in the manufacture of dairy products industry.

[62] EUROSTAT (2022) Structural Business Statistics. Accessed 0.6.01.2023

Table 20 Meat and dairy enterprise size and turnover, Structural Business Statistics (EUROSTAT, 2022)

NACE_R2 (Labels)	C101: Processing and preserving of meat and production of meat products		C105: Manufacture of dairy products	
SIZE_EMP (Labels)	Enterprises	% turnover	Enterprises	% turnover
Total	34,066		12,634	
From 0 to 9 persons employed	21,959	4%	9,658	3%
From 10 to 19 persons employed	6,100	4%	1,275	2%
From 20 to 49 persons employed	3,388	9%	792	4%
From 50 to 249 persons employed	2,085	23%	660	15%
250 persons employed or more	534	59%	249	76%

Based on this analysis and assumptions, if a threshold of all processors that have 50 or more employees was implemented, this would cover roughly 2600 entities involved in processing and preserving of meat and production of meat products, and 900 in manufacturing dairy products. Hence, with this cut-off, there would be 3500 entities in total. These numbers overstate the actual number of direct, initial processors of animal products (i.e. those who purchase animals or milk directly from farms), as this category also includes some meat and dairy product production. More detailed data indicates that only approximately 37% of the enterprises involved in processing and preserving of meat and production of meat products are involved in the processing and preserving of meat; approx. 70% of the manufacture of dairy products companies are involved in operation of dairies and cheese making. Assuming that the distribution of enterprise size and turnover at the more aggregated 3-digit NACE code level is the same as at the more narrowly defined 4-digit NACE level (enterprise size data is not available at the 4-digit level) and would hence be covered by the ETS, we estimate that the ETS would cover approximately 970 meat processors and 640 dairy processors, a total of approx. 1.600 participants. The same EUROSTAT dataset also provides data on turnover by enterprise size (presented as a proportion of total NACE sector turnover in Table above). If we assume that share of sector turnover is a reasonable indicator of embedded emissions, we estimate that a policy applying to these 1600 meat and dairy processors would cover approximately 82% of emissions associated with meat production and 91% of emissions linked to dairy production.

A cut-off at enterprise size of 50 would mean that smaller meat and dairy processors would not be covered by the policy. While at the margin this could cause some perverse incentives such that smaller firms would not want to grow in size, or that firms just above the cut-off would scale back their activity or lay off staff, we would expect that a de minimis threshold would be offset by the significant economies of scale that apply in the meat and dairy processing industry (indicated by the high market share of large enterprises). This cut-off would also minimise administration for SMEs, whilst still achieving a high coverage of sectoral emissions. Other policies could be developed to create mitigation incentives for smaller processers. Smaller processors could also be incentivized to join the ETS on a voluntary basis if this conveys additional advantages, such as participation being a requirement to establish claims about the carbon footprint of their products or to access certain support schemes under the CAP.

Unique Design Aspects

Allocation of allowances

To limit incentives to raise output to receive more permits, free allocation should be undertaken in a way that based on historical rather than production volumes (yet, it should be noted that even this approach provides a motivation to raise output to receive more permits in the future). A particular challenge for the downstream ETS is that the 'windfall profits' of free allocation would accrue to processors in the first place. If the amount of permits they receive depends on the processed volume, some part of this profit would be passed on to farms. It might be desirable to vary the amount of free allocation that processors receive by the size of the farms from which they source their inputs. This approach would, however, add additional administrative complexity to the system. In any case, if free allocation is used, it should be regarded as a temporary measure. For this reason, a clear schedule of how free allowance will be reduced will need to be established and clearly communicated from the start of the system on.

Free allocation of emission permits can also be used as a measure to lower the risk of carbon leakage. However, as described below, a downstream ETS, which applies the carbon price close to the consumption side, lends itself to a design that offers other, more effective, possibilities to address leakage. Hence, it is well conceivable that – at least in the long term – a downstream ETS can work well without free allocation of permits.

Approaches to the risk of carbon leakage

To support the third objective of this study (*safeguard against risk of carbon leakage*), it is advisable to also include imported meat and dairy products in the ETS. Here, importers could be treated like domestic producers. For imports of products that are further down the processing chain than those processors covered by this ETS, specific benchmarks will need to be developed in a way that strikes a balance between creating the right incentives for producers and respecting global trade rules. This also concerns the question of the potential eligibility of EU exporters of animal products for additional support to level the playing field on the global market, and the forms of assistance which could be considered compatible with WTO rules. For these questions, the development of the CBAM for sectors that are covered under the existing ETS can provide important guidance.

MRV Requirements

Default approach

Under the *default approach*, emissions are calculated using an emission factor per unit of output (i.e. kg of meat or litre of milk) with an emission factor that depends on a small set on readily available characteristics, such as animal type and age. Processors are responsible for reporting the respective quantities and thus the associated emissions. Auditing will be required to ensure that the reported values are in line with the actual quantities and categories sourced from farms.

Certified approach

Under the certified approach, processors would apply for a Unique Emissions Factor, which rather than using a Member State average emissions factor, would be estimated based upon the specific amount meat and milk processed by the processor[63] , multiplied by the default emissions factor. Emissions factors would be estimated at Member State level to reflect differences in regional emissions efficiencies and take into account different production methods used in different Member States and differ by animal type (e.g. goat, beef cattle, chicken).

The unique emissions factor would take into account more detailed information about the milk and meat processed, matching IPCC Tier 2 approaches (IPCC, 2006), including:

- More specific animal type sub-categories (e.g. "cattle" can be divided sub-categories such as calves, heifer replacements, heifer and stock steers, cattle in feedlots, cows, and bulls; each of which have different emissions intensities that can be more accurately estimated than simply looking at total cattle numbers).
- Animal age at processing time
- Feed information: typical diet, average feed digestibility, feeding energy etc.
- Manure management system characteristics: manure production and manure treatment method (i.e. is it stored in such a way that it decomposes anaerobically)

Data for the certified approach would be collected by processors from their supplier farms when purchasing meat/milk. Processors would be liable for data, which would be auditable. The unique emissions factor would need to be calculated regularly, e.g. every 1-3 years. The system should be designed from the start in a way that envisages a progression to the IPCC Tier 3 approach in order to provide a more reliable account of covered emissions. Stakeholder interviews suggest that at the current stage, the amount of information on emissions from meat and dairy production available varies substantially across processors, depending on their organizational structure (e.g. farmers' cooperative or multinational corporation) and the processor's ambition to reduce their greenhouse gas footprint.

To enable processors to demonstrate lower emissions than the default emission factor, monitoring at the farm level would be utilised to assess the emissions included in animal products sold to processors. Information that would need to be collected includes:

- Quantity (e.g. kg or litres) of meat and dairy products from different types of animals
- Type of feedstock
- Manure management practices
- Mitigation options taken (e.g. capturing GHGs)

This information is then used to determine emissions for which (downstream) processors need to submit emission permits. Monitoring of emissions will require certification agencies and clear rules how such agencies can be recognized and which criteria the certification process needs to fulfil. Here, models such as the proposed carbon removal certification mechanisms could be followed, e.g. Member States are responsible for certifying auditors, who in turn are responsible for auditing processors.

Box 9 New Zealand's proposed processor-level pricing for agriculture in New Zealand Emissions Trading Scheme

New Zealand's Climate Change Response Act[64] legislates for including processor-level pricing for agriculture in the New Zealand Emissions Trading from 2025. This option is considered a "back-stop"

[63] The approach proposed here is inspired by the New Zealand Emissions Trading System, which allows select ETS participants (e.g. those importing/owning/purchasing fuel) to apply for unique emissions factors rather than applying default factors. More information here: https://www.epa.govt.nz/industry-areas/emissions-trading-scheme/participating-in-the-ets/unique-emissions-factors/
[64] NZ CCRA s2A and 219: https://www.legislation.govt.nz/act/public/2002/0040/latest/DLM158584.html

option, which will be implemented if no other agricultural emissions pricing policy is developed before 2025. As other options have been developed by government, notably the He Waka Eke Noa proposal (the farm-levy approach), this policy is unlikely to be implemented, however, it offers a useful case study that may be instructional for the EU. All information comes from MfE & MPI (2022) and ICCC (2019).

In the envisaged system, agricultural processors (fertiliser importers and manufacturers, abattoirs, dairy processors, live animal exporters) will be required to surrender emission permits. To determine emissions, two alternative approaches can be used. Under the standard, basic approach, emissions are calculated by multiplying tonnes of product (i.e. meat, or milk) with an emissions factor (national average emissions factor). It is interesting to note that other sectors of the New Zealand ETS can apply for a Unique Emissions Factor, where they demonstrate that their production has lower than average emissions associated with it; this is not proposed to be accessible to agricultural processors. With regard to incentives to reduce emissions, the only individual mitigation incentivised by the simple, basic approach consists in reducing output. It does not account for any on farm mitigation or differences in emissions intensity between different farms.

The emissions are priced at standard NZ ETS New Zealand Unit price. 95% of emission permits are freely allocated, based on output (i.e. receive allowances equivalent to 95% of products, which is equivalent to 95% of emissions). This free allocation would be reduced by 1 percentage point per year. The Government committed to using revenue to promote mitigation in New Zealand. Revenue from allowance purchases goes into a general NZ ETS pool, which agriculture is then eligible to access; revenue proportions could be earmarked.

The processor-level pricing system is governed through New Zealand ETS, an already established system with clear governance structures, registries etc. Agricultural processors already report data (with no payment obligations) to NZ ETS, so are already integrated into the system. Administrative costs accordingly are low (estimated at 3million NZD (1.8million EUR) set-up, 10 million NZD annually (5.9million EUR) to operate). The envisaged system also links to sequestration generated through NZ ETS forestry rules, without any additional sequestration approaches. NZ ETS forestry rules pose some barriers to farmers: minimum size for forest sinks is at least 1ha in size and a minimum of 30m wide, and only forestry planted post 1990 recognised for crediting. No other removals options are available to farmers.

4. Assessment of the five policy options

4.1. Overview of assessment criteria and comparison of the policy options

We developed assessment criteria to carry out an evaluation of each of the five policy options. The criteria are based upon a series of indicators covering different types of impacts to be considered. The development of the indicators was based upon recommendations from the Commission as well as discussions within the consortium, and during consultations between the Task 1a and 1b leads.

An overview of the potential assessment criteria included in the evaluation along with the corresponding indicators is provided in Table 21.

To evaluate the options against the assessment criteria we provide a literature review of the scientific evidence available collected from a combination of desk-based research and interviews with relevant experts. **Table 22** provides an overview of how each of the five policy options perform against the assessment criteria indicators. In summarising the assessment of the five options, we have colour-coded the options against the assessment criteria – green signifies that the option will potentially have mostly positive impacts for that particular indicator, while red indicates mostly negative impacts, and yellow indicates both positive and negative impacts. The results of the assessment are discussed at length below in Section 4.2.

Table 21 Assessment structure, criteria, and indicators

Criteria	Type of Impact	Impact	Indicator
Effectiveness	Environmental	Climate change	Incentivise actors along the value chain to mitigate agricultural emissions
		Biodiversity	Biodiversity risks and co-benefits
	Social	Consumers	Impacts on consumer budgets and welfare
		Distributional	Distributional impacts on Member States
			Distributional issues between small and large farms
	Expeditiousness	Speed of implementation	Speed/ease of implementation
	Political and legal	Feasibility	Stakeholder acceptance
Efficiency	Economic	Sectoral competitiveness and trade balance	Impacts on sectoral competitiveness and trade balance
	Environmental	Carbon leakage	Risks of carbon leakage
	Administrative	Costs	Administrative burden and costs
Relevance	Policy relevance	Polluter pays principle	Incentivise polluters to change practices and innovate
Coherence	Policy coherence	External	Coherence with other EU policies
Added Value	Benefits	Benefits beyond Member States	EU added value

4.2. Comparison of 5 policy options across assessment criteria

Table 22 Comparison on five policy options based on assessment criteria

Criteria	Indicator	On-farm ETS (all-GHG)	On-farm ETS (livestock)	On-farm ETS (peatlands)	Upstream ETS	Downstream ETS
Effectiveness	Incentivise actors along the value chain to mitigate agricultural emissions					
	Biodiversity risks and co-benefits					
	Impacts on consumer budgets and welfare					
	Distributional impacts on Member States					
	Distributional issues between small and large farms					
	Speed/ease of implementation					
	Stakeholder acceptance					
Efficiency	Impacts on sectoral competitiveness and trade balance					
	Risk of carbon leakage					
	Administrative burden and costs					
Relevance	Incentivise polluters to change practices and innovate					
Coherence	Coherence with other EU policies					
Added value	EU added value					

Table 23 Summary of the assessment for the five policy options

	Mostly positive impacts	Both positive and negative impacts	Mostly negative impacts
All-GHG ETS	4 indicators	7 indicators	2 indicators
Livestock ETS	4 indicators	8 indicators	1 indicators
Peatlands ETS	9 indicators	2 indicators	2 indicators
Upstream ETS	7 indicators	6 indicators	0 indicators
Downstream ETS	8 indicators	5 indicators	0 indicators

In comparing the options and their expected impacts, the peatlands option, upstream option, and downstream option are expected have mostly positive impacts, while the All-GHG and Livestock options are expected to have more of a combination of positive and negative impacts. While on some of the indicators, the on-farm options may have mostly negative impacts, this is not the case for the off-farm options – however, with the caveat that some of the positive impacts for these two options are dependent on the integration of certified on-farm voluntary credits.

Based on the assessment of the indicators, described in detail in Section 4.3, all five of the policy options are expected to have mostly positive impacts on incentivising actors along the value chain to mitigate agricultural emissions, to innovate, and to adopt new practices. However, there is a caveat that the types of mitigation actions that are directly incentivised will depend on who the compliance entity is (as other actions would be indirectly incentivised): for example, if the obligation is downstream, incentives to mitigate agricultural emissions through on-farm actions will be less direct; on the other hand, an on-farm point of obligation would not provide a direct incentive for fertiliser producers upstream to develop lower emitting fertilisers All five options are also coherent with EU policies and have added value in comparison with similar policies enacted at the Member State level or at lower levels.

The on-farm options would need longer and more challenging implementation phase-ins and would have comparatively higher administrative costs compared to the off-farm options. The all-GHG ETS would have the highest administrative costs, while the use of proxy data for the Livestock ETS and the lower number of farms to administer in the Peatland ETS would reduce administrative costs for these options.

With the exception of the peatlands option, all of the options could potentially negatively impact consumer budgets, although price increases vary according to products, with beef and (to a slightly extent) dairy prices expected to rise comparatively higher to produce, poultry and pork. Negative distributional impacts on low-income consumers can be alleviated by using ETS auction revenues e,g, for targeted subsidies.

While the upstream and peatlands options have the lowest risk of impacts on competitiveness and trade, and all of the options (with the exception of the peatlands option) have risks of carbon leakage, there are policy measures, such as transitional free allocation, use of ETS auction revenues for transition support, a CBAM or multilateral trade agreements which could mitigate such risks. Additionally, negative impacts on competitiveness and trade for arable farms are expected to be low in comparison with livestock farms.

The peatlands option has high levels of co-benefits with biodiversity and few risks, while the other options have both potential positive and negative impacts.

For distributional impacts, all of the options could have a disproportionate effect on certain Member States, particularly those with large livestock sectors and/or a high number of farms on peatlands, unless this impact is compensated by the distribution of ETS auction revenues. While the on-farm options could have a disproportionate impact on small and medium size farms, the use of thresholds can mitigate such impacts. Larger farms will benefit from economies of scale, but the certified on-farm voluntary credits could provide opportunities for small farms who are not obligated to participate in the ETS to generate income if the ability to participate in groups or cooperatives of producers is introduced.

Based on the results of the stakeholder survey conducted for this study, stakeholder acceptance for all 5 of the policy options ranged from neutral to positive, with the downstream option receiving the highest positive feedback.

4.3. Assessment of policy options

Effectiveness

Incentivise actors along the value chain to mitigate agricultural emissions

Policy Option	Incentivise actors along the value chain to mitigate agricultural emissions
On-farm ETS (all-GHG)	Option has high potential to incentivise reductions of all GHG emissions, as it provides farmers with a direct price signal to encourage farmers to reduce their carbon costs.
On-farm ETS (livestock)	The ETS for livestock has a high potential to incentivise on-farm mitigation of key agricultural GHG emissions, livestock emissions through a direct price signal to farmers.
On-farm ETS (peatlands)	Although this option has a much smaller scope compared to the all-GHG and livestock options, the peatlands option has potential to create economic incentives for retiring managed lands on drained peatlands utilised for agricultural purposes. Such economic incentives will rely on the scenario that utilising the land for agricultural production must be more expensive than changing land management practices.
Upstream ETS	Option has less direct potential for incentivising GHG emission reductions (compared to the on-farm options) as its emission scope is more limited and the price signal to farmers will not be direct (passed or not via importers and manufacturers), and farmers may switch to alternatives outside the upstream ETS scope (e.g. manure as fertiliser and grass as feed) that may not always result in lower GHG emissions. However, similar to the downstream ETS, should operators opt for purchasing certified on-farm voluntary credits generated by farmers , there are incentives passed downstream to farmers to mitigate emissions. The option can also incentivise off-farm actions that will have implications for on-farm emissions.
Downstream ETS	The option has less direct potential for incentivising GHG emission reductions (compared to the on-farm options) as the price signal to farmers will not be direct and its emission scope is more limited. However it has the potential for incentivising some on-farm GHG reductions through potentially reducing consumers' consumption of animal products, which could reduce livestock numbers. If farmers participate in a certified on-farm voluntary credit approach, this option can provide further incentives passed upstream to farmers to mitigate emissions by changing feedstocks, manure management and adopting mitigation technologies. Similar to the upstream option, off-farm actions taken by downstream actors could have impacts on farm-level emissions.

Table 24 Comparison of GHG Coverage for 5 ETS Options

Source of emissions	Type of GHG			Net emissions per annum ($MtCO_2e$)	Included in ETS Scope				
	CH_4	N_2O	CO_2		All-GHG	Livestock	Peatlands	Upstream	Downstream
Enteric fermentation	√			182.5	√	√		√	√
N2O emissions from soils		√		118	√			√	
Manure management	√	√		62.9	√	√			√
Grasslands			√	25	√				
Croplands			√	22.6	√				
Liming			√	5.6	√				
Urea application			√	3.5	√			√	
Rice farming	√			2.7	√				
Other agricultural emissions	√	√		1.7	√				
Burning crop residues	√	√		0.7	√				
Other carbon-containing fertilisers			√	0.7	√			√	
On-farm energy use			√	*unknown*					

In comparing the GHG scope of all 5 options, the all-GHGs option offers the highest potential to incentivise mitigation as it includes the highest volume of emissions within its scope. However, three options, while having a smaller scope in terms of volume of emissions included, still offer a high degree of coverage to incentivise mitigation: the upstream option covers almost two-thirds of agricultural emissions, while the livestock and downstream options cover more than half of agricultural emissions. The peatlands option has the lowest level of coverage because it focuses on just one source of emissions.

While the all GHGs has the widest scope, for the other four options, farmers who are not obligated to participate in the ETS could sell credits for their additional mitigation efforts. Particularly for the upstream and downstream options, producers will have incentives to support the farmers with investments and upfront financing, and thus increase the GHG scope of potential emission reductions on-farm (for instance, in the downstream option besides facilitating reduction of livestock methane emissions, farmers could be financed to reduce emissions unrelated to livestock production). For the livestock and the peatlands options, farmers outside of the point of obligation can also participate in the certified on-farm voluntary credit approach, but for these options investments will come from farms obligated to purchase emission certificates (see Chapter 2 for explanation).

For both the all-GHG and livestock on-farm policy options, an ETS can incentivise farmers to reduce emissions by providing a *direct price signal*. The price signal could encourage farmers to reduce the carbon cost to their business, by:

(i) taking action to reduce the emissions total calculated for their farm under the system by reducing inputs causing emissions (this calculation could be based on proxy measurements, on e.g. head of livestock, or total fertiliser applied). The incentive will be to reduce livestock numbers and reduce the amount of fertiliser applied to soils. Reducing livestock numbers could be achieved by adopting efficiency measures that can increase the output per livestock animal, such as improved animal health measures. Incentivising the reduction of fertiliser use could be achieved through the adoption of better fertiliser application (timing and amount needed) or the adoption of regenerative farming practices.

(ii) Taking action to reduce the emissions calculated by adopting new on-farm management practices that will reduce emissions, such as use of feed additives improved diet for livestock, changing types of livestock, using manure, changing to perennials, switching to organic farming, etc.

According to several experts interviewed for this study, the advantages of an ETS is that it allows participants to select which are the most cost-effective measures that can reduce the largest amount of greenhouse gas emissions. For informative purposes, Marginal Abatement Cost Curves (MAC curves) can be used to identify the most cost-effective way to reduce emissions, given a target level of emissions reduction, or to determine the level of emissions reduction that can be achieved at a given cost. Marginal Abatement Cost Curves is a graphical representation of the cost of reducing a unit of greenhouse gas emissions by one monetary unit, as the level of emission reduction increases. The MAC curve is typically upward sloping, meaning that as the level of pollution reduction increases, the cost of reducing each additional unit of GHG emission also increases. The MAC curve is designed to help policy makers and stakeholders make informed decisions about how to allocate resources for emissions reductions, as well as to better understand the trade-off between the cost of reducing emissions and the benefits associated with this emissions reduction. The shape of the MAC curve is influenced by factors such as the availability of technology, the level of investment in research and development, and the structure of the economy.

Perez-Dominguez et al (2021) calculate national and aggregated EU MACCs for agriculture through a series of scenarios[65] where the GHG mitigation options are applied in the EU farming sector in the year 2030. The analysis of the results clusters mitigation measures into four groups: 1) high mitigation measures (between 3 and 10+ MtCO2e) at a relatively low cost (<60 EUR/tCCO2e abated) measures, including nitrification inhibitors, abandoning the use of organic soils, anaerobic digestion, precision farming, higher legume share on temporary grassland; 2) low mitigation measures (<1 MtCO2e) at relatively low cost (<60 EUR/tCO2e abated), including rice measures, or better timing of fertiliser application; 3) high mitigation measures (between 3 and 10+ MtCO2e) at a relatively high cost (>100 EUR/tCO2e abated), including livestock vaccination, winter cover crops, and two feed additives (nitrate and linseed); and 4) low mitigation (<1 MtCO2e) measures at a relatively high cost (>100 EUR.tCO2e abated), including low nitrogen feeding.

[65] All scenarios are 'maximum adoption share' possible scenarios. This approach to construct MACCs allows the authors to rank different technological emissions mitigation options in terms of their theoretical maximum mitigation potential and the costs attached to each emission unit abated

Findings from several studies indicate that the market impacts from carbon pricing policies for agriculture substantially affect mitigation outcomes (Isbasoiu et al 2020; OECD 2019; Perez Dominguez et al 2021; Slade 2017; Henderson et al 2017; Golub et al 2013; US EPA 2013; Wollenberg et al 2016; Avetisyan et al 2011). Table 25[66] provides an overview of studies which have examined the potential impact of different levels of carbon prices on GHG emission reductions in agriculture. Indeed, carbon pricing for livestock appears more economically efficient than consumer taxes or policies with compensating subsidies (Slade 2017; Henderson et al 2017).

Table 25 Overview of studies assessing the impacts of carbon prices on GHG emission reductions in agriculture

Study	Regional Scope	Coverage	Cost per unit of GHG emissions EUR/tCO2e	GHG emissions reduction
Isbasoiu et al 2020[67])	EU	Agricultural production	50	10-16% per annum
			100	16-25% per annum
			200	25-39% per annum
OECD 2019[68]	EU	Agricultural production	50	51.4% (total)
		Ruminants (dairy)	50	48% (total)
		Nitrogen fertilizer (kg/ha)	50	9.8% (total)
Perez Dominguez et al 2020[69]	EU	Agricultural mitigation technologies[70]	20	39% (total)
			40	32% (total)
			60	28% (total)
			80	26% (total)
			100	25% (total)
		Agricultural production mix and levels	20	61% (total)
			40	68% (total)
			60	72% (total)
			80	74% (total)
			100	75% (total)
Slade 2017[71]	Canada	Livestock production	35[72]	10–27%[73] (total)
Henderson et al 2021	Global	LULUCF + agricultural emissions	65[74]	8 GtCO2e (total)
			220[75]	12 GtCO2e (total)

[66] Table adopted from Errendal et. Al (2023), with additional studies added to table
[67] https://link.springer.com/article/10.1007/s10018-020-00293-4
[68] https://www.oecd-ilibrary.org/agriculture-and-food/enhancing-climate-change-mitigation-through-agriculture_0382e8b0-en
[69] https://op.europa.eu/en/publication-detail/-/publication/cce2a349-8052-11ea-b94a-01aa75ed71a1/language-en
[70] According to the study, carbon prices levels out at prices beyond 60 EUR/tCo2eq due to the following: "the adoption of most of the mitigation technologies increases considerably under carbon prices below 60 EUR/t CO2eq, but further adoption is clearly limited with higher carbon prices. Accordingly, the absolute contribution of mitigation technologies to total mitigation increases with increasing carbon prices, but at a decreasing rate. In relative terms, the contribution of mitigation technologies to total mitigation decreases from 39% under a carbon price of 20 EUR/t CO2eq to 25% with a carbon price of 100 EUR/t CO2eq." (Perez-Dominguez et al 2020, p. 72)
[71] https://onlinelibrary.wiley.com/doi/abs/10.1111/cjag.12157
[72] Study uses carbon price of 50 CAD/tCCO2e which has been converted into Euros.
[73] depending on abatement measures
[74] Study quotes carbon prices in USD, which has been converted into Euros
[75] Study quotes carbon prices in USD, which has been converted into Euros

Table adopted from Errendal et. Al (2023), with additional studies added

Economic barriers such as costs of mitigation practices adopted, technology transfer, and perceived risks of practice change can impact the likelihood that producers are willing to adopt supply side practices, such as improving animal diets or animal productivity, which provides a justification for the use of carbon pricing policies (Gerber et al 2013; Herrero et al 2016).

In theory the strength of the marginal price signal is the same regardless of whether allowances are allocated for free or auctioned, provided that price formation takes place where some space for auctioning and trading is left. However, a degree of inertia could be expected in farm business practices to reduce the effectiveness of the price signal if high levels of free allowances are made in the early years of the system (in line with experience of the impact of decoupling CAP support from production). Alternatively, including agriculture in CBAM could limit the need for high levels of free allocation of allowances and therefore help to prevent such inertia.

An on-farm ETS for peatlands would have broadly similar incentivising effects to the all-GHG and livestock options, but potentially less direct; this is because the processes affected by peatland emissions and removals tend to be a longer-term response to management decisions than, say, year-on-year changes in cropping, livestock, fertiliser use, etc. Rewetted peatlands have lower net GHG emissions (CO_2eq) compared to degraded peatlands. Therefore, pricing GHG emissions from degraded peatlands in combination with the option for re-wetting creates an economic incentive to retire managed land in areas with degraded peatland (Humpenoeder et al 2020).

However, studies have emphasised the challenges in incentivizing farmers to rewet their land or practice more sustainable land practices on peatlands, such as paludiculture. Schaller et al (2011) find that agricultural stakeholders and farmers are concerned about such measures, perceiving them to have high costs associated with reorganization and farm adaptation. Particularly in regions where current production on peatland sites is highly profitable or capital intensive, the attitude towards changing land management is negative, even given the prospect of financial compensation (ibid). Especially for capital intensive branches of production (i.e. dairy farming), the economic consequences of farm re-organisation are likely to jeopardise financial survival. Therefore, an emissions price will need to be high enough to provide a signal that the costs of continuing to farm intensively on degraded peatlands will outweigh the costs associated with changes in land management.

Nevertheless, farmers have indicated their preference for market-based measures in which it is possible for them to achieve higher revenues, rather than relying on state premiums for ecological services (Isermeyer et al 2019). An ETS for peatland emissions could incentivize farmers if given the opportunity to obtain revenues for utilising new production methods (i.e. paludiculture) by selling emission certificates in auction, rather than having to rely on government subsidies (ibid). In addition, farmers demonstrate a certain acceptance of reorganization if loss of income is compensated or the implementation of alternative strategies (i.e. paludiculture) receive financial support (Schaller et al 2011).

Whether an ETS for peatlands can provide the right incentives for continuous management of the land if re-wetting occurs depends on various factors. Without the provision of free allowances, there is a high probability that farmers may abandon farming activities altogether on peatlands if the carbon price is too high. However, free allowances may delay re-wetting activities if there is a long implementation period. Revenues from the ETS could be utilized to support farmers engaging in re-wetting activities. However, while a cap incentivizes reductions in emissions, as emissions fall, so too will revenue over time. Therefore, an ETS cannot necessarily provide farmers with long-term financial support for maintaining re-wetted lands.

While peatland rewetting is the best way to reverse high levels of greenhouse gas emissions, high water levels do not fit with intensive agricultural production. However, paludiculture provides a viable land use alternative. Revenues could be utilized to support farmers in transitioning towards paludiculture (therefore more temporary in nature, as farmers can continue to earn income conducting agricultural production). Evidence from peatland ecological monitoring studies proved that the climate benefit from raising water level in agricultural peatlands can be achieved without necessarily halting the productive use (Evans et al, 2021).

Paludiculture produces biomass from wet and rewetted peatlands under conditions that maintain the peat body, facilitate peat accumulation and can provide many of the ecosystem services associated with natural, undrained peatlands. The biomass can be used for a wide range of traditional and innovative food, feed, fibre and fuel products (see Tanneberger et. al 2022). Grazing livestock activities can continue on partial re-wetting grasslands. The only animal-based land use concepts for fully rewetted peatlands are keeping geese or water buffaloes, as generally conventional robust cattle are not suitable for fully rewetted peatlands (Haberl 2022). But they may be a feasible management option for sites where only moist site conditions can be achieved by rewetting measures due to lack of water or difficult site conditions (ibid).

An upstream ETS will be able to partially reduce on-farm emissions through the incentive mechanisms identified in **Figure 8**:

- From the manufacturers' side, the upstream ETS can incentivise the development of low-emitting feed and fertilisers by altering the composition of the products they manufacture, e.g. by using nitrification inhibitors in fertilisers and including specific dietary additives in feed.
- From the farmers' side, the increased prices passed on to them may incentivise more efficient use of feed and fertilisers or switching to products with lower associated emissions. However, the method of fertiliser application also greatly influences their GHG emissions, and this would not be addressed by this option. Similarly, an upstream ETS would not be able to reduce enteric fermentation emissions linked to long-term management changes and breeding practices. However, such mitigation options can be incentivised should upstream producers be allowed and opt for purchasing allowances produced from farms engaging in the 'certified on-farm voluntary credit' approach.

The potential for incentivising mitigation of GHG emissions from use of farm animal feed and fertilisers is detailed separately below.

Farm animal feed

According to Smith et al (2021), practices for reducing CH_4 emissions from enteric fermentation fall into three general categories: use of specific agents of dietary additives[76], improved feeding practices[77], and long-term management changes and breeding practices. Emissions resulting from practices under the first and second categories could be (partially) incentivised via an upstream ETS.

An upstream ETS could therefore seek to encourage the manufacture of feed with specific composition (e.g. no high fibre content, with additives that mitigate CH_4 emissions) or reduce the feed consumption. Box 10 provides an example of how applying the polluter pays principle to feed in Denmark had a positive impact on reducing pollution. An upstream ETS on feed cannot incentivise all options for reducing on-farm enteric fermentation emissions, notably those related to long-term management changes and breeding practices, unless they are purchasing certified voluntary credits generated by farms voluntarily adopting such options.

Box 10 Experiences of feed taxation in Denmark

Denmark has established a tax on animal feed phosphorus, which came into effect in 2005 and applies to the quantity of commercial animal feed phosphate. The price of the tax was set at DKK4 (EUR 0.53) per kg of phosphorus. The tax rate has not been adjusted to inflation. As of 2015, consumption of mineral phosphate in animal feeds fell by 15% (2,000 tonnes) since its introduction, with the tax believed to have improved overall efficiency in the use of animal feed.[78]

As the experience of Denmark's tax on animal feed phosphorus demonstrates, a higher costs of feed may incentivise more efficient or less intensive on-farm practices. For example, farmers may be incentivised to switch to a grass-based diet for their livestock. On the one hand, commercial feed requires more energy and resources to produce, leading to overall higher GHG emissions than grazing on grassland. Well-managed grazing systems can also support the process of soil carbon sequestration. On the other hand, extensive livestock farming based on grazing systems generally emits more GHG emissions per kg of meat produced as they are less productive per quantity of feed or land area.[79] There are also other risks and benefits linked to the potential switch from commercial feed to grassland grazing, which are discussed in the next section on biodiversity. Whether incentivising a switch to grazing is desirable therefore needs further consideration.[80]

[76] Regarding the use of specific agents or dietary additives, feed additives can mitigate CH4 emissions. Estimates from a meta-analysis demonstrate a range of CH4 emission reduction of 1-71% for cattle and 13-75% for sheep. As a proportion of total agricultural emissions, the potential GHG reduction range is between 0.3 to 26.4% (Lewis et al., 2015). A study testing 10 additives on ruminants found that two (3-Nitrooxypropanol, such as Boyaer, and dried Asparagopsis red algae) have routinely delivered over 20% mitigation of enteric methane by the consuming ruminants and that dietary nitrate is the third most effective additive (can safely deliver 10% or more mitigation when consumed) (Hegarty et al 2021). Another example researched by the US Roundtable for Sustainable Beef include monensin in feed, which has a potential to reduce CH4 emissions associated with beef by 10% (Kebreab et al 2022).
[77] Regarding improved feeding practices, digestibility and the chemical composition of the diet influence emissions (Ouatahar et al 2021). Modifications to nutrition by reducing fibre levels can lower emissions from enteric fermentation by 5-10% (e.g. Redon-Huerta et al, 2018; Hammond et al, 2015). Reducing dietary crude protein and adding fatty acid to dairy diets can also reduce CH4 and N_2O emissions (by 10-30% of N20 and 10.3% of enteric CH4 respectively). An increase in 10% digestibility in feed leads to a reduction of approximately 12–20% in enteric CH4 yield (e.g.,e.g.elying on concentrate over forage) (Ouatahar et al 2021).
[78] https://pure.au.dk/portal/da/persons/mikael-skou-andersen(d6eb07fd-3020-4801-9beb-04c0cc0f0914)/publications/the-animal-feed-mineral-phosphorus-tax-in-denmark(7b2ab39d-74e3-46ff-8732-e6c498f1a29e).html
[79] https://www.pnas.org/doi/10.1073/pnas.1308149110; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7459503/
[80] https://www.oxfordmartin.ox.ac.uk/downloads/reports/fcrn_gnc_report.pdf

Fertilisers

The type of fertiliser applied can only to some extent influence N_2O emissions. Notably, the following solutions have been identified:[81]

- Replacing traditional fertilisers with slow-release/controlled-release fertilisers. For instance, in a study on Chinese cabbage, a 50% reduction in fertiliser emissions from the use of per product functional unit was observed;[82]
- Manufacturing fertilisers containing urease and nitrification inhibitors. Nitrification inhibitors can reduce N_2O emissions by up to 50%;[83]
- Replacing urea with other ammonium nitrate fertilisers to reduce CO_2 emissions from urea application, although this could increase N_2O emissions in return.

However, the most effective way to reduce N_2O emissions from fertiliser use is to adopt fertiliser management practices at farm level through e.g. precise selection of the fertiliser dose or direct application to soil. Other farm-level practices related to tillage or replacement of fertiliser can also have a significant impact on reducing N_2O emissions. An upstream ETS would only be able to provide a limited incentive for reducing emissions from fertiliser application because these depend mostly on how much and how fertiliser is applied by farmers, which can only be partly influenced by the passed on ETS costs in the fertilisers price, rather than their composition. **Box 11** summarises the experience from several EU MS on applying the polluters' pays principle to fertilisers.

To what degree the upstream ETS price signal can be passed on to farmers depends on the extent to which fertiliser producers are able to set prices. Fertiliser prices depend on the international market situation and production costs. For example, in 2022, spikes in gas prices have led to higher production costs of synthetic fertilisers, which have been passed down to farmers.[84] This could indicate that the manufacturers can pass on cost increases, to some degree, to their customers, depending on the market circumstances.

Box 11 Experiences of fertiliser taxation in several EU MS

There are currently no fertiliser tax related to the GHG emissions of the products in any EU MS. Fertiliser taxes were set up and then abolished in three EU MS: Austria, Finland and Sweden. In the case of the first two, this tax was stopped in 1994, before their accession to the EU, and in Sweden the tax was abolished in 2009. Rates varied from between 10% and 72% of the price of fertiliser. All three countries had a fixed tax rate based on the amount of nitrogen (in kg) placed on the market.

The implementation of fertiliser taxes (at a significant level) was associated with decreasing use of fertilisers by farmers, with a price elasticity oscillating between -0.1 and -0.5. While nitrogen fertiliser consumption decreased, this did not translate into a decline in agricultural production. In addition, the price of fertiliser increased, but did not pass on to food prices. This means that fertiliser producers were passing the costs to farmers, but that farmers did not (or could not) pass on the price to their consumers. Farmers may have switched to organic fertilisers such as manure,[85] but

[81] For more explanations on each type of enhanced efficiency fertilisers see: https://www.intechopen.com/chapters/64020

[82] https://www.researchgate.net/publication/340838496_The_Impact_of_a_Controlled-Release_Fertiliser_on_Greenhouse_Gas_Emissions_and_the_Efficiency_of_the_Production_of_Chinese_Cabbage

[83] https://www.mdpi.com/2075-1729/12/3/439

[84] https://www.agroberichtenbuitenland.nl/actueel/nieuws/2022/10/06/spain-fertilizer-prices-are-threatening-upcoming-harvests

[85] http://dx.doi.org/10.1080/09640560120087615

unless there was an increase in livestock numbers and associated manure production, a reduction in sales of fertilisers suggests that synthetic fertilisers and manure were being used more efficiently, leading to less nitrogen loss to GHG emissions and water pollution.

A more qualitative study based on surveys was recently conducted in Lithuania to explore how farmers would respond to a tax on synthetic fertilisers. The study examined the price elasticity of demand according to three policy scenarios applying different tax levels. These correspond with price increases of 25, 50 or 100%, respectively. The findings of the study show that with higher prices farmers would further reduce nitrogen purchases: for example, if the price increased by 50 %, fertiliser purchases would drop by 20-50 % Some respondents indicated that they would switch to organic fertilisers instead.[86] Yet, even if the price were to be increased by 100%, farmers would not refuse mineral fertiliser usage, demonstrating the inelasticity of demand.

The upstream ETS could facilitate the uptake of more agro-ecological farming practices, that would reduce the need for fertiliser inputs. Practices grouped under regenerative agriculture include no-till agriculture — where farmers avoid ploughing soils and instead drill seeds into the soil — and use of cover crops, which are plants grown to cover the soil after farmers harvest the main crop. Other practices include diverse crop rotations, such as planting three or more crops in rotation over several years, and rotating crops with livestock grazing (WRI 2021). The fundamental principles of agro-ecology are to keep the soil covered, minimise soil disturbance, preserve living roots in the soil year round, increase species diversity, integrate livestock, and limit or eliminate the use of synthetic compounds (such as herbicides and fertilisers) (Khangura et al 2023). Such practices could have co-benefits for increasing soil organic carbon (SOC) levels in soil, although there are large variations in estimates as to the contribution such practices can make (see McDonald et al 2021).

However, there is a risk that farmers switch to fertilisers that are not covered by the ETS but nonetheless result in GHG emissions. A desk review of emission factors (EFs) found that for post-application emission, EFs for synthetic fertilizers can range between 0.03 and 12.9% of applied nitrogen (0.1 – 40 kg CO_2 e/kg of N), between 0.05 and 13.9% for manure (generally being higher than those of synthetics), between 0.11 and 1.55% of applied N for compost, and between 0 to 5.1% for digestates.[87] This means that farmers switching from synthetic fertilisers to manure as a result of the upstream ETS could represent a perverse incentive diminishing the effectiveness of the tax or even leading to higher emissions from fertiliser use than before its establishment. However, this would depend on the extent to which farmers replace synthetic fertilisers with manure (e.g. a switch to compost or digestates would result in a decrease in GHG emissions), on how manure is applied (as well as stored), and on the counterfactual use of the manure (for example, assuming no increase in livestock, how would the manure have been dealt with, and what would have been its impact on GHG and water pollution?).

For the downstream ETS, the key question is the resulting emission price and how the emission reductions will eventually be achieved. The default MRV system in the downstream option would incentivise the reduction of consumption of animal products,substitution of high-emission animal products with lower-emission products (e.g. replacing dairy with oat milk), or changing product

[86] https://ejournals.vdu.lt/index.php/rd/article/view/2855

[87] https://www.researchgate.net/publication/344417276_Greenhouse_gas_emissions_from_inorganic_and_organic_fertiliser_production_and_use_A_review_of_emission_factors_and_their_variability

formulation, e.g. by reducing the product's meat or dairy content to reduce its overall carbon footprint (see section 3.5.3 for a non-exhaustive list of measures available to downstream actors). Similar to the upstream option, individual on-farm mitigation will be incentivised by changes occurring downstream, where demand for less GHG-intensive types of meat or less GHG-intensive crops will shape on-farm production. However, the approach whereby farmers are allowed to generate certified on-farm voluntary credits can incentivise greater on-farm mitigation. The degree would depend on how effectively processors pass on the incentives for lowering emissions to farmers.

The effects of a downstream ETS can be assessed by considering how the emission price would affect the price of the final product and how in turn a higher price would affect consumption. The cost of emission permits will be – at least to some extent – passed through to final consumers. However, price is only one of several marketing instruments available to downstream actors. Other avenues include changes in the product portfolio, towards products with a lower carbon footprint, which could be supported with promotion campaigns for lower-emission products. The large number of processors in the EU suggests a high level of competition in the market, which, as a rule of thumb, correlates with higher cost pass-thorugh. As a result of higher prices, consumers will have an incentive to consume fewer animal products, or switch to more climate-friendly meat and dairy products. Estimates of potential impacts of price changes on consumer behaviour are discussed as part of the indicator on 'impacts on consumer budgets and welfare'.

It is well known in the academic literature that food price elasticities – i.e. the change of consumption induced by a certain price increase – vary across commodity groups and consumer income (Gallet 2010, Lusk and Tonsor 2010). We use the mean elasticity from available studies as a rough estimate of the elasticity in the EU. A recent meta-analysis of 93 primary studies (Femenia 2019) finds mean own price elasticities of -0.57 for meat products and -0.59 for dairy products. That means that a price increase of 10% would reduce meat consumption by 5.7%, and 5.9% for the case of dairy products.

Biodiversity risks and co-benefits

Policy Option	Biodiversity risks and co-benefits
On-farm ETS (all-GHG)	If carbon farming practices, such as agroforestry or methods to enhance soil organic carbon, are incentivised through the on-farm ETS there are positive synergies with enhancing biodiversity. Practices in relation to livestock and manure management as well as nutrient management can also positively impact biodiversity. However, there are also risks, particularly with nutrient management
On-farm ETS (livestock)	Improved livestock management, such as grazing on grasslands can have co-benefits for biodiversity, but these are highly context dependent. Technical measures may risk biodiversity loss.
On-farm ETS (peatlands)	Large level of co-benefits for biodiversity associated with peatland restoration and re-wetting, with low level of risks.
Upstream ETS	Small risk for expansion of grazing area; opportunities for co-benefit for biodiversity and natural habitats if nitrogen consumption is reduced, but dependent on whether nitrogen consumption is reduced or just replaced by organic fertilisers
Downstream ETS	Option poses similar risks and benefits to biodiversity as the on-farm (livestock) option

Certain climate mitigation approaches, such as agroforestry or no/low tillage, can provide co-benefits for biodiversity. Co-benefits for biodiversity include improving soil health, enriching below-ground biodiversity, and protecting habitats for above-ground biodiversity (see Scheid et al 2023). But some mitigation activities could also pose risks to biodiversity. For example, while improved nutrient management to reduce N_2O emissions could reduce pest attacks, acidification risks to soil, and reduce toxicity to organisms, all of which are associated with excessive fertiliser use, nutrient management may also negatively impact ecosystem biodiversity through deposition (ibid). Therefore, on-farm mitigations that are encouraged through voluntary on-farm certification should focus on practices that can enhance and safeguard biodiversity.

Animal husbandry and the associated feed production, as well as the accumulation of manure, substantially contribute to the global loss of biodiversity (Weishaupt et al 2020). An on-farm ETS for livestock could lead to the adoption of improved livestock management practices that can have co-benefits for biodiversity. For example, reduced grazing intensity on grasslands can lead to greater plant diversity, increased abundance and biomass of soil fauna, decreased nutrition runoff, and higher soil organic matter and lower soil bulk density (see Scheid et al 2023). Nevertheless, it should be noted that the overall net effects on biodiversity of livestock grazing are highly context dependent. High stocking rates of grazing animals in confined areas can negatively impact plant cover; conversely, removal of grazing has been documented to decrease plant diversity in some systems, such as grasslands. This can occur through a variety of mechanisms such as successional change to less diverse shrublands or woodlands and loss of grassland habitat (Watkinson and Ormerod 2001). A light or moderate level of grazing may result in greater plant diversity than either grazing exclusion or heavy grazing, although such responses are habitat-specific (Schieltz & Rubenstein 2016). A study by Liu et al (2015) found that for low diversity grassland, grazing by cattle alone and mixed grazing significantly increase plant diversity, but also significantly decreased plant biomass, while no significant impact occurred for either from sheep grazing only. Therefore, impacts of changing livestock practices and populations on biodiversity involve complex and variable interactions between multiple herbivore species and plant communities.

Strategies to reduce N_2O emissions through improved nutrient management on croplands and grasslands have also been found to decrease GHG emissions while enhancing biodiversity. The implementation of certain on-farm measures, such as improved nutrient planning and adjustments to the amount and timing of fertiliser application, can reduce nitrous oxide emissions from the application of fertilisers and manure. Concurrently, nutrient management measures can serve to strengthen biodiversity by reducing nutrition runoff and by addressing acidification and soil crust. Improved nutrient management can also help diminish negative impacts of toxicity to species resulting from excessive fertiliser usage. Nevertheless, it is important to take into account the specific biodiversity context of carbon farming practices. While measures may prove to yield co-benefits for biodiversity in one region, it may have negative effects elsewhere. With the view to maximise synergies between climate and biodiversity action, the opportunities and risks associated with such practices must therefore be considered carefully.

According to Havlik et al (2009), resource-related shifting effects can arise from technical measures to reduce methane emissions in animal husbandry. For example, increases in productivity in feed production can reduce the intensity of GHG emissions and prevent the expansion of farmland, but can conflict with other environmental problems such as disrupted nutrient cycles, biodiversity loss and the use of agrochemicals (ibid). Indirect shifts to other environmental problems can be expected through the subsequent use of the released land, which previously served for fodder cultivation or as grazing land (ibid).

For a peatland ETS, evidence suggests that there are large co-benefits for biodiversity associated with peatland re-wetting (see Scheid et al 2023). For soil health, peatland re-wetting contributes to the retention of nutrients that are mobilised in degraded peatland through decomposition and peat soil degradation (Bonn et al., 2016; Steffenhagen et al., 2008). Above ground, peatland re-wetting is associated with increasing populations of numerous species listed in Annex I of the Birds Directive within just a short number of years (Joosten et al., 2014). Peatlands can also provide support for species from other habitats, by providing permanent or temporary refuges for relict plant species and for species at the edges of their ranges, which have been displaced from their original habitats (Bonn et al., 2016).

Research has also found that rewetted peatlands are colonised by assemblages of aquatic organisms that are similar to previously undisturbed peatland sites (Brown et al., 2016; Carter et al., 2015; Swindles et al., 2016). Microbial recovery upon re-wetting of peatlands is substantial, which is of great consequence for below ground biodiversity since by controlling nutrient cycling, and greenhouse gas emission and uptake, microbial communities are among the primary drivers of eco-system functioning (Tanneberger et al., 2021). However, this recovery and its associated benefits are conditional on the level of degradation of the drained peat soil and may not deliver the same level of biodiversity as preserved peatlands (Lamers et al., 2015; Renou-Wilson et al., 2019). Nevertheless, in their study of the co-benefits and risks associated with various carbon farming practices, Scheid et al (2023) found no significant risks to biodiversity associated with peatland re-wetting.

For the upstream ETS, an increase in feed price could lead to farmers switching to grass to feed their livestock, with implications for land use as well as GHG emissions.[88] However, the amount of grassland needed to feed such high numbers of livestock is an unlikely solution, as doing so would not be feasible for the many farm holdings which do not have the capacity to expand (e.g. neighbouring farms around or land not suitable for grazing). In addition, it may be legally difficult for farmers to expand to "natural" areas considering the planned expansion of Natura 2000 areas under the newly proposed EU Nature Restoration Law (30% protected areas target).

Low-intensity grass-fed cattle farming systems can contribute to the preservation of biodiversity-rich grassland ecosystems. Since the total area of permanent grassland has been declining in Europe, partly due to switch to crop production,[89] a small switch to more grassland could be beneficial, at least in terms of biodiversity objectives and where these biodiversity-rich grassland ecosystems were originally located.

A reduction in fertiliser use due to price increases from an upstream ETS would reduce nitrogen losses from agricultural land to the environment, diminishing the negative impacts that nitrogen losses have on soil, air and water quality (e.g. eutrophication), ecosystems and human health.[90]

[88] Less intensive livestock systems can lead to a longer period before slaughter weight is reached. This could mean more emissions per kilogram of meat.
[89] https://www.sciencedirect.com/science/article/pii/S0167880922000408
[90] https://www.eea.europa.eu/airs/2018/natural-capital/agricultural-land-nitrogen-balance

A switch from synthetic fertilisers to organic fertilisers could also occur. A meta-analysis by O'Brien and Hatfield (2019),[91] aiming to compare synthetic fertilisers with manure, concluded that when applied at rates providing comparable levels of plant-available N, manure fertiliser can match synthetic fertiliser in crop production, quality, and digestibility. Manure application increased soil organic matter, potentially benefitting long-term soil fertility, but it also increased soil P, suggesting a threat to water quality. Soil nitrate leaching and nitrous oxide emissions were highly variable across studies, so no clear trends were evident.

Impacts on consumer budgets and welfare

Policy Option	Impacts on consumer budgets and welfare
On-farm ETS (all-GHG)	The option is expected to have a relatively pronounced impact on consumer budgets. However, there is disproportionate rise in the price of beef and certain dairy products, whereas price increases for grains, fruit and vegetables will be moderate in comparison. Possible strongest regressive effects across income groups compared to other policy options.
On-farm ETS (livestock)	Under this policy option, prices for beef and dairy are expected to disproportionately rise compared to pork and poultry prices, due to higher emission intensities, with possible positive outcomes for consumer health.
On-farm ETS (peatlands)	The limited available evidence suggests no impact on food prices if peatland restoration or re-wetting policy option is implemented.
Upstream ETS	The impact on food prices will depend on the price-setting strategies and ability of the compliance entity to pass on the cost, however, producer price transmission may be relatively weaker compared to other policy options. Price increases would be concentrated in the beef and certain dairy segments, with possible positive impacts on consumer health.
Downstream ETS	The impact on food prices will depend on the price-setting strategies and ability of the compliance entity to pass on the cost, however, producer price transmission may be relatively stronger compared to other policy options. Price increases would affect beef and certain dairy products with possible positive impacts on consumer health.

For the on-farm all-GHG and livestock ETS options, increasing food commodity prices are to be expected and the degree to which food prices will rise depends on the ETS price (Perez Dominguez et al 2009; Stefanovic et al 2016; Perez Dominguez & Fellman 2015; Perez Dominguez et al 2012; Was et al 2021), which influences production costs. A moderate burden of producer price increases is expected to be passed on to consumers (Perez Dominguez et al 2012).

Perez-Dominguez et al. (2016) analyse the impacts of a 20% compulsory emission reduction target for EU-28 agriculture and find that it would lead to minimal increases in consumer prices of vegetables and cereals (0.1%), oilseeds (0.2%), eggs (1.3%), poultry (1.7%), and pork (2.6%). Cheese prices could be expected to rise by 3.8%, with more significant price increases for butter (7.1%) and beef (12.1%)[92] (idem.). Garcia-Muros (2016) and Caillavet (2019) model the impacts of carbon price imposition on all food products in Spain and France based on life-cycle emissions and, similarly, find that higher prices are predominantly driven by dairy and non-ruminant livestock production. At carbon prices of EUR 50 per tCO2e (Garcia-Muros 2016) and EUR 56 per tCO2e (Caillavet 2019), price increases range between 4.3%-8.8% for fruit and vegetables, 4.3%-8.4% for poultry and pork, 4.3-10.5% for dairy, and 7.7-12.1% for beef. In addition, Caillavet (2019) analyses impacts of a high carbon price of EUR 140 per tCO2e,

[91] https://acsess.onlinelibrary.wiley.com/doi/10.2134/age2019.04.0027
[92] Perez-Dominguez et al. (2016) also analyse a scenario including a compulsory 20% mitigation target combined with a 80% subsidy for the voluntary application of all mitigation technologies. In this scenario the increase in the price of butter (1.6%) and cheese (0.6%) is significantly less pronounced relative to the increase in the price of beef (7.7%).

with estimated price increases of 11.6% for fruit and vegetables, 10.7% for cheese and 19.3-19.4% for other dairy and all types of meat.

It is important to note that the consumer price increases for horticultural and non-ruminant livestock products due to a potential ETS are likely to be less significant than indicated above. While the two studies referenced apply a carbon price based on lifecycle emissions, activities such as feed production and transport, which are major contributors to overall emissions associated with those products (see e.g. Andretta et al. 2021; Mengyu et al. 2022), are not within the scope of any of the presented policy options.

With all food products affected by the imposition of a carbon price, a scenario similar to an all-GHG on-farm ETS, the overall food budget may be expected to increase by around 4.5%-11.22% at a price of EUR 56-140 per tCO2e (Cavaillet 2019). With food products constituting a relatively low share of overall consumer spending, Garcia Muros et al. (2016) estimate the welfare loss associated with a price of EUR 50 per tCO2e imposed on all food products to be around 0.7% of total household expenditure.

Impacts on consumer budget are markedly lower if only livestock products are subject to carbon pricing. For example, at a carbon price of EUR 56-140 per tCO2e imposed on meat and cheese, the overall food budget is estimated to increase by around 1.59%-3.98% (Cavaillet 2019). In Sweden, a carbon price of EUR 84 per tCO2e on meat products is projected to decrease purchasing power by 0.74-0.81% (Sall 2018). Similarly, within a German context, the application of a carbon price of EUR 40-100 per tCO2e on fresh meat is expected to result in welfare losses ranging from 0.42% to 0.87% (Roosen 2022). It should be noted that none of these estimates assume the recycling of tax revenues back to the economy to support either consumers or producers.

These estimates are potentially of relevance to both upstream and downstream ETS options, as well as the on-farm livestock option. The potential impact of the upstream option on consumer prices is likely be concentrated in the livestock-related product segments, given the focus on animal feed and N_2O emissions from fertiliser, including that used in the production of feed crops, and the high nitrogen footprint of livestock products, in particular beef (Leip et al. 2013). The ultimate impact of carbon pricing through the introduction of an ETS in these policy options is likely to depend on the ambition of the system and factors affecting the price transmission mechanism, including price-setting strategies of different actors in the value chain. The experiences from three former fertiliser taxes in the EU (see Box 11) show that increased fertiliser prices did not lead to higher food prices, as the costs from the taxes were not further passed down to the end-consumer of food products. The experiences also showed that there was no reduction in agricultural output. However, the different findings from literature show that the risk of food increases price as a result of an upstream ETS cannot be ruled out.

For the downstream ETS, if the approach to purchase voluntary on-farm credits is not followed by a large number of processors, then impact on food prices would be expected to be slightly higher as fewer mitigation options would be available to farmers, resulting in slightly higher emissions prices. The policy will increase the price of meat and dairy products for final consumers. This is – at least to some extent – a desirable outcome, as reducing consumption of animal products is one of the most effective ways to reduce agricultural emissions (Ivanova et al. (2020). Higher prices for animal products will also mean lower revenues for processors and producing farms. The extent to which higher prices can be passed through to final consumers depends on their demand elasticity. The findings from the empirical literature suggest that at least some of the cost burden of an emission price would fall on producers.

There is a lack of literature estimating the potential impact of a peatland re-wetting policy at the EU level on food prices. However, Humpenoeder et al (2020) model three scenarios (a no peatland policy scenario, a peatland protection policy scenario, and peatland restoration policy scenario) for peatlands at the global level and the potential impacts on food demand. The authors find that food prices in 2035 show almost no reaction to peatland protection and restoration policies on top of climate policy for all world regions. This result holds true also for the longer-term projection of global food prices until 2100 (ibid). Moreover, food availability, which is the outcome of a price-elastic food demand response function, is identical across all three scenarios at global level (ibid).

It should be highlighted that the existing research on the effects of carbon taxes on food products suggests the resulting reductions in consumer purchasing power are unlikely to exceed 1%. It could therefore be anticipated that regardless of ETS scope and, by extension, the range of agricultural products affected by carbon prices, the overall impacts on consumer budgets will be relatively modest. In addition, the impact of an ETS carbon price on consumer budgets depends also on the extent of which ETS revenues are distributed back to actors along the agri-food value chain. For example, Cavaillet (2019) models a revenue-neutral carbon tax scenario, which assumes the subsidisation of two food groups rich in plant proteins, "fresh fruits and vegetables" and "starchy foods" with the use of tax revenue, achieving a neutral impact on consumer budgets. This suggests that the targeted use of ETS revenues to support the consumption of products with a lower carbon footprint could limit the negative impacts on consumer budgets. The second part of this study ("AgETS+Removals Study") also considers various models for using ETS revenue to financially reward carbon removals from the land sector, with potential mitigating impacts on producer costs and consumer prices.

Impacts may manifest unevenly across Member States and consumer groups, depending on their socioeconomic status and other factors. Existing research on the consequences of carbon taxes on consumer budgets predominantly concentrates on Western European countries with comparatively affluent consumers who allocate a smaller proportion of their income toward food expenditures. The studies referenced in this assessment specifically examine Germany, Sweden, Spain, and France, where the average household's food expenses as a percentage of their total spending fall either below or marginally above the EU average of 14.3%.The impacts on consumer welfare are likely to be more significant in Central and Eastern European Member States, with consumers in three EU Member States (Romania, Lithuania, Bulgaria) allocating more than 20% of their expenditure to food (Eurostat 2021). The existing literature on the socioeconomic impacts of taxes imposed on unhealthy food products also generally shows that these types of fiscal measures tend to have regressive outcomes (i.e. the average effective tax rate paid by household decreases as the tax base (consumption) grows) (McColl 2009; Sharma et al. 2014; Briggs et al. 2013). This is largely due to the fact that lower-income households spend a higher proportion of their budget on food and are therefore more likely to be affected by an increase in food prices. More recent studies that investigate the specific welfare impacts of carbon taxes on higher GHG intensity food products also tend to find that such measures are likely to have negative outcomes in terms of redistribution (García-Muros et al. 2016, Roosen et al. 2022).

There is some debate as to whether the health gains resulting from targeted consumption taxes on food counterbalance the negative effects on income distribution (Nnoaham et al. 2009). Impacts on food prices and, consequently, on EU citizens' food consumption profile, are an important consideration, given the health and nutritional outcomes associated with the consumption of livestock products. It has been estimated that 50% of protein intake in the EU is of animal origin (Westhoek et al 2016). Of this animal-based protein intake, half is from meat and around 35% from dairy (ibid.). The same assessment also found that, on average, people in the EU consumed 70% more protein than recommended by nutritionists and 40% more saturated fat. Overall, red meat consumption was found to be twice as high as the recommended levels (ibid.). Therefore, there are potential health co-benefits associated with reducing meat consumption in the EU.

Some argue that given the higher obesity prevalence and greater consumption of high energy density products among lower socio-economic groups, these demog.raphics are likely to experience progressively greater health benefits resulting from a shift in consumption (Nnoaham et al. 2009). Other modelling exercises, however, suggest that price policies would not be effective in reducing social inequalities in nutrition, given the heterogeneity of preferences and food substitutions (Darmon et al. 2014).

Changes in meat prices, particularly beef prices, could have potential implications for consumption patterns. Indeed, consumption of beef is already dropping, partly due to higher prices – in 2021, EU annual beef consumption fell by 0.3% to 10.3 kg per capita; this trend was expected to continue in 2022, with a 0.9 % drop predicted (European Parliament 2022). Raised prices due to carbon pricing policies could lead consumers to potentially compensate by consuming more plant products, meat substitutes, and in the future artificial meat (Weishaupt et al 2021). Indeed, meat consumption patterns are already changing among the young, as more than 13% of young adults in Germany do not consume meat – more than twice as many as in the population as a whole (Heinrich Boll Stiftung 2021). Because beef is more emission intensive, potential price increases for pork and poultry are expected to be less acute – therefore, consumption shifts towards less emission-intensive meat products could be expected as well (Weishaupt et al 2021).

There is, however, a large variability in meat demand elasticity estimates in response to emission pricing. While some studies find emission pricing of EUR 100 per tCO_2e of livestock leads to very small decreases (< 5%) in total meat consumption in the EU due to low demand elasticities (Zech & Schneider; Saell 2018), others find more moderate impacts of around a 15% reduction in consumption (Frank et al 2019). However, evidence does suggest that beef prices are less inelastic compared to other foods: in their literature review of over 160 studies of food price elasticity, Andreyeva et al (2010) find that beef (0.75), pork (0.72) and milk (0.65) have greater elasticity than cheese (0.44) and eggs (0.29). Several studies also find poultry demand elasticity to be significantly lower than that of other meat types. In low excise scenarios (EUR 40-56 per tCO2e), demand is estimated to fall by 8.3-8.5% for beef and 2.3-5.4% for poultry (Roosen et al. 2022; Bonnet 2018). At a price of EUR 100 per tCO2e, Roosen et al. (2022) find a demand effect of 21% on beef and veal and 8.9% for poultry. In a similar high excise scenario, Saell and Gren (2015) find market share reductions of 19% and 4.7% respectively.

Ultimately, the distributional impacts are linked to price elasticities which vary depending on a wider range of socio-economic factors (Caillavet et al 2016; Caro 2018). In their analysis of emissions-based consumption taxes in Spain, García-Muros et al. (2016) find that welfare losses may be experienced to a larger degree by groups with particular social characteristics, such as single parent households, creating a need for carefully targeted compensation policies to correct this effect. Other groups likely to be more severely affected include older and rural households, which tend to follow diets that are rich in animal products. On the other hand, young single adults and urban households are likely to suffer the lowest welfare impacts given that a relatively small proportion of their income is spent on food. When analysing the impacts of carbon taxes on fresh meat in Germany, Roosen et al. (2022) reaffirm that these measures impose a larger burden on low-income than high-income households. However, they also show that disparities are even more pronounced across generations than income groups, with low-income and older households experiencing higher welfare losses than low-income and younger households. Overall, the existing findings from literature indicate that policy impacts on households warrant more detailed assessment in order to prevent aggravation of poverty and widening income inequality within the EU (Stefanovic et al 2016).

It should be noted that, overall, there is a consensus that the negative distributional impacts can be alleviated. The literature highlights in particular combining taxes on less healthy foods with subsidies or exemptions for fruits and vegetables (Nnoaham et al., 2009; Darmon et al. 2014; Cleghorn et al. 2022). When assessing two carbon taxation scenarios with a carbon price of EUR 50 per tCO2e, Garcia-Muros et al. (2016) observe that in one scenario, which incorporates exemptions for specific products such as cereals, fruit, milk, and vegetables, comparable emission reductions can be attained while resulting in significantly reduced welfare losses (0.42%). This stands in contrast to the scenario without any exemptions, which yields a higher welfare loss of 0.74%. This may support the case for a more limited ETS scope, with a focus on the livestock sector. Negative distributional impacts could also be mitigated through the targeted use of ETS revenues. The implementation of the solidarity contribution and the Modernisation Fund under the existing EU ETS, and of the Social Climate Fund using revenues from the new ETS for buildings, road transport and other sectors, can be a source of instructive insights for addressing negative distributional impacts. Overall, conclusions from literature on impacts of carbon taxes on food underscore the importance of accompanying policies and the use of ETS revenues, which have the potential to be a decisive factor in determining the socioeconomic effects associated with the introduction of an ETS for agriculture.

Distributional impacts on Member States

Policy Option	Distributional impacts on Member States
On-farm ETS (all-GHG)	Some Member States are estimated to have higher marginal abatement costs and predicted GDP losses, with Eastern European Member States expected to experience higher GDP/capita losses; cost differences will need to be addressed.
On-farm ETS (livestock)	Option is likely to have a disproportionate impact on Member States with large livestock populations (France, Germany, Spain) as well as Member States whose agricultural emissions are disproportionately caused by livestock (Ireland, Denmark, Austria, Luxembourg).
On-farm ETS (peatlands)	Option will disproportionately affect Member States where farming occurs on drained peatlands and with high levels of emissions from peatlands (Germany, Poland, Ireland).
Upstream ETS	Some Member States are likely to be more impacted than others by the policy option because of their strong farm animal feed and/or fertiliser production sector(s), or agricultural sectors which rely heavily on commercially supplied feed and fertilisers.
Downstream ETS	The distributional impacts on Member States are expected to be similar to the on-farm livestock ETS.

For the on-farm ETS marginal abatement costs (the financial costs associated with reducing greenhouse gas emissions and abatement benefit) will vary considerably between Member States, and thus will have varying economic impacts. Marginal abatement costs can potentially be negative, i.e. when mitigation actions are cheaper than a business-as-usual option, but they often rise as more emissions need to be reduced. Overall, Austria, Netherlands and Sweden are predicted to have higher abatement costs than the EU average. Greece, Romania and Hungary are below the average, while some Member States demonstrate high variance in the spread of abatement costs, such as Italy, Poland or Germany (Perez Dominguez et al 2015).

Member States have generally similar patterns of mitigation potential and abatement costs associated with specific measures, with nitrification inhibitors and precision farming offering high mitigation potential at a low cost, and low nitrogen feeding offering low mitigation potential and a relatively high cost (see indicator 'Incentivise actors along the value chain to mitigate agricultural emissions' for a discussion on abatement costs). However, there are some differences in abatement costs according to Perez-Dominguez et al (2021): Spain has a lower potential from peatland re-wetting, unsurprisingly, because of the low presence of peatlands, but winter cover crops are a much more cost effective measure offering high mitigation potential compared to most other Member States; in Poland, precision farming offers high mitigation potential, but compared to other Member States it would have high abatement costs (almost 100 EUR/t); due to large dairy and sheep herds in Ireland, livestock measures show the highest mitigation potential, especially vaccinations and feed additives, but the abatement costs are comparably higher than in most Member States.

Despite lower abatement costs, GDP/capital losses are expected to be higher for Eastern European Member States compared with Western Member States (Orrecchia & Parrado 2013; Witzke et al 2015). This is because agricultural production in Eastern Member States is less efficient, resulting in higher GHG emissions per unit of economic output. Therefore, facilitating increasing efficiencies in Eastern European Member States will be more cost effective. An on-farm ETS will need to be designed to deal with variations in costs if emission reductions are to be achieved without unnecessarily high costs (Orrecchia & Parrado 2013).

Member States with relatively large livestock sectors may be disproportionately affected as well, meaning that mostly western Member States will be disproportionately impacted. According to Mielcarek-Bochenska & Rzeznik (2018), over 50% of the share of GHG emissions from enteric fermentation in 2018 in the EU came from four countries: France (19.7%), Germany (14.5%), Spain (10.2%) and Italy (8.2%), while Luxembourg, Cyprus, and Malta had the lowest. For some Member States, emissions from enteric fermentation make up the majority of agricultural emissions (over 50%). These Member States include: Luxembourg (58.4%), Ireland (57.9%), Austria (57.0%), Romania (54.6%), Slovenia (53.9%), Cyprus (52.4%), and Portugal (51.4%) (Mielcarek-Bochenska & Rzeznik 2018). The biggest sources of GHG emissions from manure management (CH_4 and N_2O) were Germany, Spain, and France (ibid). Member States for whom agricultural emissions from manure management was over 20% include: Denmark (26.7%), the Netherlands (25.1%), Cyprus (23.7%), Malta (22.7%), and Spain (21.9%).

These emissions statistics are indicative of the livestock populations within these Member States, particularly the cattle populations, as well as the scale of livestock production. Over 73% of the cattle specialist farms are located in 7 EU Member States (Ireland, France, Spain, Germany, Italy, Austria and Poland), with the remaining 27% distributed across the other Member States (European Parliament 2022). The top emitters of CH_4 from enteric fermentation are also the top livestock producers who account for around 60% of the EU livestock supply: France, Germany, Italy and Spain (USDA 2022).

Three Member States alone produce half of the EU's beef: France (21.2%), Germany (17.8%) and Italy (11.1%) (European Parliament 2022).

Therefore, these Member States could be impacted to a larger extent by an all-GHG, livestock or downstream ETS (but also disproportionately affected by an upstream ETS on animal feed), compared to Member States where livestock farming does not make up such a large proportion of GHG emissions, as they would bear the highest overall costs. However, Member States in which agriculture makes up a higher share of GDP (and for which livestock makes up a disproportionate share of agricultural production) will more likely be impacted: in Spain, Poland, Portugal, and Slovenia, agriculture's share of GDP is greater than 2%, whereas the share for France, Denmark and Austria is less than 1.5%, and for Ireland it is lower than 0.9% (World Bank, 2019).

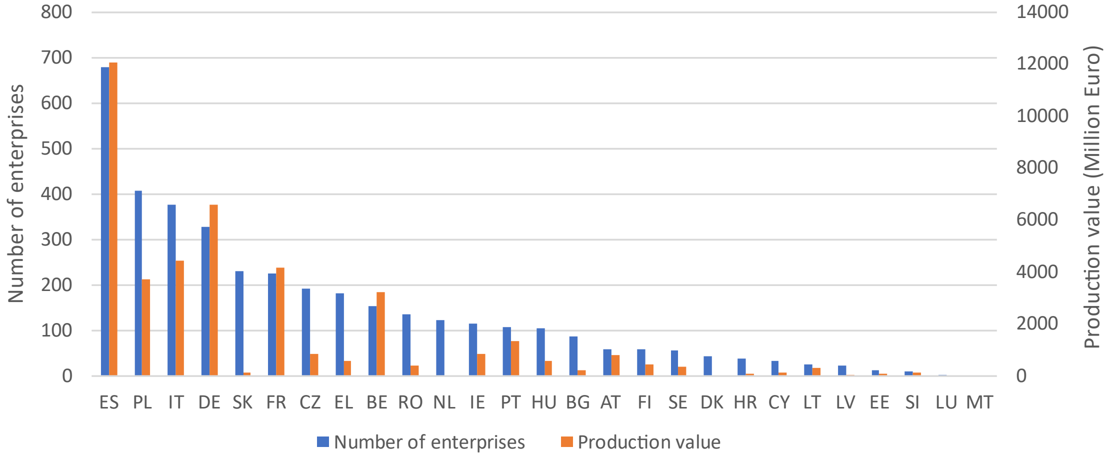
However, if ETS revenues are recirculated back to farmers in proportion to the extent to which the ETS would impact them, then potential negative impacts on agricultural production and related distributional impacts could be mitigated.

The on-farm ETS for peatlands will disproportionately affect Member States where farming occurs on drained peatlands and with high levels of emissions from peatlands (i.e. Germany, Poland, Finland). Transaction costs will be higher in Member States with high numbers of peatland holdings. However, this disproportionate burden does not impact the Member State level as much as it does at the regional level. This is because farming on drained peatlands is distributed unevenly across regions (i.e. the North of Germany would be more affected than other regions in the Member State). Therefore, potential impacts on regional economies will need to be analysed, as well as the potential for targeted public investments that will assist in stabilizing regional economies (Isermeyer et al 2019). Impacts on local populations who may be affected by side effects from re-wetted peatlands, should also be analysed (ibid).

Figure 9 and Figure 10 show that the manufacturers that would be directly impacted by an upstream ETS are concentrated in several Member States:

- For **farm animal feed**, these are primarily Spain, Poland, Italy, Germany, France and Belgium based on the number of companies and production value. Slovakia, Czechia and Greece also have a relatively high number of farm animal feed companies but a low production value. This could indicate these are primarily small manufacturers that would fall below an inclusion threshold, which is recommended for this policy option to minimise administrative burden.
- For **fertiliser production**, the Member States with the most covered manufacturers are likely Spain, Poland, Italy, Germany, France, the Netherlands and Belgium. Austria, Lithuania and Finland also have a relatively high production value compared to the number of enterprises. This could indicate that there are several large fertiliser manufacturers in those countries that would be covered under the upstream ETS.

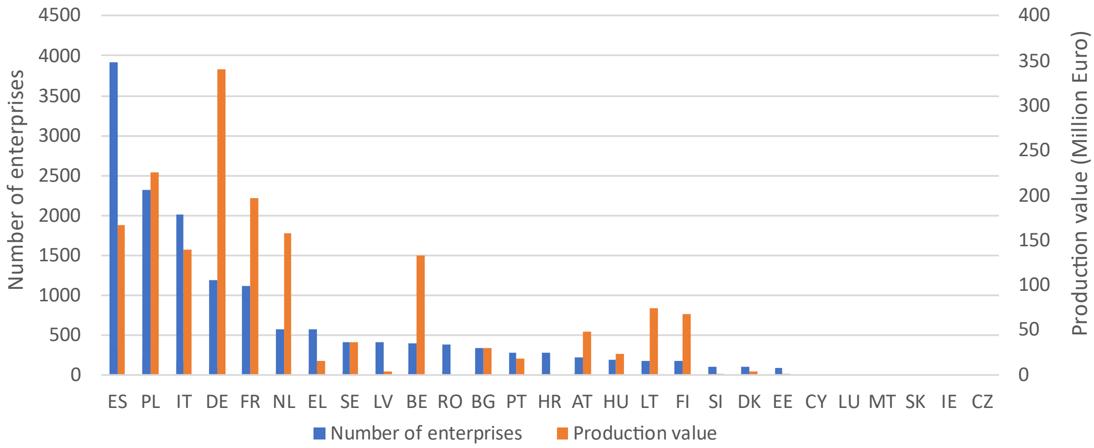
Figure 9 Number of enterprises and production value across the EU for farm animal feed (NACE 10.91), average of 2017-2020



Source: Eurostat Structural Business Statistics

Note: for some countries, no data was available and therefore show as zero value

Figure 10 Number of enterprises and production value across the EU for fertilisers (NACE 20.15), average of 2017-2020



Source: Eurostat Structural Business Statistics

Note: for some countries, no data was available and therefore show as zero value

The degree to which feed and fertiliser manufacturers in the different Member States will ultimately be impacted financially by the upstream ETS depends on the degree to which a carbon price incentivises innovation that will lower their compliance costs, including putting lower-emitting products on the market. Upstream actors could also reduce compliance costs by reducing the production of their higher-emitting products and/or passing on their compliance costs to their customers, i.e. distributors, vendors and ultimately farmers.

Distributional issues between small and large farms

Policy Option	Distributional issues between small and large farms
On-farm ETS (all-GHG)	Differences in farm size can lead to varying mitigation costs. While small farms could potentially be excluded from this option, the EU's largest farms will benefit from economies of scale. CAP funds could be used as a buffer to reduce such discrepancies.

On-farm ETS (livestock)	Smaller farms will be disproportionately affected by an ETS system, and therefore thresholds should be considered. Because livestock is an important risk reduction strategy for vulnerable rural communities, the use of thresholds should be considered based on a cost-benefit analysis for different threshold levels.
On-farm ETS (peatlands)	Exclusion of small farms may limit the objective of peatland restoration and re-wetting. A high share of small farms do not have enough resources for expensive investments to adopt new management practices.
Upstream ETS	Administrative costs will be less problematic for larger entities already complying with the EU ETS, compared to smaller entities that have no prior knowledge of ETS systems.
Downstream ETS	As small processors would not be included, the brunt of the administrative costs would be borne by large-scale processors, who can be expected to be able to cover them. An important asymmetry could arise under the complex approach, which offers possibilities to demonstrate that emissions are below the default emission factor. The associated MRV requirements (which need to occur at the farm level) could be more easily handled by large farms, putting small ones at a disadvantage.

While the on-farm ETS policies for all-GHGs and livestock could implement thresholds, there will still be uneven impacts between farms due to size differences, as these can lead to varying costs (Cooper et al 2013; González-Ramírez et al., 2012; Pérez Domínguez & Fellmann, 2015; Van Doorslaer et al., 2015; Grosjean et al 2016). Some reduction options will require large-scale investments, which may be more accessible to larger farms due to economies of scale (Grosjean et al 2016). CAP funds could be used to reduce discrepancies between large and smaller farms and could also be used to compensate potential 'losers' from the on-farm policy options.

There are a large number of semi-subsistence farms across the EU, but disproportionately in Eastern European Member States such as Romania. For such farms, keeping livestock is an important risk reduction strategy for vulnerable communities (Herrero et al 2016). At the same time, livestock can be important providers of nutrients and traction for growing crops in smallholder systems. In addition, there will be high investment costs, for example, for the construction of facilities to reduce emissions, which may exceed the cost of buying additional certificates to keep the same amount of livestock (Weishaupt et al 2020). Therefore, smaller farms will be disproportionately affected by an ETS system and the use of thresholds should be based on a cost-benefit analysis for different threshold levels.

Distributional issues between large and small farms are quite unique for the peatlands ETS policy option. While for the other on-farm options small farmers would be disproportionately burdened with high transaction and abatement costs, evidence suggests that small farmers cultivating peatlands are more willing to adopt new changes in land management if the financial incentives are high enough, as this may increase their income security (Schaller et al 2011). Larger farms, however, appear less willing to adopt such changes as the more profitable a farm is, the more farmers oppose management changes on cultivated peatlands (Schaller et al 2011). In regions where the average percentage of farms' peatland is high, measures are more likely to be opposed than within regions where farms are affected by only a small amount of acreage (ibid).

Nevertheless, peatland cultivation is essential to the incomes of farmers, and a high share of small farms do not have enough resources for expensive investments to adopt new management practices (Buschmann et al 2020). In addition, geographical aspects and the spatial setting of a farm might be of equal importance to farm size: a farmer who manages peatland at a slightly lower elevation than a neighbouring farmer at a higher elevation bears a much higher risk when entering a re-wetting scheme

(Haefner et al 2021). This is because their fields in the sink would be completely flooded in wetter years, and therefore not be utilized at all for agricultural purposes (ibid).

For the upstream ETS, the difference in direct impact between small and large producers lies mainly in the administrative burden. In the case where compliance entities have to determine and report the GHG emissions associated with their products, there will also be a difference in administrative costs between companies depending on whether they already participate under the current EU ETS. Companies that already participate could build on their existing MRV processes and infrastructure. Other compliance entities would have to set up new processes. This may lead to higher costs for smaller manufacturers compared to larger ones, since large manufacturers are generally already covered under the current EU ETS.

For the downstream ETS the default MRV method will have a comparatively limited impact on small farmers. Even if the certified MRV approach is implemented, the administrative requirements for farmers will be considerably less than under the on-farm options. This reduces the potential distributional impacts between large and small farmers, as all farmers will face the same market prices and opportunities. If a processor can use voluntary on-farm credits, there could be some additional administrative requirements that would disproportionately affect small farms, which have fewer resources to cover additional costs, however, the processor should bear (at least part of) the costs of implementation.

Speed/ease of implementation

Policy Option	Speed/ease of implementation
On-farm ETS (all-GHG)	The use of thresholds for farm size will help to ease the implementation by reducing transaction costs. However, compared to all the other policy options the all-GHG option will have the largest number of participants, making implementation challenging.
On-farm ETS (livestock)	The use of thresholds based on livestock units (LSUs) could ease the burden of implementation, however a large number of farms will be within the scope of the policy even at the highest thresholds (i.e. almost 30,000 farms for threshold above >500 LSUs). In addition, the use of LSUs as a threshold could incentivize livestock farmers to divide their holdings into smaller installations to avoid participation.
On-farm ETS (peatlands)	Because of the need to involve all farms on drained peatlands (number is currently unknown due to lack of data available), the implementation of this policy option will be complex and will most likely occur over a long period of time.
Upstream ETS	Speed of implementation will be facilitated by the small number of regulated entities and their existing knowledge of the EU ETS, but setting emission factors and establishing a cap are expected to be bottlenecks.
Downstream ETS	Option could ease difficulties associated with implementing on-farm policy options, due to lower complexity and smaller number of participating actors.

Many studies highlight the potential challenges associated with implementing an on-farm (all-GHGs) ETS due to the large number of farms within the EU (Ancev 2011; Gerber et al 2010; Perez Dominguez & Fellman 2015; Smith et al 2007). Transaction costs could be particularly burdensome for small farms in the EU (Gerber at al 2010). Therefore, the use of thresholds to exclude smaller farms can ease the policy implementation process, but the exact level of this threshold would require further assessment.

Even with the thresholds considered in this study, this policy option will still have an extremely high number of participants (if small farms < 5 ha are excluded then over 3.2 million farms will still participate). Analysis could be conducted on the proportion of agricultural emissions and mitigation potential that could be covered by an ETS targeting only the largest farms and fewer emissions could be conducted. For example, Grosjean et al (2016) use the Farm Accountancy Data Network (FADN) to establish a Lorenz Curve, which finds that the top 10% of emitters are responsible for 38% of agricultural GHG emissions, while the top 20% emit 50% of the sectoral emissions. Therefore, the threshold capturing the largest (and therefore fewest) farms combined with a high level of coverage of emissions captured by the threshold should be further explored.

For the on-farm ETS for livestock, a framework for the coverage of livestock farms could be based upon the cattle and lowered thresholds for livestock that has been proposed by the Commission under the Industrial Emissions Directive. Using the framework for the IED can ease the implementation of this option despite the large number of farms included under the option. However, it should be taken into consideration that the use of livestock units as a threshold could create a potential incentive to circumvent emissions trading by dividing livestock farms into smaller plants (Weishaupt et al 2020). This could potentially be addressed through similar provisions to those proposed by the Commission as part of the IED revision. In article 70b, the proposal introduces an aggregation rule which would prevent farms from avoiding compliance obligations in this way.

For the on-farm ETS for peatlands, implementation will be complex and will most likely occur over a long period of time for various reasons. First, there is a difficulty in implementing thresholds for participation, as the goal of a peatlands ETS is to incentivize either partial or full restoration of peatlands. Because peatland re-wetting requires collective action at the watershed level (i.e. the groundwater level cannot in many instances be brought about by individual farmers without affecting neighbouring farms), setting a size-based threshold for ETS participation would be counterproductive. Second, there is a lack of data in many Member States for the number of farm holdings on drained peatlands , so more in-depth farm statistics will be needed to assess the impacts of this policy option. Third, due to low levels of agricultural production on peatlands, some Member States lack relevant national systems for peatlands and therefore would need support from the EU to establish such systems. Fourth, a long implementation period will be needed in order to allow farmers the time to adopt new land management practices (such as paludiculture) or engage in re-wetting.

If the upstream ETS builds on existing legislation such as the current EU ETS, implementation time can be shortened. Especially for entities that already have existing compliance obligations under the EU ETS, implementation could be structured to only add an element to their existing compliance obligation instead of introducing a new process. However, for entities not operating in the current EU ETS, implementation will require more time as they will need to set up the necessary MRV processes and infrastructure. Time will also be needed to set emission factors and establishing a cap, both of which being the main bottlenecks of this policy option.

The downstream ETS would ease barriers to implementation compared to the on-farm policy options, due to lower complexity and smaller number of participating actors. A downstream ETS that covers processors with 50 or more employees would put a price on approximately 82% of emissions associated with meat production and 91% of emissions linked to dairy production, while only requiring a total of about 1.600 processors to participate in the ETS. This would limit transaction costs for trading and surrendering emission permits and hence be administratively substantially less demanding than an ETS in which farms are the regulated entities.

Stakeholder acceptance

Policy Option	Stakeholder acceptance
On-farm ETS	The majority of stakeholders consulted for this study agree that increased climate ambition for the agricultural sector is needed and that carbon pricing is an effective mechanism to facilitate mitigation. Regarding the point of obligation, the on-farm options were the least supported, but nevertheless still received overall neutral ratings, rather than being viewed in negative terms by stakeholders, with those identifying as 'farmers' generally less supportive than overall opinion. Many agricultural stakeholders consider agriculture to be a special case and anticipate the administration of a potential on-farm ETS likely to be challenging.
Upstream ETS	Stakeholder feedback indicates that the upstream model was generally viewed as a neutral option by all stakeholders, including those from the fertiliser and feed producer sectors.
Downstream ETS	Stakeholder feedback indicates that a downstream policy option is the most preferred point of obligation, with overall positive support among stakeholders.

The stakeholder acceptability of the on-farm policy options may be challenging, as farmers may be less willing to adopt mitigation practices if they are required to do so – indeed, recent research by Barreiro-Hurle et al (2023) in which the authors conduct a behaviour experiment with farmers, indicates that mandatory requirements for farmers decrease voluntary contributions to the environment. Other studies have demonstrated a reluctance among farmers to adopt practices to reduce emissions on their farm (Tzemi & Breen 2018). However, a pricing instrument such as an ETS is designed to incentivise actors to take the most cost-effective measures to reduce emissions, and evidence indicates that farmers are willing to uptake mitigation practices they consider to be the most cost-effective (Felciano et al 2014).

Nevertheless, findings on the attitudes of farmers towards mitigation demonstrate that farmers consider agriculture to be a 'special case' that should be exempt from complying with GHG emission reduction targets (ibid). The livestock sector may be particularly resistant to reducing GHG emissions (see Box 12 below for an overview of the challenges in implementing a livestock to land ratio policy in the Netherlands). Therefore, understanding and integrating stakeholder views is elemental for success in mitigation in agriculture, in order to draft a policy measure that they will accept and implement (Sorvali et al 2021). Two of the experts interviewed for this study also observed that effective communication around the economic benefits of certain mitigation measures at farm-level was important to alleviate farmers' concerns (ranging from e.g. the reduction in synthetic fertiliser application without a negative impact on yields to solar panel installation on organic soils).

Box 12 Proposed programme for the buyout of livestock farms - key lessons from the Netherlands

The Netherlands has the highest density of livestock in Europe, with more than 100 million cattle, chickens, and pigs in total. The Dutch government has a €25 billion plan to radically reduce the number of livestock in the country, of which €7.5 billion is allocated towards buying out livestock farms. The plan is aimed at reducing nitrogen pollution but will also have co-benefits for water protection and GHG emissions. The plan is not just for farmers but will also be used to buy land for nature conservation. The proposal for tackling nitrogen emissions indicates that there will be radical cuts in livestock numbers – the government has estimated that 11,200 farms will have to close, and another 17,600 farmers will have to significantly reduce their livestock populations. This result is expected to be close to 1/3 of a reduction in livestock numbers in the Netherlands.

The Dutch government is dividing the Netherlands into a map with regions zoned on soil, water, and biodiversity quality. Each specific region and its farmers will be assigned nitrates reduction targets, ranging anywhere from 12-70% by 2030. These targets apply at the regional (rather than farm) level.

The plan consists of 4 options:

1) Farmers in some areas deemed environmentally suitable by the government will be supported to invest in farm innovation to make their enterprises more sustainable. This funding will come from the 25B fund;
2) Measures will be introduced to 'extensify' livestock production with less animals, as well as encouraging farmers to sell their products regionally. For highly stocked dairy farmers, there will be supports to move from their intensive systems to less intensive farming practices. The Dutch government is proposing to buy some of these farmers' debt and enable them to 'start over';
3) For those who wish to retain their current practices, when in areas which are zoned to have exceptionally poor soil and water quality, or are near a nature conservation area, these farmers will be asked to relocate to other parts of the country;
4) The last option will involve the complete (voluntary) buyout of farms. The objective of buyouts is to support farmers who do not have a successor to exit the sector and return their land to nature. If an insufficient number of farmers volunteer to sell their land, laws will be applied for mandatory buyouts (similar to governments purchasing of farmland on planned motorway routes). However, forced buyouts are a scenario the government would like to avoid.

Initially, the reaction from the livestock sector was mixed. However, even before the plan was announced, various Dutch farmer organizations were calling for protests, emphasising the need for support from the government. The protests have received a significant amount of media attention around the globe. In addition, Dutch political parties are divided over whether the programme should be implemented. This experience with the introduction of the livestock programme highlights the challenges associated with the political feasibility of a comprehensive policy option targeting emissions from livestock.

The original plan, called MGO, was proposed in 2020 and had a €300 million budget aimed at buying out dairy, poultry and pig farms that emit large amounts of nitrogen close to vulnerable nature areas. MGO is considered a failure since the 12 provinces have not bought a single farm using the MGO programme in two years. 150 farms initially showed interest but over half have dropped out during negotiations, and the rest have not been bought as of yet. This highlights the challenges faced in reducing livestock numbers through financial incentives – while the free allocation of allowances may incentivise farmers to adopt technical mitigations, it may not be enough to incentivise the reduction of livestock numbers.

In 2022, the Dutch government proposed the MGA2, intended to replace the MGO scheme. MGO has been the subject of criticism by the agricultural sector, with many farmers exiting the program, because of the prohibition of profession rule – under MGO livestock farmers are not allowed to start a new livestock farm elsewhere in the NL. With the introduction of MGA2, the prohibition would be lifted, encouraging farmers to wait to sell their farm until the new scheme is implemented. But this is causing concerns in the European Union, as bought-out Dutch farmers may go to other countries, such as e.g. Hungary or Poland, pushing out the local farmers and disrupting the European market. Importantly, this could lead to carbon leakage effects within the EU, as the polluting activities shift from one Member State to another. Overall, the challenges faced at the Member State level in the Netherlands highlight the added value of an EU-wide livestock policy to avoid such impacts.

For the off-farm ETS options (upstream and downstream), existing studies point to potential political opposition to fertiliser and meat taxes (e.g. Söderholm and Christiernsson 2008; Rougoor et al 2010), which could also be expected under the upstream and downstream ETS options. Redirecting the revenues to the feed and fertiliser manufacturers and meat and dairy processors (e.g. support research in low-emitting products) and farms (e.g. support for the deployment of climate-friendly equipment and practices), as well as proposed exemptions on small entities, could reduce opposition,[93]. Nevertheless, imposing new costs on feed and fertiliser manufacturers or food processors that would be at least partially passed on to farmers is expected to be contentious in a context of high prioritisation of food security as a political objective following Russia's invasion of Ukraine.[94]

To gauge initial stakeholder acceptability, the consortium conducted a stakeholder survey (n=91) which provides insights into the views of relevant stakeholders of the proposed ETS policy options in this study. One quarter of stakeholder respondents are active in agriculture (food and/or feed) (n=27; 25%), food processing (n=17; 16%) and manufacturing of fertilisers, feed or other agricultural input (n=10; 9%). Respondents indicating "Other" belong to organisations on carbon certification programmes, industry associations, thinktanks or consumer organisations. Respondents within the agriculture and food processing sectors were asked to specify their sub-sector of operation. The majority of those from the agriculture sector were active in mixed farming (n=14; 52%), followed by crop farming (n=7; 26%).

Results from the stakeholder survey indicate that the majority in all stakeholder groups supported a significant or slight increase in policy action to reduce agricultural emissions. One third of the respondents thought that putting a price on GHG emissions from the agriculture sector to incentivise GHG emissions reduction in that sector is very effective (n=30; 33%), and a further 28% (n=25) thought it was somehow effective. On the other hand, a smaller proportion of the question's respondents stated that doing so would have a limited effectiveness (n=16; 18%) or not be effective at all (n=15; 17%). In the open-ended responses, 7 respondents emphasised their support for carbon pricing on agricultural GHG emissions, explaining that it is an effective tool to reduce emissions or that it would help the business case for more efficient products and technologies. Conversely, 14 respondents indicated that they opposed carbon pricing in the sector due to concerns about food security, negative impacts on (small) farmers, and/or the risk of production being moved to countries with less stringent requirements (carbon leakage).

When providing feedback on which agricultural value chain actor should be the compliance entity under an ETS, the survey results indicate a preference for food processors as the compliance entity (with an

[93] https://www.sciencedirect.com/science/article/abs/pii/S1462901107001189 ; http://dx.doi.org/10.1080/09640560120087615
[94] https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/ensuring-global-food-supply-and-food-security_en

average rating 4.0 out of 5) – 43% of respondents rated the option as a 5 (strongly agreeing to a downstream option) and only 10% rated the option a 1 or 2 (strongly disagree or disagree). Among respondents from the food processing industry, the downstream option received a rating of 3.83. The upstream option was less favoured compared to the downstream option, with 32% of respondents rating the option as 5 (strongly agree), while 19% rated it a 1 (strongly disagree). Nevertheless, the overall rating was still more positive at 3.4. Among respondents from the fertiliser and feed producers industry, the option received a score of 3.22. Selecting farmers as the compliance entity was the least favoured option but nevertheless still received an overall positive response (with an average rating of 3.17 out of 5) – 27% of respondents rated the option as a 5, while 22% rated the option as a 1. Among respondents who identified as 'farmers' within the agricultural sector, this option received a less favourable response, with an average score of 2.58 from respondents.

Table 26 Responses to Stakeholder Survey Regarding Obligated Compliance Entity

Response	1	2	3	4	5	No opinion	Average rating	*n*
Food processors (downstream ETS)	6%	4%	17%	20%	43%	10%	4.00	*70*
Other actors (e.g., retailers, consumers)	15%	2%	12%	18%	23%	30%	3.48	*60*
Fertiliser and feed producers (upstream ETS)	19%	7%	14%	18%	32%	11%	3.40	*73*
Farmers (on-farm ETS)	22%	11%	14%	15%	27%	11%	3.17	*73*

Respondents presented differing views regarding the feasibility of the ETS options. A majority of respondents (n=46, 63%) agree that a downstream ETS would be either somewhat or very feasible. About half of respondents (n=36, 49%) rate an upstream ETS option as either very or somewhat feasible. An on-farm ETS sees the lowest respondents' scores for feasibility with 6 respondents rating it as very feasible compared to 12 respondents seeing the option as not feasible at all. For 10 of these 12 respondents, their main activity was in the agriculture (food and/or feed) sector.

Respondents were also asked how upstream producers or downstream processors should meet their compliance obligations under the upstream or downstream ETS options: the most frequently chosen option was to make upstream or downstream actors pay farmers within their own value chain (r=31; 42%). This indicates support for including a policy design option such as the 'certified on-farm voluntary credits in which obligated parties can purchase credits generated by non-obligated parties who have taken mitigation actions on-farm.

New Zealand has been an important testing ground for both the practicalities and the politics of establishing an on-farm carbon pricing policy. Interviewees involved in the development of a carbon pricing policy for agriculture in New Zealand stressed the importance of stakeholder feedback throughout this process. Earlier attempts to integrate agriculture into its ETS failed on several occasions due to political opposition.

After failing again to incorporate the sector into the ETS in 2017, the incoming Labour Party government introduced an Interim Climate Change Committee, later to be established as the New Zealand Climate Change Commission[95]. The committee was charged in particular with looking at how best to incorporate agricultural emissions in the ETS; the Committee's report in 2019[96] recommended a farm-level levy-rebate scheme for livestock emissions (by far the largest source of NZ agricultural

[95] Climate Change Response (Zero Carbon) Amendment Act 2019
[96] ICC Action on Agricultural Emissions Report, 2019

emissions), which should be linked to the ETS cap-setting process, with levy rates set annually to align with the ETS price. The Government has adopted this recommendation, and now aims for the introduction of a pricing mechanism by 2025 outside of the framework of the NZ ETS[97]. Proposals were taken forward by He Waka Eke Noa, which is a partnership between the government, farming sector, and Maori to measure, manage, and reduce emissions in agriculture.

In its recommendations, the He Waka Eke Noa partners asked farmers and growers about policy options in February and March 2022, before giving advice and putting forward a preferred recommendation to the Government in May later that year. The Partnership involved stakeholder feedback from farmers and growers in considerations of the trade-offs between the options when preparing final recommendations. Such inclusion of stakeholder feedback has been integral to progress being made in finalising a carbon pricing mechanism for the agricultural sector in New Zealand, which it intends to finalise before 2025. Two options have been proposed, including a farm-level carbon levy and a processor-level carbon levy, and the government has included a 'backstop' option if no agreement is finalised before 2025, in which agriculture would be enrolled in the NZ ETS.

Efficiency

Impacts on sectoral competitiveness and trade balance

Policy Option	Impacts on sectoral competitiveness and trade balance
On-farm ETS (all-GHG)	The policy option could reduce output for the livestock sector, while impacts on crop production are more moderate, with some crop producers increasing production. Some farmers will earn additional revenues through the trading of emission certificates, although this would depend on whether there are free allocation of certificates. Net imports are expected to increase, while EU agricultural exports will go down, leading to a worsening of EU trade balance for livestock-based products in particular. However, If a CBAM for agriculture is introduced, the impact on trade flows could be mitigated.
On-farm ETS (livestock)	The economic precariousness of stable income for cattle farmers combined with higher levels of emissions means that these producers will be the most likely livestock farms to be negatively impacted. Imports are expected to increase and export-dependent producers could potentially be harmed. Abatement opportunities using technical options have limited emissions reduction potential, and therefore cattle farmers will need to reduce livestock numbers. If meat importers were covered by a CBAM, the impact on trade flows could be mitigated.
On-farm ETS (peatlands)	Farm income for those producing on cultivated peatlands will be impacted. However, for the agricultural sector as a whole, there is enough land available for agricultural expansion on mineral soils. Evidence suggests that peatland protection and restoration measures hardly increase the whole system costs on top of costs for agricultural production and therefore negative impacts on the sector's competitiveness are not expected. Trade patterns are not expected to be impacted by a peatlands policy option.
Upstream ETS	Minimal impacts on competitiveness of regulated entities are expected due to the proposed design of the upstream ETS to include importers, but there is a risk of impact on farmers. Minimal impacts on trade balance/investment flows expected for feed manufacturers due to limited existing trade, and for fertiliser manufacturers if importers are covered as proposed in the upstream ETS.

[97] "Towards a productive, sustainable and inclusive economy: Aotearoa New Zealand's First Emissions Reduction Plan", NZ Government June 2022, chapter 13

Downstream ETS	Similar to the Livestock ETS, livestock farms will be negatively affected. If importers of meat were integrated into the ETS or CBAM was extended to cover meat importers, the impact on trade flows could be mitigated.

The EU agricultural sector currently performs well when it comes to its competitiveness, globally it is the top trader of agri-food products. In recent years, the EU agricultural sector has increased its contribution to the EU's total exports. This position has remained stable despite recent challenges posed by geo-political circumstances, such as the war in Ukraine: EU agri-food trade totalled over 400 billion EUR in 2022, with a positive trade balance of 58 billion EUR.[98] Despite price increases, volumes of agri-food products traded have not decreased, and in some areas have increased (cereals), with exports increasing 31% compared to 2021 (ibid). The top exports include: cereals and cereal preparations (€23 billion), as well as animal products (ibid), with dairy accounting for almost half of exported animal products, followed by pigmeat, and poultry and eggs. Imports to the EU also increased in 2022, by 32%, with top imports including oilseeds and protein crops, fruits and nuts, coffee, tea, cocoa and spices, and cereals. Table 27 below provides a comparison of EU agri-food exports and imports for 2022.). This surplus is based on an overall trend for the past two decades, as between 2002 and 2021, EU trade in agricultural products more than doubled. In this period, exports (5.4 %) grew faster than imports (4.2 %) (Eurostat 2022).

Table 27 EU Agri-Food Exports and Imports in 2022 (in million EUR)

Agri-food Category	2022 Exports	2022 Imports	2022 Trade Balance
TOTAL	229 810	171 768	58 041
Cereals	16 856	12 745	4 111
Cereal preparations	22 935	4858	18 078
Dairy products	20 403	2 550	17 853
Mixed food preparations and ingredients	14 871	6 700	8 171
Vegetables	8 265	5 070	3 196
Preparations of fruit, nuts and vegetables	10 496	6 512	3 984
Fruit and nuts	6 0222	22 196	-16 174
Sheep and goat	679	1 313	- 635
Sugar and isoglucose	619	1 399	-779
Horticulture	4 479	2 097	2 381
Pigmeat	13 819	373	13 446
Oilseeds and protein crops	2 517	25 799	-23 281
Coffee, tea, cocoa, and spices	7 400	21 944	-14 545
Beef and veal	4 334	2 597	1 736
Poultry and eggs	5 931	2 284	3 647
Other animal products	8 204	6 083	2 121

From an economic point of view, around 22% of the value of EU total agricultural production is of animal origin and more than 60% of EU agricultural area is used for feeding animals (Eurostat 2022). In

[98] https://agriculture.ec.europa.eu/system/files/2023-04/monitoring-agri-food-trade_dec2022_en.pdf

2018, the EU-28 was the world leader in milk production at 166 billion litres (Eurostat 2019). The EU is the second largest pig meat (pork) producer with 24 million metric tonnes of carcass equivalent (tce), and the third largest for both poultry meat production (15 million tce) and beef meat production (8 million tce) (Eurostat, 2019). The EU cattle herd is already shrinking, due to high input costs and environmental restrictions.[99] Despite increasing cattle carcass, beef and cow herds are forecast to continue declining between 2022 and 2032 by 9.1%, particularly in France and Germany due to the limited availability of fodder and high feed prices (ibid) resulting from extreme weather conditions during the summer that impacted corn crops, and high energy prices. Many cattle farmers are already giving up production, despite already receiving the highest level of subsidies in the agricultural sector. While dairy herds are also expected to decrease, EU milk production is predicted to go down only by 0.2% and the EU's position as the largest global dairy supplier is not expected to be jeopardised (ibid).

However, despite declining herd sizes for cattle and dairy, the EU as a whole is largely already self-sufficient in beef, producing more than is consumed domestically each year, with an export surplus of about 8-10% of production (see. Table 27 above). A very small quantity of beef is imported (about 4% of production), mostly imported from the UK as well as higher-value product from South America.[100] The European net exports of animal products rose by more than threefold between 2000 and 2019 when they reached €33.7 billion (these trade figures do not include intra-Community trade).[101]

Impacts on sectoral competitiveness and trade balance will be highly dependent on whether the ETS option includes free allocations to mitigate the costs, or if a CBAM for agriculture is introduced, both of which could reduce the potential negative impacts from price pressures of imports.[102]

A study by Perez Dominguez et al (2016) provides insight into whether an ETS policy would reduce agricultural output, estimating that the introduction of a 20% GHG reduction target for the sector could reduce Utilised Agricultural Area (UAA) output up to 3.1%. Within the sector, impacts of GHG reduction efforts are predicted to have a disparate effect on the livestock industry, while impacts on crop production are more moderate. Perez Dominguez et al (2016) provide estimates of reductions in agricultural output based on GHG reduction targets, with and without the voluntary uptake of mitigation technologies: a 20% GHG reduction target for agriculture reduces crop output between 0.1 (fruit ad vegetable crops) and 1.3% (other crops), cereals will go down by 4.4%. while dairy goes down by 3.4% and beef by 16.1%; however, with the uptake of mitigation technologies, the estimated impact on cereals is -3.1%, while beef is -10.2%, -and dairy is -3.2%. A decrease in cereal production is connected to a decrease in demand for fodder as a result of a decline in livestock production.

There are also estimates of impacts on agricultural production based on carbon prices. Orrecchia &. Parrado (2014) estimate that a carbon price of €41.4/tCO2e will reduce the output of crop production by ~0.08 to 0.56% in Western Europe and 1.10 to 1.27% in Eastern Europe, while livestock output is expected to go down by 2.82% in Western Europe and 2.27% in Eastern Europe. Perez Dominguez et. al

[99] https://agriculture.ec.europa.eu/news/eu-agricultural-outlook-2022-32-production-growth-major-agricultural-sectors-slow-down-2022-12-08_en
[100] https://agriculture.ec.europa.eu/system/files/2023-04/monitoring-agri-food-trade_dec2022_en.pdf
[101] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Extra-EU_trade_in_agricultural_goods#EU_trade_in_agricultural_products:_surplus_of_.E2.82.AC33_billion
[102] It is possible that the introduction of additional measures may have a limited impact on the imports of certain agricultural products traded under tariff-rate quotas (TRQs). This may be the case where high domestic-border price differentials exist and the TRQs are binding, with imports constrained by the over-quota duty. However, the share of TRQs with binding quotas appears to be low and the overall significance of those to ETS impacts on trade balance is likely to be minimal.

(2010) estimate that a carbon price between 73 and 89 EUR/tCO2e will reduce beef production by 8%, sheep and goat will fall by 3%, while dairy and pork production do not change, and poultry production increases.

It should be noted that the reduction in output modelled by Perez Dominguez et al. (2010) does not account for a potential recycling of ETS revenues back to the sector (e.g. to promote innovation, equitable outcomes for farmers, or the provision of ecosystem services) that may mitigate the impact of carbon pricing on agricultural output. The impacts on production are projected to be larger for a stronger cap if there are no increases in subsidies for farmers, but the impacts are lessened by the uptake of mitigation technologies (Perez Dominguez et al 2016).

Under emissions pricing scenarios for the agricultural sector, net imports are expected to increase, while EU agricultural exports will go down: Fellman et al (2015), Witzke et. al (2015), and Perez Dominguez et al (2016) find that almost all agricultural EU exports decrease leading to a worsening of the EU trade balance. The authors conclude that despite increases in prices of emission-intensive products, established consumer habits force their compensation by imported goods. However, both Perez Dominguez et al (2016) and Witzke et al (2015) find that impacts on worsening trade balance can be reduced by at least one-third when technical mitigations are voluntarily adopted.

Table 28 below provides estimated impacts on exports and imports based on a 20% GHG reduction target for the agricultural sector by 2030 (compared to 2005) from Witzke et al (2015) and Perez Dominguez et Al (2016). It shows the estimated impacts of three scenarios: 1) without technological mitigation at farm level, 2) with technological mitigation options available to farmers on a voluntary basis, and 3) with technological mitigation options available to farmers on a voluntary basis and supported with an 80% subsidy. The modelling results show that the negative impacts on trade balance are significantly less pronounced when subsidies for technological mitigation are provided to EU farmers, especially in relation to beef, pork and dairy products, compared to the no subsidy scenario. This suggests that the recycling of ETS revenues to encourage climate mitigation by farmers would likely alleviate negative impacts of carbon pricing on trade.

Table 28 Estimated impacts of GHG reduction targets on trade, with and without voluntary adoption of mitigation technologies, and with subsidies for their adoption

Output Activity	Imports/Exports	20% GHG reduction target - impact on trade			
		No technological mitigation options available	Technological mitigation options available but not subsidised		80% subsidy for the voluntary application of mitigation technologies
		Witzke et al (2015)	Witzke et al (2015)	Perez-Dominguez et al (2016)	Perez-Dominguez et al (2016)
Beef	Imports	235.9%	64.3%	28.5%	22.5%
	Exports	-93.5%	-62.1%	-65.3%	-46.5%
Dairy	Imports	41.7%	9.9%	11.6%	1.0%
	Exports	-20.0%	-7.2%	-8.4%	-1.5%

Pork	Imports	222.0%	64.4%	51.3%	15.0%
	Exports	-51.5%	-21.7%	-38.0%	-13.6%
Veg. and perm. Crops	Imports	2.1%	0.8%	1.3%	1.3%
	Exports	-1.6%	-0.8%	-1.0%	-1.3%
Other arable crops	Imports	-1.3%	-2.5%	-3.1%	-8.2%
	Exports	-6.0%	-1.7%	-1.5%	-1.3%
Cereals	Imports	83.0%	28.6%	2.8%	5.1%
	Exports	-22.7%	-9.2%	-4.0%	-4.4%

With the estimated impacts on production and trade expected to be largest for beef, cattle producers will be the most likely livestock farms to be impacted. Indeed, beef may become the least profitable sub-sector for livestock, and farmers may expand their business into more profitable sub-sectors such as dairy, since dairy is estimated to have comparatively smaller impacts (Donellan et al 2014). Cereals imports and exports will be impacted by changing livestock production, however, the trade impacts for vegetable and permanent crops will be comparatively very small; in the case of 'other arable crops, exports will only go down slightly, but imports will not increase.

While the potential impact of livestock producers transferring production to other sub-sectors should be further analysed, future studies will need to consider that the EU already has a low percentage of imports of beef, with the UK and South America as its main competitors. In addition, the implementation of a CBAM should be integrated into future analyses when examining impacts on the livestock sector.

For the on-farm ETS for peatlands, the realization of mitigation measures often implies land use changes with important socio-economic implications. Impacts of re-wetting will depend on how the land is utilized afterwards: after re-wetting the land could fall fallow, and no commercial use will take place. If this is the case, then the sector will lose the production and economic contribution of the output from the land that has been discontinued (Isermeyer et al 2019). Further, there are costs from hydraulic engineering measures that are required for re-wetting (ibid). Krimly et al (2016) estimate that compared to other land management practices on peatlands (i.e. paludiculture), the complete re-wetting of an area has high abatement costs and causes the highest loss in gross farm income, with the highest income losses per hectare for peatlands used as arable land compared to conversion of grassland into wet grassland.

In pricing emissions from drained peatlands used for agricultural purposes, the economic costs will be felt immediately by landowners, who will have to purchase emission rights to continue using this land for production purposes (Isermeyer et al 2019). If the price of emission certificates is higher than the landowner's income from agricultural production, landowners will most likely sell their land (which may plummet in value due to these costs) (ibid). Such a scenario could be mitigated by establishing a long period for implementation of an emissions trading system and offering landowners a minimum guaranteed price for selling emission certificates. This minimum auction price needs to be high enough for a long enough period of time to provide an incentive for farmers to decide jointly to rewet.

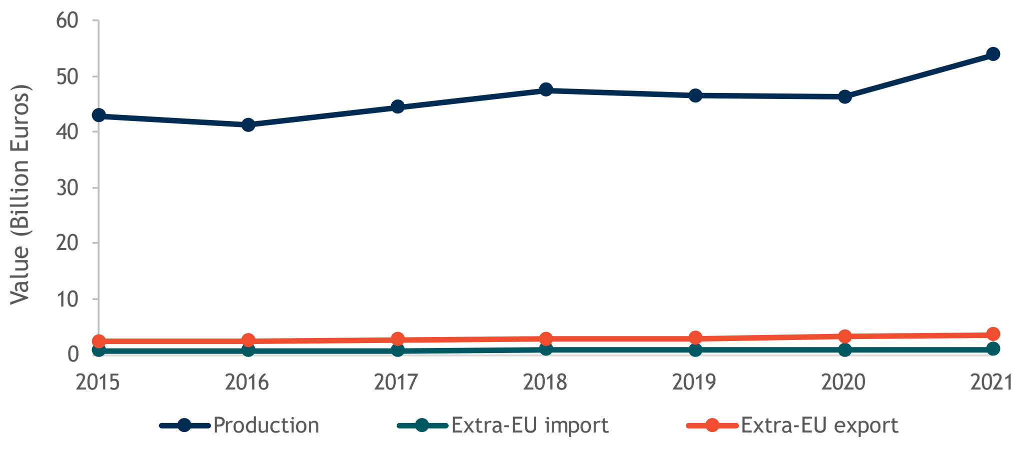
However, while production may shift between regions (from peatland soils to mineral soils) or between Member States, evidence suggests that global trade patterns are not altered by peatland protection and restoration policies (Humpenoeder et al 2020). Despite abatement costs and impacts on farm income, in their cost-benefit analysis, Isermeyer et al (2019) estimate that in the long-term, the economic benefits of re-wetting peatlands outweigh the costs. In particular, paludiculture is a favourable land use alternative with low abatement costs even when investment costs are comparably high (Buschmann et al 2020). Taking into account potential costs, market revenues, additional income from subsidies and profits, peatlands managed under paludiculture can be economically viable under moderately favourable conditions (Tanneberger et al 2020). However, wet peatland management is only interesting to farmers if the sum of the revenues significantly exceeds the total costs (ibid).

For the agricultural sector as a whole, there is enough land available for agricultural expansion on mineral soils (Hein and van der Meer 2012). Evidence suggests that peatland protection and restoration measures hardly increase the whole system costs on top of costs for agricultural production (Humpenoeder et al 2020).

For the upstream ETS, minimal impacts on competitiveness of regulated feed entities are expected due to the proposed design of the upstream ETS to include importers. Almost all of the EU **farm animal feed production** (NACE 10.91) is consumed within the EU with little reliance on imports. This reflects the findings of Wesseler et al. (2015) that in the EU farm animal feed is mainly produced and consumed in the same country.[103] However, fertiliser production is much more internationally-oriented, and therefore potential cost increases of EU-produced fertilisers due to the upstream ETS could risk affecting their international competitiveness.

The risk of the upstream ETS affecting the international competitive position of EU animal feed producers and impacting the trade balance is limited at a sector level, particularly if importers are covered under the upstream ETS and exporters exempted. Over the past years, feed imports from outside the EU only constitute 2% of the EU demand (see Figure 11 below).[104] In addition, on average only 6% of the EU production is exported to countries outside the EU. EU producers of farm animal feed therefore mainly operate on the EU market. While the impact on trade in agricultural goods would depend on the level of price pass-through to farms, the fact that there is currently a low level of imports and exports of feed, would potentially moderate the impacts of an on-farm ETS.

Figure 11 EU value for production, extra-EU import and extra-EU export for farm animal feed (NACE 10.91)

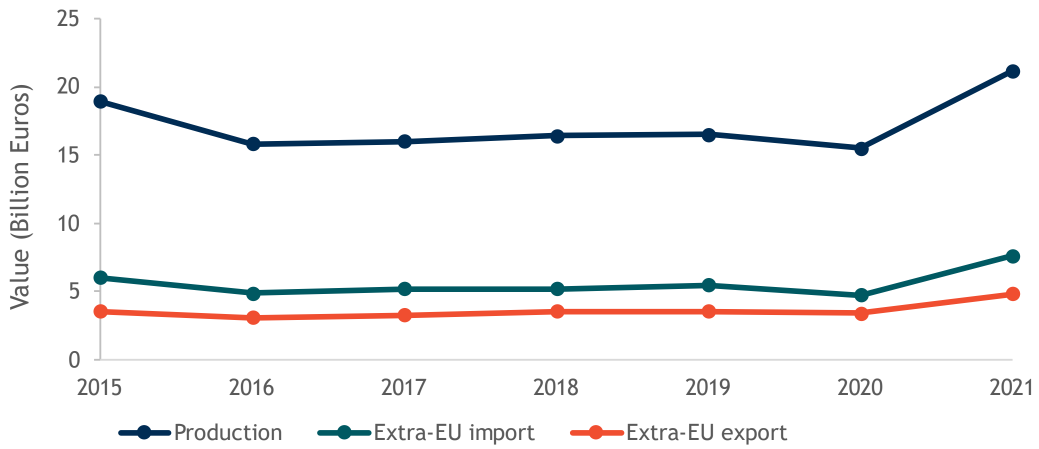


[103] https://www.europarl.europa.eu/RegData/etudes/STUD/2015/563385/IPOL_STU(2015)563385_EN.pdf
[104] Demand = production + import - export

Source: Eurostat Comext

Potential cost increases of EU-produced fertilisers due to the upstream ETS could therefore risk affecting their international competitiveness and carbon leakage risk, impacting the trade balance if importers are not covered under the upstream ETS and exporters not exempted. Figure 12 shows that over 2015-2021, imports from outside the EU fulfilled 29% of the EU demand. In the same period, 21% of EU-produced fertilisers were exported to countries outside the EU. Including imported fertilisers and exempting exported fertilisers would therefore be important to limit the potential negative impacts on the trade balance.

Figure 12 EU value for production, extra-EU import and extra-EU export for fertilisers (NACE 20.15)



Source: Eurostat Comext

The downstream ETS could have negative impacts on sectoral competitiveness, and even stronger ones relative to the on-farm ETS options, as fewer mitigation measures will be recognised, giving the sector less ability to cost-effectively mitigate and therefore reduce emissions obligations and associated costs. However, the use of certified on-farm voluntary credits can expand upon recognised mitigations, and therefore increase options for cost-effective mitigations.

However, if importers of meat were integrated into the ETS or CBAM was extended to cover meat importers, then the impact on trade flows would be more limited. It would be relatively straightforward to implement these options within the processor-level ETS, relative to whole-farm ETS, given the equivalent points of obligation. If such measures were not implemented, the processor-level ETS is likely to have slightly larger impacts on trade flows due to the slightly higher costs relative to whole-farm ETS (due to fewer mitigation options being recognised by the processor-level ETS).

Risk of carbon leakage

Policy Option	Risks of carbon leakage
On-farm ETS (all-GHG)	Increasing agricultural production outside the EU is expected to increase particularly for the livestock sector (although less of an impact on crop-based production is expected), therefore increasing non-EU agricultural GHG emissions. However, the risks can be reduced with multilateral agreements, free allocation, and/or a CBAM.

On-farm ETS (livestock)	Similar to the on-farm (all GHG) option, the pricing of emissions from livestock could instigate leakage effects with the risk of livestock production moving outside of the EU, depending on the price. Similar to the all-GHG option, the risk can be reduced with multilateral agreements, free allocation, and/or a CBAM.
On-farm ETS (peatlands)	Option has low risk of carbon leakage. Additional emissions from shifting production to mineral soils will only account for a fraction of the avoided emissions from peatlands.
Upstream ETS	Option has risk of carbon leakage downstream of the value chain at the farm-level.
Downstream ETS	If imports are not covered, carbon leakage might be a substantial risk, especially for meat. Yet, the downstream ETS lends itself to addressing all emissions on the consumer side (i.e. including imports), thus addressing carbon leakage.

Based on predicted impacts to trade, agricultural emissions, namely those in the livestock sectors, in non-EU countries are expected to increase for the on-farm all-GHG ETS, on-farm livestock ETS and downstream ETS, therefore limiting the mitigation benefits (Cooper et al 2013; Gerber et al 2010; Gonzalez-Ramrez et al 2012; Murray & Baker 2011; Perez Dominguez & Fellman 2015; Van Doorslaer et al 2015). There are varying predictions of the degree to which emission reductions within the EU will be negated by increasing emissions outside the EU, and thus it is unclear what the magnitude would be. Leip et al (2010) find that an ETS for agriculture would reduce emissions in the EU by 20%, but livestock emissions would increase 6% outside the EU, while Van Dooerslaer et al (2015) find a leakage rate exceeding 100% in some scenarios, which would make an ETS environmentally ineffective. Most studies find the largest leakage impacts with the livestock sector, for example Fellman et al (2018) find that the share of EU mitigated emissions offset by emission leakage may be as high as 91%[105], with over 90% of the leakage caused by EU imports of animal products. Estimates of mitigation leakage rates for production of cattle and dairy herds range between 25% to 65% (Zech & Schneider 2019; Golub et al 2010Gerber et al 2010; Grosjean et al 2016). Because production costs will rise, marginal livestock farmers whose profits are already at the limits of profitability will only continue producing if beef or dairy prices rise with the price of emissions (Isermeyer et al 2019). It should be noted, however, that thes scenarios modelled in these studies do not include free allocation or make assumptions about targeted use of carbon pricing revenues. bo These and other anti-leakage measures have been examined for other sectors (e.g. those covered by the EU ETS), and are likely to be key in determining the leakage outcomes. Some authors also find that unilateral emission reduction policies in agriculture can lead to a loss in competitiveness rather than to significant emission leakage effects (Matoo & Subramaniian 2013).

Grosjean et al (2016) argue that the literature on emission trading systems has generally overestimated carbon leakage in modelling predictions compared to ex-post evidence. This view was supported by one of the interviewees who highlighted that the commonly used models did not capture marketing benefits and the enhanced access to some markets due to improved sustainability credentials. As the EU is an open economy, an increase in EU prices will potentially lead to increasing imports from third countries (Isermeyer et al 2019). This will depend on whether third countries pursue climate protection goals for livestock less ambitiously, as livestock farming would move to locations where it is not sanctioned (ibid). Perez Dominguez & Fellman (2015) argue that the impact of carbon leakage can be reduced with multilateral agreements with key trade partners, such as Brazil, China, the U.S., Australia and New

[105] In their model, Fellman et al. (2018) assume an EU-wide reduction in agricultural non-CO2 emissions of 28% in the year 2030 compared to 2005.

Zealand. Perez Dominguez et al (2016) also find that when mitigation technologies are subsidised, the rate of leakage is reduced between 10-15%.

According to the OECD (2021), the implementation of Carbon Border Adjustments in the agricultural sector can reduce carbon leakage, though the extent of this reduction varies significantly with country characteristics. In particular, for the livestock sector, the implementation of a border adjustment could neutralise carbon leakage. Ghosh et al. (2012) find that when policies are based on all GHGs, implementing carbon border adjustments in the European agricultural sector increases the European agricultural output by 0.76% – resulting in a negative[106] leakage of approximately -8% in comparison to alternative scenarios where no carbon border adjustments are applied to agricultural imports.

Carbon leakage associated with an increase in imports to the EU may be also partially mitigated by the existing customs protection for milk and beef. Isermeyer et al (2019) recommend that for climate policy purposes, the EU should initially maintain this high level of protection in order to be able to establish a cap-and-trade system.

The potential leakage risks for the on-farm ETS for peatlands is considered to be low in comparison with the other on-farm ETS policy options. Isermeyer et al (2019) use Germany as an example of the low risk of leakage. According to the authors, if all agriculturally used peatlands in Germany were re-wetted, agricultural production will shift elsewhere; this could lead to an intensification of production (i.e. more nitrogen fertiliser use) or to land use change (i.e. cultivation of fallow land), which could lead to additional GHG emissions. The shift in production will lead to additional emissions, because there is land both within and outside the EU that can be cultivated, and there is potential scope for increasing yields and reducing post-harvest losses. However, these additional emissions will only account for a fraction of the avoided emissions from peatlands (ibid).

The potential for the upstream ETS to affect the carbon leakage risks of EU animal feed producers and impact the trade balance is limited at a sector level, particularly if importers are covered under the upstream ETS and exporters exempted. While covering fertiliser importers under the upstream ETS can mitigate impacts on the trade balance and carbon leakage risks, price increases of fertilisers and feed as a result of manufacturers passing on the ETS costs could indirectly increase the risk of carbon leakage further down the value chain. Higher costs for fertilisers and feed could negatively affect the competitive position of farmers and thus increase their carbon leakage risks.[107]

For the downstream ETS, the risk of carbon leakage could also be addressed by integrating importers of meat into the processor-level ETS. By its construction as a downstream ETS, the proposed system lends itself to relatively easy inclusion of imports, and experiences with the CBAM can inform the design of a pricing system targeting consumption.

Administrative burden and costs

Policy Option	Administrative burden and costs
On-farm ETS (all-GHG)	An external expert assessment would be costly. A system based on farms inputting their own data would be less expensive, but would be potentially

[106] A negative leakage occurs when emissions decrease in non-implementing countries.
[107] European Parliament Committee on Agriculture and Rural Development (2022). Opinion on the proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism.

	complex and challenging for many farms, and would face significant risks of variation in approach. There is potential for small farms to group themselves together into a 'group of operators,' similar to how a cooperative operates, which is the approach proposed under the Carbon Removal Certification Framework.
On-farm ETS (livestock)	Number of farms makes administrative costs high, but the availability of proxy data can reduce admin costs compared to the all-GHG option. Most of the data required is already collected under existing agricultural regulations and applications for subsidies under the EU Common Agricultural Policy and with cattle farms now being proposed for integration into the Industrial Emissions Directive, synergies with monitoring under this legislation could be made.
On-farm ETS (peatlands)	The administrative costs per holding are likely to be significant due to the relative complexity of estimating and assessing emissions. However, there would be comparatively fewer farms as obligated parties compared to the other on-farm options.
Upstream ETS	The upstream option has a relatively low administrative burden and would be less costly compared to e.g. an on-farm ETS.
Downstream ETS	Only a relatively small number of processors would need to participate in the ETS, thus limiting administrative costs. Participation of farms through the generation of certified on-farm voluntary credits would impose some MRV costs on them, which could be problematic for small farms – although it may be possible for small farms to collaborate as 'groups of operators' to reduce transaction costs. Randomized auditing represents a potential solution.

As discussed in Chapter 2 two potential administrative options for the 'certified method' (external assessment or on-farm carbon calculation) could be explored. An external expert assessment would have high levels of administrative costs. A system based on farms inputting their own data would be less expensive. Notably, the Commission already collects large amounts of data from Member States for CAP monitoring and evaluation, which could be synergized with the 'certified approach.' However, according to a report by the ECA (2022), current data and tools do not deliver certain significant elements related to the details of the environmental practices applied on farm. The ECA report also found gaps in available data that would need to be addressed = for example data on the quantities of fertilizers used in the EU are not available, as only some Member States provide this data.

To address environmental data gaps, the Commission intends to convert the Farm Accountancy Data Network (FADN), which monitors farms' income and business activities and is utilised to assess the impact of measures taken under the CAP, into a Farm Sustainability Data Network (FSDN). This shift is intended to assist with collecting farm-level data on the Farm to Fork and Biodiversity Strategy targets, as well as other sustainability indicators. The list of new data and variables to be included in the future FSDN will be set out in secondary legislation (implementing and delegated acts). With a view to supporting an ETS for agriculture, the FSDN could be useful in collecting data to build upon for on-farm MRV, although it will not provide all of the data needed for an assessment.

On-farm MRV would be potentially administratively burdensome and challenging for many farms; and would face significant risks of variation in approach, and could be subject to manipulation (either unintentional or intentional). Transaction costs[108] for farms inputting their own data could be burdensome for some farmers (Grosjean et al 2016). Transaction costs can act as an entry barrier for those unable to afford assistance needed with engaging in emissions trading activities (Smith et al

[108] defined as the time and expense associated with complying with a policy such as fling paper work, obtaining legal advice, and registering emissions (Gerber et al 2010)

2007), and non-obligated farms, particularly small farms, who wish to participate by generating 'certified' on-farm voluntary credits may also face barriers to entry in generating revenue.

Under the Carbon Removal Certification Framework, to simplify the process for smaller farmers and foresters, a provision has been made for a collective verification approach called 'group of operators.' Because of the barriers faced by small farmers who would want generate voluntary credits, an ETS could allow for a similar approach in which farm operators to come together as a 'group of operators' in order to ease the administrative burden. The 'group of operators' could act on behalf of farmers in a similar way to cooperatives.

There is a general trade-off between the high level of accuracy in measuring emissions at the farm level, and transaction costs and the associated enforcement costs (Weishaupt et al 2020; Stubenrauch 2019). Measuring agricultural emissions is more challenging than CO_2 emissions from fossil fuels due to the dispersion of emissions in time and space and their heterogeneity linked to biological processes, thereby increasing costs for MRV. According to Thamo et al (2013), measurements of on-farm emissions could cause farm profits to fall by between 14-30%, depending on the measurement method. Less costly estimates, such as those based on proxies, have less of a distributional impact on farm profits. However, such measurements have much higher levels of uncertainty in estimating quantities of GHG emissions. For livestock emissions, using estimates based on livestock numbers could be differentiated by distinguishing between different production methods (i.e. grazing or intensive livestock farming), or species type etc. However, the further refinement of required data will also increase overall transaction costs.

For the on-farm ETS for livestock, there will be a potentially high administrative burden to record and monitor emissions, as direct measurement of on-farm livestock emissions is complex, which could lead to problems for small farms due to high transaction costs (Ekhardt et al 2018; Moran et al 2011; Leip et al 2010; Wirsenius et al 2011; Gerber et al 2010; Grosjean et al 2016). Administrative costs for a livestock sector emissions trading system will be broadly similar to the all-GHGs option, but with some savings in comparison, with no potential need for collecting data from fertilizer suppliers. Although less accurate, it is easier to objectively measure the number of animals than on-farm emissions: most of the data required is already collected under existing agricultural regulations and applications for subsidies under the EU Common Agricultural Policy (De Cara et al 2011). Assuming that data on livestock held by each farm is readily available via animal health authorities, calculations of emissions will be relatively straightforward: emissions factors can be applied to the livestock numbers for each farm (differentiating by age and breed where possible). Importantly, should conclusions on negotiations of the revised Industrial Emissions Directive include cattle farms, monitoring under this legislation could be synergised with an ETS, which could save costs of administration.

For the on-farm ETS for peatlands, the administrative costs per holding are likely to be significant due to the relative complexity of estimating and assessing emissions. On-farm monitoring and verification of emission reductions from peatland re-wetting is relatively complex and requires staff time as well as equipment, maintenance, and data analysis costs (Artz et al 2018). MRV usually needs to be frequent, and can be prolonged and intensive (Greifswald, 2021). However, proxies for emissions reductions have been used in many countries, including the average emissions observed on different condition or primary vegetation types (e.g. the GEST approach in Germany, see Couwenberg et al. 2011). Nevertheless, measuring emissions on site was found to be a better estimate of the achieved carbon benefits as proxies tend to underestimate the achieved reduction in emissions (Guenther et al 2017; Arzt et al 2018).Guenther et al (2017) directly calculate the cost of monitoring emissions on peatland restoration projects in Germany, finding them to be cost-effective in the evaluation of the effectiveness of the work. As experience and access to equipment grows, the capital costs required for MRV may fall, as has been demonstrated in some cases already (Birnie & Smyth, 2013). The same may be true for recurrent costs, both via technological advances on the ground and through the potential use of remote monitoring (Moxey and Moran, 2014).

Member States will also be impacted differently by administrative costs: there will be no cost to those without peatlands as the legislation does not need to be applied within these countries. Those with high numbers of farms on peatlands will face the largest administrative burden, although Member States with a small number of farms may face high levels of costs per farm, since relevant national systems will need to be established. MRV costs will be particularly high if the policy requires on-farm assessments. Such assessments would require site visits and detailed measurements by accredited experts, for which the costs may exceed the price of emission certificates for the farm's emissions. While a threshold could lower administrative costs, excluding smaller land holders would risk making collective re-wetting actions more challenging.

An upstream ETS would regulate fewer entities than an on-farm ETS, which would both facilitate implementation and decrease administrative costs. The overall administrative costs for regulated entities would be lower as there are fewer of them, but the costs would also be lower for public authorities as they would need to oversee compliance and enforcement for fewer entities. Specifically for the administrative costs related to MRV, this depends on the type of MRV approach employed as discussed in the policy description section on *Administration*.

The downstream ETS is relatively less complex than the on-farm ETS options, as it involves fewer participants. If the downstream ETS builds on existing legislation, implementation time can be relatively short. In any case, there will be some time needed to determine emission factors and the cap. If the processor opts for the 'certified method', this approach can enable unique emissions factors to be implemented. Similar to the on-farm ETS, a voluntary on-farm MRV will need a more fine-grained understanding of emission factors as well as the administrative infrastructure to monitor production processes on the farm level. For this reason, it might be advisable to start the system with an introductory period that only allows for the simple approach procedure and then phase in the complex approach.

Relevance

Incentivise polluters to change practices and innovate

Policy Option	Incentivise polluters to innovate and change practices
On-farm ETS (all-GHG)	The All-GHG ETS option has the potential to incentivise changes in practices across various types of farming, such as regenerative practices, precision farming, or climate smart agriculture. It can also facilitate changes in output activities, such as transitioning towards lower emissive livestock or towards more arable crop farming. The all-GHG can also facilitate changes off-farm behaviour by influencing consumption behaviour.
On-farm ETS (livestock)	A Livestock ETS can facilitate the uptake of on-farm mitigation technologies, such as feed additives, improvements to animal health, and efficiencies in

	output per animal. The livestock option can influence changes in the choices made by downstream processors, as well and potentially facilitate innovations in new technologies for meat replacement. Similar to the all-GHG option, the Livestock option can facilitate changes in consumption behaviour.
On-farm ETS (peatlands)	A peatlands option can incentivise farmers to adopt new farming practices such as paludiculture, or other types of land use to generate income, such as the installation of solar panels on re-wetted peatlands.
Upstream ETS	An upstream ETS can incentivize off-farm changes in practices and innovations for the emissions covered, if manufacturers re-orient their production towards products which lead to less on-farm GHG emissions, or to innovate and develop such products. For importers, an upstream ETS could incentivise them to focus their import business on more low-emitting products. The ability of farms to generate 'certified' on-farm credits can facilitate changes in practices on-farm.
Downstream ETS	A downstream ETS can incentivise off-farm changes in practices relevant for the emissions covered, for instance, investments in new technologies, such as cultured meats and dairy, efficiency improvements allowing for reduced purchases of GHG-intensive raw materials, diversifying product portfolios, product reformulation, such as lowering a product's meat or dairy content; or by steering consumer choices towards less GHG intensive products through marketing campaigns. The ability of farms to generate 'certified' on-farm credits can facilitate changes in practices on-farm.

Several experts consulted for this study stressed in their interviews the primary advantage of a market-based instrument, such as an ETS, as providing flexibility: those who are obligated to reduce their emissions have the flexibility to decide the most cost-effective for the highest level of emission reductions. Thus, an ETS can facilitate changes in practices to a heterogenous group of participants and respond to challenges of information asymmetry by allowing participants to decide for themselves how to meet their obligated emission reductions.

An ETS option not only provides flexibility in choosing to adapt new practices, but can also encourage innovation. Proponents of market-based instruments to facilitate climate action argue that such policies can spur technological innovation (Acemoglu et al 2012; van den Bergh & Savin 2021). Indeed, the Porter-Linde (1995) hypothesis stipulated that instead of being an obstacle to innovation, appropriately designed flexible regulations, such as market-based regulations, that do not prescribe specific technologies, can indeed *promote* innovation. Lim & Prakash (2023) test the Porter–Linde hypothesis, which suggests that flexible and non-technology-forcing regulations can facilitate innovation: the authors find that the adoption of carbon pricing policies is associated with an increase in patent applications for climate mitigation technologies.

For livestock, farmers may be incentivised to change on-farm practices, such as improving animal diets, improving animal health to increase the output per animal, and using feed inhibitors. However, such practices are estimated to reduce emissions by around 15% (Wirsenius & Hedenus 2014). Therefore, changes in technical practices on livestock farms alone will not be enough to reduce emissions from livestock (Weishaupt et al 2020). Without reductions in livestock numbers, technical measures and switching agricultural practices (i.e. grazing animals) will not be sufficient to limit the increase of the global mean temperature to 1.5°C (Ekardt et al 2018; Hedenus et al 2014; Searchinger et al 2018).

The average per capita consumption of animal products is high in the EU, both in absolute terms (twice as high as the world average) and with respect to nutritional recommendations (Buckwell & Nadeu 2018). According to Buckwell and Nadeu (2018), these consumption levels were much higher than recommendations for meat and only slightly higher than recommendations for milk. A modelling study of EU agricultural emissions by Bryngelsson et al (2016) examines 14 common sustainable dietary patterns across reviewed studies, showing reductions as high as 70-80% of GHG emissions for vegan-based diets., Bryngelsson et al (2016) also find that without a reduction of 50% in ruminant meat consumed, the EU cannot meet its required climate target.

Therefore, there will need to be fundamental changes in the activities of farmers, as well as changes with downstream actors, to bring about the necessary emission reductions. For downstream practices, Verschuuren (2023) emphasizes cultured meat and dairy as a potential disruptive innovation on the food market, which could accelerate changes in practices. Replacing animal-grown meat and animal-produced milk with lab-grown meat and dairy has the potential to reduce greenhouse gas emissions from livestock to zero, reduce the current nitrogen and phosphate overload, and transform landscapes through the reallocation of space now used for grazing and for the production of animal feed to other uses (ibid). Other downstream actions that can impact on-farm emissions have also been highlighted in chapter 3, such as: efficiency improvements allowing for decided purchases of raw materials; diversifying product portfolios; product reformulation, such as lowering a product's meat or dairy content; steering consumer choices towards less GHG intensive products; or though supplier incentive programs.

A shift in consumption, away from animal- to plant-based food products, is likely to cause changes at the level of on-farm production, with new jobs emerging in the cultured meat and dairy sector, as well as many farmers continuing crop production on a larger scale to meet the demand for plant-based food products. While farmers can potentially transition into arable farming, or to other types of livestock less affected by carbon pricing, such as dairy or poultry, they can also transition into practices that can bring about new business opportunities, such as vertical farming, precision farming, or climate smart agriculture.

An expert in policies for peatlands interviewed for this study noted how an ETS could incentivise the uptake of paludiculture practices on peatlands, and even combining these efforts with installing solar panels on rewetted peatlands which would bring in additional income, noting recent estimates that show that, in many cases, such a shift could be much more profitable than agricultural production. The adoption of such practices on peatlands utilised for agricultural purposes may be easier to do in a flexible market-based scenario, rather than in a restrictive command and control system where there may sometimes be a lack of clarity on what is and isn't allowed.

Similar to the downstream ETS, an upstream ETS can facilitate actions off-farm to reduce emissions. The option could incentivise EU manufacturers to re-orient their production towards products which lead to less on-farm GHG emissions, or to innovate and develop such products. For importers, an upstream ETS could incentivise them to focus their import business on more low-emitting products. Changes in on-farm practices could also be incentivized through an upstream ETS, as manufacturers and importers may pass on the increased costs due to the upstream ETS, which could ultimately increase the prices that farmers pay. As a result, this creates a price incentive for farmers to use the purchased product more efficiently, adapt their purchasing decisions by switching to products which are cheaper (by virtue of being less polluting), or look for other approaches to improving yields.

Both the upstream and downstream ETS options can also facilitate changes in practices on-farm through the 'certified on-farm MRV', which can provide financial incentives for farmers to innovate and change.

The ‘certified on-farm MRV’ approach for these options could also facilitate changing practices in value chains by changing the relations between agricultural producers and up or downstream businesses. Currently, there is asymmetric value distribution in agri-food supply chains - while the largest number of businesses and employees involved in agri-food supply chains is in the agricultural sector, the added value belonging to agriculture in the whole food chain is much smaller compared to the food processing and retail industries. Asymmetric value distribution within the European agri-food sector varies between sectors and/or over time, with some producers being more negatively impacted than others, or some producers more negatively impacted during different time periods (Swinnen et al., 2021). Perceptions among rural producers of asymmetric value distribution have led to relations between producers and other supply chain actors becoming characterised by mistrust and a lack of solidarity (H2020 SUFISA) (Busch & Spiller, 2016), leading to calls for policies that can re-balance the market power relations between supply chain actors (Copa Cogeca, 2016).

The ‘certified on-farm voluntary MRV’ could facilitate new forms of vertical arrangements in supply chains by establishing value creating networks pursuing value-based strategies. In values-based supply chains, rather than emphasizing ‘value’ as profits, what is ‘valued’ is a commitment between supply chain actors to collaborate in ways to achieve sustainability objectives. As discussed above, there are already such models of these types of vertical coordination, as demonstrated by the Arla Sustainability Incentive Model. By facilitating collaborative approaches involving the whole supply chain, this can create more symmetrical relations between up and downstream actors seeking solutions to decrease emissions, as well as provide ecosystem services/public goods related to land management.

Coherence

Coherence with other EU policies

Policy Option	Coherence with other EU Policies
On-farm ETS (all-GHG)	Coherent with the IED, F2F Strategy, and the CAP. May conflict with coupled income support under the CAP.
On-farm ETS (livestock)	Coherent with the IED, F2F Strategy, animal welfare legislation, and the CAP. May conflict with coupled income support for livestock under the CAP.
On-farm ETS (peatlands)	Coherent with Carbon Removal Certification Mechanism, the NRL, and the CAP. May conflict with income support for farms on cultivated peatlands under the CAP.
Upstream ETS	Coherent with the Nitrates Directive, IED, F2F Strategy, EU ETS, and CBAM.
Downstream ETS	Coherent with the ESR, Farm to Fork Strategy, and CBAM. May conflict with coupled income support for livestock under the CAP.

Industrial Emissions Directive (IED)

The IED is the main EU legislation regulating the environmental impacts of large agro-industrial sources. The purpose of the IED is to further control industrial pollution, while simplifying regulations, lowering the administrative burden, and improving enforcement. The law currently covers intensive rearing of pigs and poultry, but the Commission has proposed to update the IED to include cattle installations as well. The IED aims to lower emissions by impacting the conditions under which an industrial installation can operate, ensuring these conditions are in accordance with the principles of its provisions through the permitting process. Permit conditions must be based on Best Available Techniques (BATs), which are the most environmentally effective of economically viable techniques available.

Thus, under the proposed revision to the IED to include cattle farms as well as lower thresholds for pig farms, the expectation is for the development of BATs that can facilitate the reduction of methane emissions. BATs are developed using the *Sevilla* process, which is a participatory, science-based information exchange involving industry, national and Commission experts (the Joint Research Centre), as well as civil society groups and actors. Norms for each sector are established in the Best Available Techniques Reference Documents (BREFs). Therefore, the Commission could align the conclusions of the BREFs and the recommended BATs with an on-farm ETS for livestock.

The Commission has proposed a threshold for the size of installations that will fall under the legislation: all cattle, pig, and poultry farms with over 150 LSU, meaning the IED will apply to ~13% of the EU's largest livestock farms: 10% of cattle farms, 18% of pig farms, and 15% of poultry farms. Currently, the proposed updates are now under Trilogues. The determination of the threshold for livestock farms under the proposed updates to the IED will also inevitably influence the threshold considered for an on-farm ETS for livestock.

Manufacturers covered under the IED need to ensure that they are compliant with the environmental requirements in their permit to operate. These environmental requirements relate to their direct emissions (GHG and other pollutants) and not to any emissions from the use of their products. There is therefore no overlap in regulated emissions under the IED and an upstream ETS, but administrative procedures for the upstream ETS could build on those of the IED.

More generally, the current IED framework does not allow for the regulation of emissions which are covered by the EU ETS (Article 9 (1)). However, the incompatibility of imposing emissions rules simultaneously under the EU ETS and the IED is under debate (Verschuuren 2022) and avoiding interaction between the two pieces of legislation is likely to become increasingly challenging (for example, as breakthrough carbon reducing technologies begin to qualify as BAT) (Bartolucci 2021).

Farm to Fork (F2F) Strategy

The objective of the F2F Strategy is to mainstream sustainability in the EU food sector, addressed separately from the Common Agricultural Policy (CAP). The Strategy is a communication that details objectives and aspirations. It is accompanied by a Draft Action Plan and matches specific legislative actions with a timeframe for achievement. Relevant to the on-farm ETS (both all-GHG and livestock) and both the upstream and downstream ETS policy options are specific quantified targets for 2030, such as a reduction in nutrient surplus bt at least 50%. Relevant to both the all-GHG on-farm option and the upstream option, the Strategy also includes a commitment to help member states extend the application of precise fertilisation techniques and sustainable agricultural practices (notably in hotspot areas of intensive livestock farming) and of recycling of organic waste into renewable fertilisers. Member states are expected to do so by incorporating measures in their CAP Strategic Plans.

All of the policy options could potentially be coherent with the proposed action under the Draft Action Plan for an overarching legislative framework for sustainable food systems. This framework would be aimed at promoting policy coherence and mainstreaming sustainability in all food-related policies, and would combine mandatory and voluntary measures.

Other aspects of the F2F Strategy will be particularly relevant to the on-farm ETS (all-GHG and livestock), the upstream ETS, and the downstream ETS, including:

- Market access facilitation for sustainable feed additives (such as algae and by-products from the bioeconomy)
- 50% reduction target in sales of antimicrobials for livestock
- Revisions to animal welfare legislation
- Promotion of sustainable food consumption (which will involve promoting a more plant-based diet with less consumption of red meat)

The incentives created by the on-farm ETS options (all-GHG and Livestock) as well as both the upstream and downstream ETS would thus be fully consistent with the Farm to Fork Strategy.

Framework for Carbon Removals Certification

The Commission's proposed Framework for Carbon Removals Certification aims to incentivise increased carbon removals by establishing rules for the certification of carbon removals, including removals from climate-friendly soil management. This includes a specific focus on promoting "carbon farming", a category that includes climate-friendly soil management actions. Climate-friendly soil carbon management poses significant challenges for certification, including accurate quantification of mitigation, additionality, non-permanence, and sustainability (McDonald et al 2023). The proposed scope of the framework also includes peatland re-wetting due to its large potential to reduce carbon release. Therefore, the proposed methodologies to quantify removals for both mineral soil and peatlands, to be developed in delegated acts, will have large implications for the administration and oversight of the all-GHG and peatlands ETS policy options, particularly for MRV aspects; the certification and verification rules of the CRCF could also be relevant for the administration of many ETS options, especially if the certified MRV approach is selected. However, ETS options applying to emissions from soils (all GHG option, peatland option) could potentially be inconsistent with the CRCF which aims to reward landowners for avoided release of carbon, contrary to an ETS which would require farmers to purchase allowances for emissions from mineral and organic soils, or for farming on cultivated peatlands. The Commission would need to consider a stepwise alignment of the two policies.

Nature Restoration Law (NRL)

An Agri-ETS could be coherent with the recently proposed NRL features specific restoration targets for Europe's degraded ecosystems, habitats and species, including grasslands and peatlands. In addition, the draft law includes a target to restore drained peatlands under agricultural use beyond peatlands listed in Annex I of the Habitats Directive 92/43/EEC, focusing on agriculturally used peatlands. The proposal contains separate targets for restoration and re-wetting of peatlands, as follows: 30 % of such areas by 2030, of which at least a quarter shall be rewetted; 50 % of such areas by 2040, of which at least half shall be rewetted; 70 % of such areas by 2050, of which at least half shall be rewetted. Inevitably, an ETS for peatlands will contribute towards achieving these targets under the NRL. Relevant to the MRV aspects of a peatland ETS policy option, Article 17 of the proposal requires Member States to monitor almost all ecosystem types, *except* peatland restoration on drained organic soil. This means that for the time being, an ETS for peatlands cannot rely on an already established EU-level monitoring system under the NRL.

Nitrates Directive

Four of the ETS options (all-GHG, livestock only, upstream, and downstream) would be coherent with the Nitrates Directive,[109] which requires codes of good agricultural practices and measures to prevent and reduce water pollution from nitrates. In non-Nitrate Vulnerable Zones, the codes of good agricultural practices are implemented by farmers on a voluntary basis. Conversely, in Nitrate Vulnerable Zones, their implementation is mandatory alongside other measures such as limitation of fertiliser application (mineral and organic), taking into account crop needs, all nitrogen inputs and soil nitrogen supply, and maximum amount of livestock manure to be applied.

Sustainable Use of Pesticides Regulation (SUR)

The SUR proposal aims to change the existing Directive into a Regulation, making it binding to Member States, and includes 2030 EU wide targets to reduce by the use and risk of chemical pesticides by 50%.

A potential AgETS is likely to be consistent with the proposed Regulation, with possible synergies between the two. The proposal provides for improved data and monitoring systems and obligates Member States to establish a system of independent advisors, who need to be consulted by the farmer on a mandatory basis. Strategic advice provided through the system would include the use of precision farming techniques, the promotion of which is one of the key objectives of the proposal. The implementation of the Regulation could help establish structures that may subsequently facilitate the roll-out of AgETS MRV and, more broadly, support farmers in accessing knowledge and technologies applicable for emission reductions through more efficient fertiliser use.

New Genomic Techniques (NGT) Regulation

The proposal for a regulation on plants obtained by certain new genomic techniques aims to address the specificity of NGT plants, which currently fall under the scope of the GMO legislation. It sets new requirements for the development and placing on the market of NGT plants obtained by targeted mutagenesis and cisgenesis and products containing those, reducing regulatory burden on particular NGTs categorized as equivalent to conventional plants.

A potential AgETS would likely be consistent with the objectives of the proposal as stated by the Commission, which include the deliberate placing on the market of NGTs that contribute to the sustainability objectives of the European Green Deal. There is potential for NGTs to deliver benefits through improved yields, nutrient efficiency, and resistance to biotic and abiotic stress, which can support emissions reductions in agricultural production. However, the environmental consequences of full-scale deployment are yet to be fully understood, with possible negative impacts in terms of changes in resource use and pest and weed presence.

Animal welfare legislation

Current animal welfare regulations at European or member state level essentially correspond to a preventive approach through the prohibition or limitation of certain practices that potentially generate pain and suffering. Such regulations also obligate the use of some practices to increase the welfare of animals and, in particular, to encourage the expression of their natural behaviour. Livestock activities are covered by five directives which impose minimum standards while the transport and the killing of animals are covered by regulations which set up similar requirements for all Member States. Directive

[109] https://environment.ec.europa.eu/topics/water/nitrates_en

98/581 regulates the protection of animals kept for farming purposes; other directives and regulations are specific to either a species, or to a phase of animal farming: Directive 2008/1193: Calves; Directive 1999/745: Laying hens; Regulation 1/20059: Animal transport; Regulation 1099/2009: Killing of animals.

Under the F2F Strategy, the Commission intends: to initiate an evaluation and revision of the existing animal welfare legislation, including on animal transport and slaughter of animals, due for 2023; that the new EU Strategic Guidelines on Aquaculture will support the review of animal welfare legislation; and that it will consider options for animal welfare labelling, which today remains voluntary and largely unregulated.

Changes to animal welfare legislation can potentially reinforce an on-farm ETS for livestock, as healthy animals require less natural resources, and sustainable livestock management practices can lead to reductions of GHG emissions.

EU ETS

Even though an ETS for agricultural emissions has important differences with the existing ETS for stationary sources, the former could build on some experiences and existing infrastructure for the latter. For instance, trading and registries for emission permits could be hosted by the same entities responsible for the existing ETS. Moreover, an agricultural ETS could probably be introduced as part of the ETS directive, as has been the case for the ETS 2 for road transport, buildings and additional sectors that will start by 2027.

The MRV procedures for an upstream ETS could build on the MRV in the existing EU ETS, with some additional data collection. Large fertiliser and feed manufacturers are included in the EU ETS for their direct emissions from the manufacturing of their products based on the inclusion criteria as defined in Annex I of the EU ETS Directive:[110]

- ***Combustion activity:*** all feed and many fertiliser producers are covered under the EU ETS based on the criterion that they have combustion units with a total rated thermal input of more than 20MW, excluding those using only biomass and units of less than 3MW. The units concerned are mainly boilers, dryers, furnaces and heating equipment.
- ***Production of nitric acid and ammonia:*** fertiliser producers are covered under the EU ETS for the N_2O and CO_2 emissions linked to production of nitric acid and CO_2 emissions linked to ammonia production.

There is no overlap with regulated emissions under the current EU ETS and an upstream ETS on agricultural emissions, because the EU ETS only covers GHG emissions associated with the production of fertiliser and feed, whereas the upstream ETS considered in this study would target the emissions resulting from the consumption of these products. The only relevant exception is **urea production**. Ammonia producers already pay for the CO_2 emissions released by urea application under the EU ETS where the urea is produced using CO_2 from ammonia production.[111] An upstream ETS would need to take this into consideration to avoid CO_2 emissions from urea application being priced twice.

[110] https://www.i4ce.org/wp-content/uploads/13-03-Climate-Report-39-Agriculture-in-the-EU-ETS_CDC-Climat-Research.pdf
[111] Section 17 of Annex IV of Commission Implementing Regulation 2018/2066 (Monitoring and Reporting Regulation)

Carbon Border Adjustment Mechanism (CBAM)

From 2027, importers of energy-intensive products will also have to purchase certificates at the price equivalent to the EU ETS price. This approach, which will be introduced to limit carbon leakage, does not include agricultural products. As it puts the emission price on final consumers, it has some parallels with the downstream ETS for livestock, which also applies a price closer to final consumers than an approach that addresses emissions released in production. Hence, a downstream ETS could also include imports. This would partially mitigate the risk that emission reductions in the EU are undermined by outsourcing of production to third countries with less ambitious mitigation policies. However, products that have already been processed outside of the EU would require the additional effort to determine their emission factors. As outlined in Chapter 3.1.3, accounting for and validating emissions embedded in both processed and unprocessed food products present several challenges which are likely to be more difficult to overcome than in the case of the products currently in scope.

The CBAM could also be particularly aligned with an upstream ETS, as starting from October 2023, importers of fertilisers produced outside the EU will have to report the CO_2 and N_2O directly emitted during their production – while this only covers emissions from production, it could be extended to emissions from use. From 2027, importers will also have to purchase certificates at the price equivalent to the EU ETS price faced by EU producers of fertilisers. This does not include any GHG emissions related to consumption of fertilisers. The only exception may be the CO_2 emission from urea application as discussed in the previous section on the EU ETS, to ensure a consistent scope with the EU ETS. Farm animal feed is not covered under CBAM.

While there is no overlap in the current CBAM and the upstream ETS (except potentially CO_2 emissions from urea application), the MRV procedures and infrastructure being developed under CBAM could be used for importers of fertilisers and feed under the upstream ETS. This would be similar to making use of MRV procedures and infrastructure under the EU ETS for EU producers of fertilisers and feed.

The Common Agricultural Policy (CAP)

The CAP has, among others, a clear objective on climate change mitigation and adaptation, with different types of interventions for supporting both emission reductions and removals with practices at farm level. This makes the on-farm ETS policy options (all-GHG, livestock, and peatlands) in principle coherent with the CAP objectives. On the other hand, there may be frictions with the CAP for some specific aspects, particularly if analysed in isolation.

Some parallelisms between the CAP and an on-farm ETS can be drawn. According to Leach (unpublished):

> *…both the ETS and CAP can be seen as regulatory structures designed to intervene in the market in order to achieve stabilising effects. The CAP has long done this with compensatory payments for non-production as well as direct payments to ensure that European farmers receive minimum prices and direct payments to maintain livelihoods while competing in international markets. Similarly, the EU ETS has provided free allocations to those that utilise the most efficient technologies available (p. 16).*

It has also become the norm within the CAP to integrate compensation to farmers for changing farm management and production methods in pursuit of non-economic objectives, in particular in relation to the environment. Box 13 provides an overview of the potential coherence and conflicts between an agricultural ETS and the CAP.

Box 13 The CAP and an agricultural ETS

A successful implementation of an on-farm ETS will need coordination with the Common Agricultural Policy (CAP), which plays a key role in shaping the way that agricultural and forestry land are managed in the EU. Representing 33% of the EU budget, the CAP provides basic income support to over 6 million EU farmers and supports compliance with environmental and animal welfare regulations as well as contributing to the shift towards increased environmental and climate measures. Climate action has been a main objective in the CAP since 2013, and, in the previous period (2014-2020), 25% of the budget was allocated to interventions mitigating and adapting to climate change (ECA, 2021). Despite this, agricultural GHG emissions at the EU level stagnated, and in some Member States they have increased. It has also to be considered that overall inventories in MS for agriculture is in between Tier 1 and 2 and then not able to reflect improvements in farm management. By its nature, most of the CAP interventions finance measures that are more relevant for carbon removals in soil and biomass than for reducing GHG emissions, such as protecting soils from erosion or increasing crop rotations. In addition, Member States tag certain measures under “climate spending” regardless of whether climate action is the central aim of the measure, or just a small side effect, having multiple benefits.

In the new CAP (2023-2027) ‘climate change’ is one of the ten key objectives addressed and interventions targeting climate objectives are found in the first pillar (direct payments) as well as the second pillar (rural development). The new CAP includes new interventions and enhanced compliance which can contribute to the ETS option. Next to the mandatory Good Agricultural and Environmental Conditions (GAECs), which include as a novelty also an obligation to preserve organic rich soils (GAEC 2), CAP interventions that could support the proposed ETS option include eco-schemes, coupled income support and rural development measures. Eco-schemes are a novel element in the CAP design and place their focus on measures that contribute to soil fertility and increased soil organic carbon stocks. Examples of these measures include reduced or no-tillage, crop rotations with legumes, avoiding the conversion of grasslands into arable land, introduction and maintenance of organic farming, and measures to reduce soil erosion such as the application of soil covers. The environmental and climate commitments under Pillar 2 offer flexibility to include measures contributing to GHG emissions mitigation and implementation of an ETS. In France, for instance, one such intervention supporting the transition of practices to reduce the carbon footprint of farms incorporates a sub measure that requires GHG emissions assessment of farms and a reduction of at least 15% compared to the baseline.

The CAP also offers room to intervene positively on emissions from organic soils. Germany has programmed an intervention under the Environmental and Climate Commitments in Pillar 2 that promotes re-wetting of peatlands, including grazing with peatland livestock breeds and establishment of paludiculture. However, not all regions in Germany with peatland area are implementing it. In the case of emissions from fertilisers, one of the main measures proposed by the CAP is the increased crop rotations with the incorporation of legumes (this is part of many eco-schemes). Spain has introduced an additional GAEC on ‘sustainable fertilisation’. It obliges farmers to have a fertilisation plan and register all fertiliser and organic matter inputs. It also aims to ensure that farmers comply with regulation on manure and slurry application. Implicitly this should bring to a reduction on the use of fertiliser as overfertilisation would be minimized.

The CAP is a significant source of income for livestock farmers, in particular for those with grazing cattle, sheep and goats. There are several interventions in the CAP which could contribute to the ETS but are currently in conflict with the presented option. This is the case of interventions supporting extensive grazing or calf rearing (coupled income support) with payments per LSU or grazed hectare. In some cases, the number of funded LSU is limited, in others the stocking densities are limited (in some cases higher than the 150 LSU/ha suggested here), but ceilings are not mandatory and are not always included by Member States or their regions. This means that in some cases such interventions could lead to increased GHG emissions. Given the high dependency of extensive livestock farmers on this type of income support - according to the Thuenen Institute (2022) for the current CAP funding period around 70 % of coupled payments are proposed to go to animal production, with Germany, Sweden and Austria planning for 100% of these payments to go to livestock - these measures keep livestock numbers, and their associated emissions from enteric fermentation. Most of the funds are earmarked for cattle farming, followed by dairy cow farming, and some more extensive variants. Some of the plans include limits on livestock numbers or density for coupled income support (e.g. France, Spain), while most do not (e.g. Germany, Italy).

The CAP has a strong influence on how peatlands are managed. One of the most promising measures in the CAP is the introduction of GAEC 2, which obliges farmers to protect wetlands and peatlands. However, its potential to reduce GHG emissions remains uncertain. Only eight Member States have committed to making CAP funding conditional on GAEC 2 starting from 2023, with most countries taking advantage of the derogation option included in the regulation and opting to delay its entry into force until 2024 or 2025.

Member States also have the possibility to programme interventions contributing to peatland restoration and management under the Rural Development Programme (Pillar 2). Germany, the largest emitter from peatland in the EU, has programmed an intervention under the Environmental and Climate Commitments in Pillar 2 that promotes re-wetting of peatlands, including grazing with peatland livestock breeds and establishment of paludiculture. However, not all regions in Germany with peatland area are implementing it.

On the other hand, a few measures in the CAP could create frictions with the proposed ETS. GAEC 1, which obliges farmers to maintain permanent pastures, can play against the re-wetting and instalment of paludiculture activities on peatland that is currently under permanent pasture.

Nevertheless, the CAP framework is in general suitable for realising an EU-wide realignment towards agro-ecological practices and supplying (co-)funding to reach the climate goals (Greifswald Mire Centre 2019). Additionally, revenues from an ETS could be invested into practices and programmes funded under the CAP to reinforce its objectives through supporting farmers in adapting new practices that funded under the CAP. Similar to the just Transitipn Fund for the EU ETS, revenues from an AgETS could be used not just to support climate-friendly practices, but practices with large overlapping co-benefits with biodiversity and social sustainability. In particular, funds for advisory services for the certified MRV approach could be implemented through the CAP.

Added Value

EU Added Value

Policy Option	EU Added Value
On-farm ETS (all-GHG)	An ETS for agriculture at the EU level lowers abatement costs compared to individual ETS' at the Member State level which can create a patchwork of different rules and procedures, potentially hindering the functioning of the internal market. Ensures also consistency with approaches to apply a carbon price to emissions from stationary sources (ETS1) as well as emissions from road transport and buildings (ETS2).
On-farm ETS (livestock)	Similar as on-farm ETS for all GHG. The example of the Netherlands livestock reduction programme provides evidence (see Box 12) of the risks of carbon leakage within the EU as well as potential impacts of national measures on the functioning of the EU internal market. Ensures also consistency with approaches to apply a carbon price to emissions from stationary sources (ETS1) as well as emissions from road transport and buildings (ETS2).
On-farm ETS (peatlands)	An EU-level policy could avoid potential shifting of production onto organic soils from one Member State to another, therefore reducing internal carbon leakage risks.
Upstream ETS	Lower abatement costs, no intra-EU carbon leakage risks and harmonised MRV rules under an EU level upstream ETS as opposed to a patchwork of different rules and procedures at member state level. Ensures also consistency with approaches to apply a carbon price to emissions from stationary sources (ETS1) as well as emissions from road transport and buildings (ETS2).
Downstream ETS	Similar as for on-farm ETS for all GHG. Ensures also consistency with approaches to apply a carbon price to emissions from stationary sources (ETS1) as well as emissions from road transport and buildings (ETS2).

An ETS for agriculture at the EU level lowers abatement costs compared to individual ETS' or carbon pricing schemes at the Member State level. De Cara & Jayet (2011) find that an EU ETS for agriculture could lower abatement costs by a factor of 2-3 compared to those achieved individually by Member States. In addition, Leach (unpublished) argues that a lack of an EU-level policy can create a patchwork of different rules and procedures for Member States, potentially hindering the functioning of the internal market. Leach (unpublished) also argues that in establishing the current EU ETS, the EU has already made the economic case for why it is preferable to have an ETS at the EU level as opposed to the Member State level: in its 2000 Green Paper, the Commission argued that the EU would be able to achieve collective emissions reductions that would be EUR 1.7 billion cheaper than if Member States were to run their own domestic system.

In addition to the costs savings, preventing carbon leakage within the EU and ensuring the functioning of the internal market are other aspects of the added value of an EU-wide policy. For example, the efforts to establish a livestock to land ratio policy option in the Netherlands demonstrates the risks of both carbon leakage and EU internal competition rules if there is no EU-level policy overseeing livestock GHG emissions reduction.

While there are fewer concerns regarding emission leakage for a peatland policy option, the added value over a similar policy at the Member State level is that while production will most likely shift from organic to mineral soils, an EU-level policy will disincentivize shifting production to cultivated peatlands in other Member States. If a Member State implements a peatland policy option only at the national level, this could potentially risk shifting agricultural production from peatlands in one Member

State to peatlands in another Member State, therefore negating the emissions savings. An EU-level policy can avoid such internal leakage challenges.

An EU level upstream or downstream ETS would also lower abatement costs compared to individual member state policies. More importantly, an EU-level ETS would also avoid carbon leakage risks between EU member states and ensure harmonisation of MRV rules and procedures. The latter is particularly important in an upstream ETS where the compliance obligation of regulated entities is determined based on emission factors, which need to be based on consistent rules to ensure a level playing field in the EU.

5. Conclusions of Part 1

This study has provided an overview of five potential policy options applying the polluter pays principle towards agricultural GHG emissions, focusing on emission trading systems as potential market-based mechanisms that could be implemented at the EU level. The policy options include three on-farm ETS options (all-GHGs, livestock only, and peatlands only) as well as two off-farm ETS options - a downstream option and upstream option. The study does not intend to be a concrete policy proposal for introducing an agricultural ETS, but rather it aims to provide *workable examples* of how the EU could implement a polluter pays policy to address agricultural GHG emissions.

The study provides an overview of the main potential policy design aspects relevant for an Agricultural ETS as well as the specific design options unique to each option, and how they can be administered. The potential design aspects for an Agricultural ETS consider governance, administrative oversights and costs, requirements for MRV (monitoring, reporting, and verification) of emissions, as well as regulatory flexibilities. This study has also assessed the potential impacts of these five options . This analysis is based on theoretical and empirical literature as well as interviews with experts, and inputs from a stakeholder survey and workshop. The ETS options are assessed for effectiveness, efficiency, relevance, coherence and added value, focusing on potential impacts on environmental objectives such as incentives to reduce emissions and protect biodiversity, but also economic impacts on sectoral competitiveness, trade balance, and consumer budgets and well-being.

The policy options presented in this study provide an opportunity to address a wide scope of sources of agricultural emissions. Various studies demonstrate the vital importance of the agricultural sector in achieving emission reductions that will contribute towards meeting EU and global climate targets - achieving net zero emissions by 2050 will not be possible without substantial reductions in agricultural emissions (Frank et al 2019; Herrero et al 2016; Hedenus & Wirsenius 2014; Bajželj et al 2014; Bellarby et al 2013).

5.1. Key strengths and trade-offs between potential ETS options

The key strength of the on-farm policy options, in comparison with the off-farm policy options, is the provision of a *direct price signal* to incentivise farms to change their practices and innovate to reduce their emissions. The all-GHG on-farm ETS is the most comprehensive option of the five analysed in this study that has the widest scope to address emissions in agriculture. However, the livestock ETS also covers a large scope of agricultural emissions. For the livestock ETS, depending on the threshold for participation expressed in livestock units, there is the potential to capture a large degree of coverage of agricultural emissions based on the proportion of farms. For the on-farm ETS options, a price signal could incentivise cost-effective actions across various types of farming through the adoption of agro-ecology farming practices as well as transitioning towards lower emissive outputs. Indeed, several experts interviewed for this study stressed the comprehensiveness of these two options and the potential of a direct price signal to facilitate changes in practices, particularly with the certified approach to MRV.

A key trade-off of the off-farm ETS options (upstream and downstream) is that their effectiveness will be dependent on the extent to which incentives are passed to farms. While the two off-farm options include a substantial scope of emissions in their design - the downstream option covers CH_4 and

N_2O emissions associated with livestock production, while the upstream option addresses from N_2O emissions from fertiliser use and CH_4 emissions from enteric fermentation (as influenced by feed) - the incentive to change through price signals is a less direct relationship. However, for the off-farm options, farms can also be incentivised to change practices if they are allowed to generate certified on-farm voluntary credits to reward on-farm mitigation activities. It will be important to distinguish if those mitigation activities and related credits would concern emissions within or outside the scope of the off-farm ETS options. In case emissions within the ETS scope are concerned, a cap adjustment mechanism would need to be considered to ensure that individual mitigation actions also translate into corresponding overall emission reductions of the sector.

For the off-farm options, the willingness of farms to volunteer to generate on-farm voluntary credits will depend on the price of emission allowances in the emission trading system. The market price must be higher than the cost of mitigation actions and their monitoring on-farm to incentivise participation in the voluntary credit approach. For the downstream option it also seems likely that for final consumers, there are additional barriers that need to be addressed to make the price signal fully effective. This likely includes behavioural aspects (such as habit formation and peer effects) and informational constraints, which could be addressed by marketing campaigns by food processors as a downstream system could incentivise such actions.

A key tradeoff of the on-farm options is the administrative complexity and costs due to the sheer number of participants as well as the complexities associated with an on-farm MRV system. This study has outlined how proxy measures and default emission factors could be utilised and, particularly for livestock emissions, how existing data collected under other EU policies (e.g. animal welfare legislation and the CAP) could reduce the costs associated with the implementation of the on-farm options. The study has also proposed potential de minimis thresholds for the all-GHG and livestock options to reduce the number of potentially regulated entities. Nevertheless, the downstream and upstream options would have comparatively fewer participants, and therefore could ease the administrative burden and costs of an ETS for agriculture.

A key strength of the upstream and downstream options is the potential to facilitate a whole value-chain approach to addressing agricultural emissions. The possibility to generate certified on-farm voluntary credits allows farms to participate in an ETS, providing financial incentives to adopt new practices that can reduce emissions. However, the up- and downstream options can also incentivise off-farm mitigation actions: for example, upstream, innovation for more efficient fertilisers could be facilitated, while downstream food processors could change food recipes to opt for lower emissive ingredients or innovate to develop new products such as alternative protein technologies.

The possibility to generate certified on farm voluntary credits in the upstream and downstream options could facilitate new vertical arrangements in agri-food supply, which could reduce asymmetric value distribution. As discussed in Chapter 4, there is asymmetric value distribution in agri-food supply chains - the added value belonging to agriculture in the whole food chain is much smaller for farms compared to the food processing and retail industries. The voluntary credit approach could create collaborative opportunities with various actors coming together to emission reductions and facilitating transitions towards more climate-friendly value chains. As demonstrated by the Arla Sustainability Incentive Model, new forms of vertical coordination can be established through this encouraging different value chain actors to form new types of relationships in which up- and downstream actors are supporting changes in production practices on farms.

Another key strength of the off-farm options is the potentially positive social acceptance for such options among agri-food value chain stakeholders. When asked about their views on where the point of obligation should be for an agricultural ETS, stakeholders overall responded most positively to the downstream option, while expressing apprehension regarding certain aspects of the on-farm options: namely the administrative feasibility, as well as potential negative impacts on farmer income and trade and competitiveness.

To address key strengths and trade-offs, a potential consideration for an agricultural ETS may be to combine various design aspects of the different policy options outlined in this study. For example, if the point of obligation is off-farm, to ensure that both livestock emissions and emissions from fertiliser are addressed, a combined 'processor' ETS that combines the upstream and downstream points of obligation could be a potential option, similar to the processor levy proposed in New Zealand. While it would be possible to facilitate the participation of farms in the off-farm ETS options through the voluntary credit approach, several interviewees stressed the importance of including livestock farms as a point of obligation to incentivise changes in practices. Two interviewed experts recommended including only the largest cattle farms in an agricultural ETS, which could limit the number of regulated entities while including some of the largest agricultural GHG polluters, thus excluding other types of livestock farms (pig, poultry) which are far less emissive. In addition, a peatlands expert stressed the opportunities for incentivising peatland re-wetting activities, or paludiculture, through an agricultural ETS. Therefore, consideration of how farms on peatlands could be included in an agricucltural ETS (beyond the voluntary credit approach) is warranted.

5.2. Potential next steps in considering an ETS for Agriculture

If the Commission considers to move forward with an ETS for agriculture, there will need to be preliminary actions to prepare the smooth implementation of such a system. In particular, there are particular actions to phase-in and support an MRV system, for both the certified and default approaches. In addition, policy considerations will be needed on how to support farmers with the needed financial support to transition towards climate mitigation practices and actions before ETS revenues are available.

There would be a need to establish a harmonised GHG reporting tool at the farm-level in the EU. Such an MRV tool will need to be used consistently by different industries and types of farms within the sector and incorporate all relevant gases. Some Member States are already implementing GHG auditing programmes for farms, and there are many existing voluntary assessment tools, as discussed in Chapter 2, that could be utilized as models for an EU-wide MRV system. An effective MRV system will need to address information asymmetry and allow participants to decide for themselves how to meet their obligated emission reductions.

An on-farm GHG reporting tool would need to provide farms with detailed and up-to-date information on the mitigation actions with the highest GHG reduction potential that are the most cost-effective. The tool would need to inform farmers on cost-effective measures that are reflective of the farm's specific context, such as biophysical geographical aspects, socio-economic conditions, and changing market conditions (e.g. commodity prices). One way of communicating such information is to provide regularly updated and detailed marginal abatement cost curves (MACCs) that are tailored for each Member State. The Irish Teagasc has provided three iterations of MACCs for the agricultural sector for the purposes of assisting farmers with their efforts to reduce GHGs. The rationale for providing updated MACCs is that costs and benefits can change over time. For each Member State, MACCs can be tailored to provide detailed analysis and a comprehensive review of relevant measures designed to address the specific context of the respective Member State, both from an economic and climate perspective.

Information on cost-effective high impact mitigation actions should be communicated through the introduction of a user-friendly Decision Support Platform. Information such as MACCs are not necessarily easily interpretable by farmers, and therefore must be communicated in a way that is both practical and understandable. The introduction of a Decision Support Platform would need to take place before the introduction of an ETS – similar to how the New Zealand government has introduced the 'Know Your Numbers' programme before implementing its agricultural carbon levy. The platform can provide each farmer with an estimate of the greenhouse gas generated on their specific farm, and to do that in a way that requires the minimum of effort on the part of the farmer, while allowing the farmer to explore the impact of the adoption of mitigation actions on their farm's emissions figures. The tool could provide farms with an action plan to record mitigation practices that will improve the GHG performance of a farm. Funding from the CAP could support advisory services (and eventually replaced with ETS revenue) could be utilised to support such a platform. Equitable access and use of these resources will need to be taken into consideration, as widespread use could be impeded by the prevailing disparities in terms of internet accessibility, digital literacy, and familiarity among farmers across regions and Member States. Equitable access is needed to avoid a situation where only very advanced and professional farms benefit from the introduction of the self-reporting system.

Prior to considering the implementation of an ETS, the EU would need to consider where to direct transitional aid (through the forms of subsidies, grants, and loans) for farms in support the adoption of climate-friendly practices. While changes in practices are needed, farmers will also face upfront costs for investments that are needed in equipment, structures, input supplies and management regimes, as well as machinery, technology, and training. Such upfront costs may deter farmers from transitioning towards more climate-friendly practices due to perceptions of risks associated with the costs of changes. Funds from the CAP could be aligned in a complementary manner with revenues from an ETS. While revenues from an ETS can be utilised for transitional aid once occuring, depending on the availability of CAP funds, other sources at both the EU and Member State level might be needed for a time-limited period. Time-limited financial support could provide farmers with the investments and knowledge needed to bring them into compliance (or participate on a voluntary basis) with an ETS. Bradley and Baldock (2023) argue that such directed support should be focused on a just transition, where opportunities are provided for all farmers for reskilling, retraining, and diversification of income. Transitional aid measures should be focused on "tailored farm-level transition plans, enhanced business advice about how to diversify and increase business and environmental resilience and technical advice on the best means of selecting and implementing sustainability practices" (ibid, p.26).

A dedicated fund created for farms from ETS revenues combined with CAP funds could align agricultural spending directed towards innovation and modernization of farms. Generating revenues is one of the main advantages of an ETS, and this could be utilized to support the agricultural industry in transitioning towards mitigation actions. As discussed at length in the second part of this study, “Linking carbon removals in the land sector to an agricultural Emissions Trading System”, revenues could be targeted towards payments for carbon removals through various potential policy models. How revenues from an ETS are utilized could be used in a complementary manner with funds from the CAP, as the CAP makes up a significant proportion of the EU’s MFF. A discussion on how to combine these two instruments is necessary in order to provide the needed financial support for farms. While revenues from an ETS and CAP funds can be utilised for transitional aid, other sources at both the EU and Member State level will be needed for a time-limited period.

Opportunities for financing from financial institutions would be needed for transitional aid as well – policies will need to further develop risk sharing mechanisms between private and public financing and facilitate support for financial intermediaries to increase their understanding of the needs of the agricultural sector. Obtaining financing for investments related to climate change may pose difficulties for farmers. Given their significant growth potential, small and medium-sized farms in particular need to be able to access to adequate financing pathways with the view to strengthen sustainability in the farming sector. Risks associated with farming activities (e.g. weather conditions, market crises, animal diseases), the economic viability of farms (e.g. low and variable profit margins/cash flow), and lack of appropriate immovable collateral and/or credit history are some of the main barriers for farmers to access finance. Supporting policies are needed to ensure farmers get the right access to financing by expanding factors that are included in financial institutions’ decision-making process, such as sustainability-focused loans.

5.3. Open Questions and further Research

This exploratory study provides background analysis for considerations on the development of an ETS policy for agricultural GHG emissions (should this be a direction chosen by EU policy makers). However, there are remaining questions that should be addressed in future research. These include:

The feasibility of a Carbon Border Adjustment Mechanism (CBAM) for agri-food goods – while a potential solution to mitigate risks of carbon leakage, a CBAM for agri-food goods could be administratively complex. Imported agri-food goods have a very different footprint depending on where they are produced, and information on inputs throughout the value chain for agri-food goods can be challenging to obtain. Therefore, research into the practicalities of a CBAM for agri-food goods is warranted in advance of extending the EU’s CBAM to agri-food goods once an ETS for agriculture would be introduced.

The implications of tariff rate quotas for an agricultural ETS - in cases where agricultural products are subject to two-tiered tariff schemes established under WTO, preferential or free-trade agreements, the degree of impact of an ETS for agriculture of the imports of those products could be influenced by the quota fill rates and domestic-border price differentials. A further analysis of the effects of a potential agricultural ETS on the imports of agri-food products currently managed through tariff rate quotas enabling specific quantities of products to be imported at reduced duty rates is warranted. An evaluation of the existing trade dynamics for such products would provide insight into possible existing barriers to imports increasing as a result of EU carbon pricing, aid the understanding of possible ETS outcomes for trade balance, and help to inform the development of measures addressing carbon leakage.

The link between consumer behaviour and the risk of carbon leakage – according to the OECD (2019), the literature on emission trading systems has generally overestimated carbon leakage in modelling predictions compared to ex-post evidence. This view was supported by one of the interviewees who highlighted that the commonly used models did not capture marketing benefits and the enhanced access to some markets due to improved sustainability credentials. Currently, the EU exports more agri-food goods than it imports, and only a small proportion of consumed meat and dairy is imported. Importantly, carbon leakage rests on consumer behaviour. Much of the economics research on carbon leakage assumes that consumers will be less willing to pay a premium for goods that have reduced their carbon footprint – this assumption does not necessarily align with sociological research on willingness to pay, which indicates that such willingness among consumers is quite high. Additionally, carbon leakage estimates assume consumers will increase their consumption of imported goods. There is a lack of sociological research examining European attitudes towards imported meat and dairy products and whether they would prefer cheaper imports from third countries in place of EU products. Currently, the only empirical evidence is from meat taxes in Denmark and Switzerland, which did result in increased imports of meat. However, these increases namely came from (other) EU Member States. Therefore, a similar increase in imports from non-EU countries cannot necessarily be assumed if there is an EU-wide ETS.

The impacts of communication and marketing strategies on willingness to reduce meat consumption - for the downstream ETS, this study has emphasized the potential impact of marketing strategies to encourage consumers towards products with a lower footprint. Such strategies could support all of the ETS options in this study. There are studies examining consumer willingness to reduce meat consumption, and compared to willingness to pay a price premium, willingness to reduce meat consumption is lower. In particular, communication of the health benefits of reducing red meat consumption, such as medically prescribed healthy diets (e.g. "cardiac diets," such as the Mediterranean diet or DASH diet), could be effective in facilitating willingness to consume less meat. Therefore, further interdisciplinary research is needed on effective communication and marketing strategies that can impact EU consumer behaviour.

Comparison of distributional impacts on consumer budgets across income groups and Member States, taking also into account the use of ETS revenues - this study has reviewed the potential impacts on the agricultural sector's competitiveness and on consumer budgets due to price fluctuations. It is worth reiterating that the existing research on the effects of carbon taxes on food products suggests the resulting reductions in consumer purchasing power are unlikely to exceed 1%. It could therefore be anticipated that regardless of ETS scope and, by extension, the range of agricultural products affected by carbon prices, the overall impacts on consumer budgets will be relatively modest. In addition, agri sector studies on price impacts often neglect the role of the potential use of revenues to alleviate such impacts, due to the limitations of the modelling tools used. Therefore, future research could explore potential impacts of revenue use, in particular potential impacts of utilising revenue for payments for removals, as discussed in the second part of this study, 'AgETS+Removals.' Nevertheless, impacts on budgets may manifest unevenly across Member States, and across consumer groups, depending on their socioeconomic status and other factors. Existing research on the consequences of carbon taxes on consumer budgets predominantly concentrates on Western European countries with comparatively affluent consumers who allocate a smaller proportion of their income toward food expenditures. Therefore, further research into the comparative impacts on budgets both between income groups and across Member States is warranted – this can aid in the development of a carefully targeted approach to ensure that vulnerable groups would not be disproportionately affected by an agricultural ETS.

The policy 'mix' needed to support a potential agricultural ETS and climate mitigation in the sector - agriculture is a sector where climate change will require a complex mix of policy measures within a framework of a holistic approach, from different points of view and different perspectives. A climate policy package for agriculture will contain several abstract policy goals and concrete policy measures. An ideal policy mixture can improve the effectiveness of the individual policy measures, minimize possible unintended effects, and/or facilitate the interventions' legitimacy and feasibility in order to increase efficiency." Designing an ETS for agriculture would need to be part of wider systemic change. Further analysis is needed of what kinds of supporting policies and reforms to current policies can enable change. An ETS for agriculture could potentially play an important role, but it would be one piece of the puzzle. The complexity of agriculture needs a wider approach, as desired changes in behaviour will result not just from one individual policy instrument, but a package of measures encouraging or discouraging a range of behaviours.

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Annex

Where the PPP is applied (object/activity)		GHG Scope	Data availability, GHG data availability	System boundaries	Point of obligation	Potential policy option applying the PPP	Potential policy Instrument(s)	What practices might be encouraged to reduce farmgate emissions?	Empirical examples	Feasibility	Other Comments
Direct emission price	CH_4 emissions	CH_4	Problematic (i.e. methane emissions), Readily available (i.e. livestock numbers)	Livestock, Manure management, Manure application	Farm	Fixed price-based (i.e. tax), Quantity-based (i.e. ETS, or sectoral targets), Standards (i.e. emission standards), Penalty-based (i.e. CAP payment reductions)	Tax on CH_4 emissions (farm level), ETS for CH_4	**direct:** reduced livestock numbers, improved manure management practices, improved livestock management practices (i.e. feed efficiency); use of feed additives;	Norway methane model; US IRA proposal for a fee on methane	Problematic due to lack of data on emissions at farm level (though Carbon Cycles Communication promises farm-level data by 2028)	Over half (53.7%) of agricultural emissions are (short-lived) CH_4 emissions and can mostly be traced to livestock activities (i.e. enteric fermentation). It may be logical to have separate pricing for CH_4 emissions to incentivise changes in livestock practices, since 25% of EU farms are solely livestock farms. However, separate pricing for CH_4 and N_2O may be problematic for mixed farms, which make up around 21% of EU farms
	N_2O emissions	N_2O	Requires new data collection (i.e. fertiliser practices)	Fertiliser, Manure application	Farm	Fixed price-based (i.e. tax), Quantity-based (i.e. ETS, or sectoral targets), Standards (i.e. emission standards), Penalty-based (i.e. CAP payment reductions)	ETS for N_2O, Tax on N_2O emissions (farm level)	**Direct:** enhance nitrogen management through nutrient planning; reduced fertiliser use; **indirect**: improved soil management	ETS for N_2O: Alberta Nox ETS	Proxy measures likely to be required, making this similar to some output and other options below	43.7% of agricultural emissions are (long-lived) N_2O emissions and can mostly be traced to the use of nutrient inputs (i.e. fertilisers) and the release of N_2O in agricultural soils (mainly from the topsoil) occurs through detritification. It may be logical to have a separate emissions price for N_2O emissions to incentivise changes in farming practices that will mitigate N_2O emissions (ie fertiliser management), since crop-specialised farms make up over half of EU farms (52.5%) However, separate pricing may be problematic and overly complex for mixed farms, which make up around 21% of EU farms

Where the PPP is applied (object/activity)		GHG Scope	Data availability, GHG data availability	System boundaries	Point of obligation	Potential policy option applying the PPP	Potential policy Instrument(s)	What practices might be encouraged to reduce farmgate emissions?	Empirical examples	Feasibility	Other Comments
	CO_2 emissions	CO_2	Problematic (i.e. methane emissions)	On-farm energy use, Burning crop residues, Soil carbon emissions	Farm	Fixed price-based (i.e. tax), Quantity-based (i.e. ETS, or sectoral targets), Standards (i.e. emission standards), Penalty-based (i.e. CAP payment reductions)	Tax on CO_2 emissions (farm level); ETS for CO_2	**Direct**: reduce emissions of on-farm machinery and equipment; reduced crop burning; re-wetting of peatlands; paludiculture	BC carbon tax on farm income	Only pricing CO_2 emissions would cover just 2% of agricultural sector emissions	CO_2 emissions largely covered by ETS/ETS2
	All emissions	All	Problematic (i.e. methane emissions), Requires new data collection (i.e. fertiliser practices), Readily available (i.e. livestock numbers)	Livestock, Manure management, Fertiliser, On-farm energy use, Manure application, Burning crop residues, Soil carbon emissions	Farm	Fixed price-based (i.e. tax), Quantity-based (i.e. ETS, or sectoral targets), Standards (i.e. emission standards), Penalty-based (i.e. CAP payment reductions)	ETS for all agricultural emissions (farm level), Tax on emissions (farm level)	**direct**: reduced livestock numbers, improved manure management practices, improved livestock management practices (i.e. feed efficiency); improved fertilisation of rice; enhanced nitrogen management through nutrient planning, reduced fertiliser use; lower emission on-farm machinery; improved soil management practices; reduced crop burning; low emission farm equipment and machinery; re-wetting or better management of peatlands; paludiculture	NZ backstop, NZ He Waka Noa, EU ETS2	Extremely complex to measure and potentially burdensome to administer	Issue of comparing different gases: Methane is relatively short-lived gas (half-life 8 years); in New Zealand they have separate pricing (and targets) for methane (rather than using Global Warming Potentials)

Where the PPP is applied (object/activity)		GHG Scope	Data availability, GHG data availability	System boundaries	Point of obligation	Potential policy option applying the PPP	Potential policy Instrument(s)	What practices might be encouraged to reduce farmgate emissions?	Empirical examples	Feasibility	Other Comments
Input	Fertiliser inputs	N_2O	Requires new data collection (i.e. fertiliser practices)	Fertiliser, Manure application	Fertiliser producer or vendor	Fixed price-based (i.e. tax), quantity-based (i.e. ETS, or sectoral targets)	Nitrogen Fertiliser Tax	**direct**: reduced fertiliser use; **indirect**: enhanced nutrient management planning	Fertiliser taxes in various European countries	Tax policy is an area where any EU decisions require a unanimous decision among member states in council. A number of member states will completely oppose community-level competences for taxation, especially in the agricultural sector (i.e. Ireland)	Overall downside of input-based pricing is that not all farmgate emissions are addressed, e.g. CO_2 from soil and burning crop residue. (although for the latter it might be theoretically possible by monitoring crop residue based on produced crops). Other emissions may be left out out if emissions were priced based on input, but could be covered under "Activity" as point of regulation (see below)
	Livestock numbers	CH_4	Readily available (i.e. livestock numbers), Problematic (i.e. methane emissions)	Livestock, Manure management	Farm or meat processors	Fixed price-based (i.e. tax), penalty based (i.e. CAP payment reductions)	Livestock tax	**Direct**: reduced livestock numbers; **indirect**: improved animal health and monitoring; animal feed mix optimisation	NZ proposal to tax cows; theoretical proposal to tax livestock producers	Taxation instruments will require unanimity in Council	
	On-farm energy use	CO_2	Problematic (i.e. methane emissions)	On-farm energy use	farm or energy supplier	Fixed price-based (i.e. tax), penalty based (i.e. CAP payment reductions)	Cap deductions - reductions for use of high emitting machinery	**Direct:** low emissions on farm machinery and equiment	Examples of energy consumption taxes in other sectors (i.e. the UK's climate change levy)	Taxation instruments will require unanimity in Council	
Output	Meat and dairy	CH_4	Readily available (i.e. livestock numbers)	Livestock, manure management	food retailer/wholesaler, consumers	Fixed price-based (i.e. tax)	Meat consumption tax	**Indirect:** reduced livestock numbers	Meat consumption tax in DK	Taxation instruments will require unanimity in Council	While there is strong evidence of 'sin' taxes encouraging more healthy behaviours (ie tobacco, sugar), consumption taxes may disporpotionately affect lower

Where the PPP is applied (object/activity)		GHG Scope	Data availability, GHG data availability	System boundaries	Point of obligation	Potential policy option applying the PPP	Potential policy Instrument(s)	What practices might be encouraged to reduce farmgate emissions?	Empirical examples	Feasibility	Other Comments
	retail/ consumption	All	Requires new data collection (i.e. fertiliser practices)	Livestock, Manure management, Fertiliser, On-farm energy use, Manure application, Burning crop residues	food retailer/wholesaler, consumers	Fixed price-based	consumption tax applied to retailers/wholesalers	**indirect**: reduced livestock numbers; lower crop output	Sugar taxes in various jurisdictions (Hungary, Denmark, Finland, France)	Taxation instruments will require unanimity in Council	income households and have unintended consequences on food inequality. A non-flat tax may be more difficult to implement
	Food processing	All	Requires new data collection (i.e. fertiliser practices)	Livestock, Manure management, Fertiliser, On-farm energy use, Manure application, Burning crop residues	Meat and food processors	Fixed price-based (i.e tax), quantity-based (i.e. ETS, or sectoral targets)	ETS on emissions (processor level), Emissions tax for processors (based on quantity produced); Emissions tax (taxed at point of entry onto market - eg abattoir)	**Indirect:** reduced livestock numbers, reduced fertiliser use;	NZ backstop proposal	MRV requirements are less complicated for processor-based instrument	Less complicated and more concentrated application of PPP to fewer actors. However, may have less of an impact on reducing emissions than direct applications of the PPP to farmgate emissions.
On-farm activity	Manure application	N_2O, CH_4	Problematic (i.e. methane emissions)	Manure application, soil carbon emissions, fertiliser	farm	Quantity-based (i.e. ETS, or sectoral targets), Penalty-based (i.e. CAP payment reductions), Standards (i.e. emission standards)	Cap deductions (enhanced cross compliance)	**Direct**: improved manure management practices; improved livestock management practices; **indirect**: reduced livestock numbers; reduced demand for meat	Nitrogen surplus tax in NL	Emissions from manure can be large, but quite variable (ie can vary by climate) and therefore inventories are associated with	maybe include compliance with codes of practice etc to modulate assumed emissions?

Where the PPP is applied (object/activity)		GHG Scope	Data availability, GHG data availability	System boundaries	Point of obligation	Potential policy option applying the PPP	Potential policy Instrument(s)	What practices might be encouraged to reduce farmgate emissions?	Empirical examples	Feasibility	Other Comments
	Manure management	CH_4, N_2O	Problematic (i.e. methane emissions)	Manure management, Livestock, Manure application	farm	Quantity-based (i.e. ETS, or sectoral targets), Penalty-based (i.e. CAP payment reductions), Standards (i.e. emission standards)	Cap deductions (enhanced cross compliance)	**Direct**: improved manure management practices; improved livestock management practices; **indirect**: reduced livestock numbers; reduced demand for meat	Kazakstan manure tax	high levels of uncertainty (see Sommer et al 2019)	Potential duplication with IED BREF for Cattle that will be developed in coming years? Pig and Poultry BREF already include manure management techniques for permitting purposes
	Burning crop residues	CO_2	Readily available (i.e. livestock numbers)	Burning crop residues	farm	Penalty-based (i.e. CAP payment reductions), Standards (i.e. emission standards)	Cap deductions (enhanced cross compliance)	**direct:** reduced crop burning	UK levy on burning crops	Already addressed in CAP GAECs	Usually addressed through regulatory measures in most jurisdictions, rather than through polluter pays instruments
	Farming on peatlands	CO_2	Data on ha of organic/peatland soils is most likely available but may need developing	Soil carbon emissions	farm	Quantity-based (i.e. ETS, or sectoral targets), Penalty-based (i.e. CAP payment reductions), Standards (i.e. emission standards)	Peatland tax	**Direct**: re-wetting/management of peatlands; paludiculture in place of dry-land agriculture	Tropical carbon taxes in Columbia and Costa Rica (revenues generated are invested in restoring and improving land management)	Lack of specific empirical case studies to examine	Integrating an emission-based tax together with an option to invest in a subsidized adjustable drainage system on peat soils in a farm-level dynamic optimization model could promote GHG abatement significantly on farms and areas with abundant peatlands (see Purola & Lehtonen 2022)

PART 2: Linking carbon removals in the land sector to an agricultural emissions trading system

AgETS+Removals study

Executive Summary - Part 2

The second part of this study investigates how a future emissions trading system on agriculture GHG emissions (AgETS) could serve to financially reward carbon removals from Land Use, Land Use Change, and Forestry (LULUCF). The first part, "*Applying the polluter-pays principle to agricultural emissions - Pricing agricultural GHG emissions along the value chain via emissions trading (AgETS Study)*" has considered the design considerations and options for an AgETS. This part assesses how such an AgETS could be extended to financially reward LULUCF carbon removals – including soil carbon, agroforestry, afforestation, improved forest management, and biochar. Such a link could be established indirectly by using revenue raised from the AgETS or directly with compliance entities under the AgETS as a source of demand. In this study, we refer to an AgETS with a carbon removal reward system as **AgETS+Removals**.

In addition to reducing their GHG emissions, the agriculture, forestry and land-use sector can also contribute to climate change mitigation by increasing the carbon removed from the atmosphere. While drastically reducing emissions will be essential to achieve climate neutrality, carbon removals will also be needed to compensate for the remaining hard-to-abate emissions. To meet the 2030 LULUCF targets of 310 Mt CO_2-e net removals per year, to achieve the EU Climate Law target of climate neutrality by 2050 and net negative emissions thereafter, carbon removals must increase. Economic incentives and market-based mechanism can play an important role in scaling up the technologies and fostering the emergence of new business models for carbon removals. The EU Commission's proposed Framework for Carbon Removal Certification (CRCF) aims to increase voluntary LULUCF carbon removals and provides important context for this study.

To support the design of an AgETS+Removals policy, this report provides an overview of four key elements:

- **AgETS policy**: What type of emissions trading systems for agriculture are LULUCF removals being connected to?
- **LULUCF removals options:** What removals activities and actors will be incentivised, and how will removed amounts be measured?
- **Key design decisions:** What rules, regulations, and design decisions are needed for an effective and efficient AgETS+Removals policy?
- **Removals policy model:** What policy model can be applied to incentivise LULUCF removals under an AgETS+Removals policy?

The report is based on a review of the theoretical and empirical literature, including case studies of eight existing market mechanisms that include removals. It also reflects insights gathered through interviews, a public survey, and a workshop of experts and stakeholders.

AgETS design

The design of the AgETS will determine the demand for LULUCF removals in the combined AgETS+Removals market. The first part of this study identified five options for an emissions trading system to cover agricultural emissions and evaluated these options. Emissions trading systems can create incentives for LULUCF removals either directly (if emitters can fulfil part of their compliance obligation with removals credits) or indirectly (if the government as a central buyer procures removal credits with revenue from the AgETS, or uses the revenues in some other form to fund LULUCF removals). The design of the AgETS would determine the potential demand for LULUCF removals in an AgETS+Removals policy, including the stringency of its cap.

LULUCF removals options

LULUCF carbon removals offer significant potential for mitigating climate change, with some removals options available at costs aligned with the prices that could reasonably be expected in an AgETS. Though dependent on certification rules and removal policy design, EU Commission modelling and evidence from voluntary and regulatory carbon markets for LULUCF removals and marginal abatement cost studies suggest that some forest management, agriculture, and afforestation removals could be delivered at prices below €25 per tonne CO_2e . With higher prices, larger volumes of removals and a broader range of removal types would become available. The mitigation potential of LULUCF removals options remains uncertain due to differences between the overall technical potential and the economic potential, which reflects how much mitigation would be implemented at a specific carbon price. The economic potential can be significantly lower due to economic barriers such as learning requirements, investment requirements, and transaction costs.

The nature of LULUCF removals poses some challenges to their incorporation into an AgETS+Removals policy. LULUCF removals are very context specific and therefore complex to monitor, report, and verify. Soil carbon and agroforestry have relatively small per ha per year sequestration rates and lack standardised quantification approaches. The impact of biochar application to soil health and biodiversity are still uncertain. For improved forest management practices, demonstrating additionality has proven difficult in existing mechanisms that credit LULUCF removals. Further, there are concerns that climate change and extreme events will undermine mitigation potential and permanence of LULUCF removals, as well as issues of land competition with food and biomass. Uncertain, overestimated, or non-additional LULUCF removals would undermine the environmental integrity of an AgETS+Removals: for instance, if non-additional LULUCF removals replace emissions reductions, there will be more emissions in the atmosphere than would have occurred if removals had not been linked to the AgETS. The CRCF methodology, which is currently still under development, aims to manage and contain such risks.

Key design decisions under an AgETS+Removals policy

Integrating LULUCF removals into an AgETS+Removals expands the options for emitters to meet their ETS compliance obligations. It may therefore lead to the substitution of some agricultural emissions reductions; the extent of this substitution will depend on the relative costs of LULUCF removals compared to agricultural emissions reductions. This, in turn, depends on the stringency of the AgETS cap and the resulting carbon price under the AgETS: the higher the price, the more relevant the issue becomes. Evidence from integrating international credits in the EU ETS illustrate that their inclusion can significantly lower market prices and therefore compliance costs but at the same time lower the incentive for domestic mitigation by the emitters covered under the ETS. This would be problematic, particularly if it exacerbates existing path dependencies and creates the impression that business as usual plus removals would be an alternative to structural changes required for deep emission reductions. When setting the AgETS+Removals cap, any expected contribution from removals must thus be factored in, along with the expected emission reductions by the sources covered in the ETS; these assumptions need to be reviewed and, if necessary, revised periodically. In this way, regulators must manage the risks to ensure that the incentives for agricultural emissions reduction remain sufficient, for instance by not directly linking removals to the AgETS, increasing the stringency of the AgETS+Removals cap, or by restricting (quantitatively or qualitatively) the use of LULUCF removals.

From a climate mitigation perspective, LULUCF carbon removals differ from agricultural emissions reductions, especially because LULUCF removals are impermanent and at risk of reversal. This risk is particularly high for soil carbon sequestration, which can be quickly and easily reversed. In contrast, agricultural emissions reductions are, by definition, permanent: a ton of emissions avoided today can never be "re-released" to the atmosphere, unlike LULUCF removals. The risk of non-permanence can be somewhat managed e.g. through eligibility restrictions, temporary credits (as is proposed by the CRCF) with an inbuilt decay function or with finite validity, buyer and seller liability for reversals, and discounting or insurance. However, these management approaches can only manage the risks associated with non-permanence, they do not overcome the root cause of non-equivalence. Some stakeholders in the workshop and survey conducted for this study therefore argued that the scale up of removal activities should be treated as separate and complementary to emission reductions, expressing their strong opposition to a system where emission reductions and removals are interchangeable.

In a dynamic view, removals should be scaled up, particularly in the medium to long-term (e.g. 2040s or post-2050), to balance out hard-to-avoid residual emissions. For removals to fulfil this role, they must scale up gradually, while advancing technologies, reducing costs, standardizing protocols (e.g. MRV), and fostering competition. Some stakeholders argue for treating removals separately from emission reductions to mitigate risks. Others see scaling up carbon removals as positive. The key objective is finding the right pace in policies to incentivise removals without risking impermanence or emission deterrence. This necessitates a gradual integration of removals into AgETS, with careful monitoring and adjustments.

Removals policy models to link to an AgETS

Five different policy models for linking a reward system for removal activities to an AgETS have been assessed, each offering different strengths and weaknesses to increase LULUCF removals. These policy models are defined according to three overarching approaches, reflecting how they are connected to the AgETS:[112]

- **'No link: disconnected markets' –** Removals are kept separate from the AgETS, with the government using revenue generated by AgETS to fund removers (i.e. no impact on AgETS cap)
- **'Indirect link: Interconnected: through government' –** The government sits between AgETS polluters and the LULUCF removers, mediating the AgETS demand for removals credits and the LULUCF supply, funding LULUCF removals using AgETS revenues or demand and in return releasing allowances into the AgETS corresponding to the LULUCF removals (i.e. affecting the AgETS cap).
- **Direct link:** The AgETS polluter purchases removals credits directly from the remover, with the removals credits affecting the AgETS cap. Three models have been considered:
    - **'Interconnected: Deductions'** – AgETS polluters reduce their AgETS compliance obligation by carrying out LULUCF removals on their own land under an on-farm AgETS or in their own supply chain under a downstream AgETS. In this model, the remover and the polluter are the same entity.

[112] Polluter refers to the compliance entities under an AgETS. Removers refers to the entities implementing LULUCF carbon removal activities.

- **'Interconnected: External credits'** – Removers can sell credits directly to AgETS polluters; removers participate voluntarily and are external to the AgETS.
- **Integrated ETS** – Removers are integrated into the AgETS as obligatory compliance entities. Participants are rewarded with allowances in return for certified carbon removals, which increase the AgETS cap.

The different removal policy models explored in this study pose different strengths and weaknesses as tools to effectively, efficiently, and equitably achieve increased LULUCF removals and agriculture/land sector mitigation. Which removal policy model is selected determines the policies' ability to meet its objectives. Selecting between different removal policy models often implies trading off between different objectives (e.g. effectiveness / environmental integrity vs. efficiency / low costs of removals) as evident from Table A. Navigating these trade-offs requires, first and foremost, clarity about the objectives and possibly their changing relevance over time: while effectiveness / environmental integrity would seem paramount in any timeframe, it can also be argued that achieving greater efficiency now can help to enable greater ambition later, if the (political or economic) cost will decline over time.

Table A Theoretical assessment of the removals policy model

		No link	Indirect link	Direct link		
		No link: Disconnected' market	Interconnected: through government	Deductions	Interconnected: External credits	Integrated ETS
Effectiveness	Increased land-based removals					
	High quality removals					
Efficiency	Static efficiency					
	Dynamic efficiency					
	Economy-wide efficiency					
	Administrative costs					
	Participant transaction costs					
Coherence	AgETS match					
Political/legal feasibility	Absence of legal/political barriers					

Ongoing monitoring and regular evaluation is important to reduce the, considerable uncertainty associated with any inclusion of removals in an AgETS market, irrespective of the removals policy model. This can help to learn from mistakes and contain the associated risks. All of these models involve learning-by-doing: as monitoring, reporting, and verification methods improve, or if initial experience with the AgETS+Removal demonstrates that they cost-effectively deliver the desired mitigation effects, then more integrated models (such as interconnection through government) could be considered. Another important consideration is the possibility for different policy models to be applied for different removals activities, depending for instance on the impermanence risks associated with those activities.

Given the risks identified above, regulators should begin with the simplest and least risky policy models. The **disconnected market** model is the least risky model because AgETS revenue is used to fund LULUCF removals, but removals cannot be used to comply with the AgETS, nor can removals credits be traded in the AgETS. The **deductions model** would risk some substitution of emissions reductions, but since participation in the model is limited to installations already covered by the AgETS cap, the risk would be smaller than in other models. The **integrated ETS model** poses significant risks and involves high administrative costs, and should represent at most a long-term orientation rather than a concrete AgETS+Removal option for the near-term future.

Stakeholder activities conducted in this study found that support widely differs for the removal policy models in combination with the studied AgETS options. All AgETS options - on-farm, upstream (e.g. ETS obligations on feed and fertiliser importers), and downstream (e.g. ETS obligations on milk and meat processors) - can be combined with all removal policy models except for the deductions model with an upstream AgETS due to practical challenges. The downstream AgETS in combination with the 'No link: disconnected market' model and the 'Direct link: deductions' model received the strongest support among stakeholders surveyed for this study, as shown in Table B. In contrast, combinations of the 'Indirect link: interconnected through government' model or 'Direct link: external credits' model were the least preferred by stakeholders, particularly when combined with an on-farm ETS or upstream ETS. In general, the stakeholders opposed an on-farm ETS in almost all combinations.

Table B Stakeholder preferences for combinations between AgETS options and removal policy models

Policy models for linking LULUCF carbon removals	AgETS options		
	On-farm ETS	Upstream ETS	Downstream ETS
No link: Disconnected market	+/-	+/-	++
Indirect link: Interconnected through government	--	-	+
Direct link: Deductions	--	+/-	++
Direct link: External credits	--	-	+
Direct link: Integrated ETS	-	+/-	+

Note: ++ = strongly preferred, +/- = neither prefer or not preferred, -- = strongly not preferred.

An AgETS+Removals policy must be accompanied by wider sectoral and economy-wide changes to transition the land sector to sustainability. Increasing the climate ambition of the Common Agricultural Policy will be essential to synergistically reduce opportunity costs of implementing carbon removals for farmers and could support farmers to develop the skills and knowledge associated with carbon removals. In addition, much abatement potential remains untapped all along the agricultural value chain. The role of removals will change over time: initially, accelerating emissions reductions and tackling the necessary structural changes needs to have priority, with a relatively limited role for removals. That role is set to increase in significance as the economy approaches climate neutrality in the 2040s, and net-negative emissions in the second half of the century. Since the regulation and incentivisation of removals is a new field and will involve much learning-by-doing, it is all the more vital to initiate this learning process now, to avail of a well-understood and well-regulated market for removals activities at the time when it is needed.

This exploratory study provides background analysis for the assessment of an AgETS+Removals policy (should this be the future policy direction), although many questions still have to be answered. The study identifies a number of open questions and areas for further research, including:

- How the final form of the CRCF methodologies (which are still under development) fit to the removals policy models discussed in this report;

- A need for further research into EU-level marginal abatement cost curves for LULUCF removals to better understand potential removals supply in Europe;
- An assessment of the new Common Agricultural Policy (2023-2027) and its ability to deliver LULUCF removals, and how the new CAP might interact with any AgETS+Removals policy;
- Further research on the impacts of biochar, for example with respect to land-use change, soil health, and biodiversity;
- A need for further development of monitoring, reporting and verification approaches to address the significant uncertainties and assumptions inherent in their application;
- The development of the policy models into concrete AgETS+Removals policy options to be assessed according to their economic, environmental, and social impacts.

Résumé - Partie 2

Cette étude exploratoire examine comment un futur système d'échange de quotas d'émission de GES d'origine agricole (AgETS) pourrait servir à récompenser financièrement les absorptions de carbone dans le secteur de l'utilisation des terres, du changement d'affectation des terres et de la foresterie (UTCATF). La première partie de cette étude intitulé " *Applying the polluter-pays principle to agricultural emissions - Pricing agricultural GHG emissions along the value chain via emissions trading (AgETS Study)*" a examiné les considérations et les options de conception d'un AgETS. Cette partie évalue comment un tel système pourrait être étendu pour récompenser financièrement les absorptions de carbone liées à l'UTCATF - y compris le carbone du sol, l'agroforesterie, le boisement, la gestion forestière améliorée et le biochar. Un tel lien pourrait être établi indirectement en utilisant les revenus générés par l'AgETS ou directement avec les entités de conformité dans le cadre de l'AgETS comme source de demande. Dans cette étude, nous appelons ***AgETS+Removals*** un système AgETS avec un système de récompense pour l'absorption du dioxide de carbone.

Outre la réduction de leurs émissions de GES, les secteurs de l'agriculture, de la sylviculture et de l'aménagement du territoire peuvent également contribuer à l'atténuation du changement climatique en augmentant la quantité de dioxide de carbone éliminée de l'atmosphère. S'il est essentiel de réduire radicalement les émissions pour parvenir à la neutralité climatique, l'absorption du carbone sera également nécessaire pour compenser les émissions restantes difficiles à supprimer. Pour atteindre les objectifs de l'UTCATF pour 2030, à savoir 310 Mt CO_2-e d'absorptions nettes par an, et pour atteindre l'objectif de la loi européenne sur le climat, à savoir la neutralité climatique d'ici 2050 et des émissions nettes négatives par la suite, les absorptions de carbone doivent augmenter. Les incitations économiques et les mécanismes fondés sur le marché peuvent jouer un rôle important dans l'extension des technologies et favoriser l'émergence de nouveaux modèles commerciaux pour l'absorption du carbone. Le cadre proposé par la Commission européenne pour la certification de l'absorption du carbone (CRCF) vise à accroître l'absorption volontaire du carbone de l'UTCATF et fournit un contexte important pour cette étude.

Afin d'aider à la conception d'une politique AgETS+Removals, ce rapport fournit une vue d'ensemble de quatre éléments clés :

- **Politique AgETS :** À quel type de système d'échange de quotas d'émission pour l'agriculture les absorptions dans le secteur de l'UTCATF sont-elles liées ?
- **Options d'absorption de l'UTCATF :** Quels sont les activités et les acteurs qui seront encouragés à procéder à l'absorption et comment les quantités absorbées seront-elles mesurées ?
- **Décisions clés en matière de conception :** Quelles sont les règles, les réglementations et les décisions de conception nécessaires à une politique efficace et efficiente en matière d'AgETS+Removals?
- **Modèle de politique d'absorption :** Quel modèle de politique peut être appliqué pour encourager l'absorption dans le secteur de l'UTCATF dans le cadre d'une politique AgETS+ Absorptions?

Le rapport s'appuie sur une analyse de la littérature théorique et empirique, y compris des études de cas portant sur huit mécanismes de marché existants qui incluent l'éloignement. Il reflète également les idées recueillies lors d'entretiens, d'une enquête publique et d'un atelier réunissant des experts et des parties prenantes.

Conception de l'AgETS

La conception du système AgETS déterminera la demande d'absorptions liées à l'UTCATF sur le marché combiné AgETS+Removals. La première partie de cette étude a identifié cinq options pour un système d'échange de quotas d'émission couvrant les émissions agricoles et les a évaluées. Les systèmes d'échange de quotas d'émission peuvent créer des incitations à l'absorption du dioxide de carbone, soit directement (si les émetteurs peuvent remplir une partie de leur obligation de conformité avec des crédits d'absorption), soit indirectement (si le gouvernement, en tant qu'acheteur central, achète des crédits d'absorptions avec les revenus de l'AgETS, ou utilise les revenus sous une autre forme pour financer les absorptions du dioxide de carbone). La conception de l'AgETS déterminerait la demande potentielle absorptions du dioxide de carbone dans une politique AgETS+Removals, y compris la rigueur de son plafond.

Options d'absorption du dioxide de carbone dans le secteur de l'UTCATF

Les absorptions de carbone liées à l'UTCATF offrent un potentiel important d'atténuation du changement climatique, certaines options d'absorptions étant disponibles à des coûts alignés sur les prix auxquels on pourrait raisonnablement s'attendre dans le cadre d'un AgETS. Bien que cela dépende des règles de certification et de la conception de la politique d'absorption, la modélisation de la Commission européenne et les données provenant des marchés volontaires et réglementaires du carbone pour les absorptions et les études sur les coûts marginaux de réduction suggèrent que certaines absorptions liées à la gestion forestière, à l'agriculture et au boisement pourraient être réalisées à des prix inférieurs à 25 euros par tonne de CO_2-e. Des prix plus élevés permettraient d'obtenir des volumes d'absorptions plus importants et un éventail plus large de types d'absorptions. Le potentiel d'atténuation des options d'absorptions du carbone liées à l'UTCATF reste incertain en raison des différences entre le potentiel technique global et le potentiel économique, qui reflète l'ampleur des mesures d'atténuation qui seraient mises en œuvre pour un prix du carbone donné. Le potentiel économique peut être nettement inférieur en raison d'obstacles économiques tels que les exigences en matière d'apprentissage et d'investissement et les coûts de transaction.

La nature des absorptions du dioxide de carbone pose certains problèmes pour leur incorporation dans une politique AgETS+Removals. Les absorptions liées à l'UTCATF sont très spécifiques au contexte et donc complexes à suivre, à rapporter et à vérifier. Le carbone du sol et l'agroforesterie ont des taux de séquestration par hectare et par an relativement faibles et ne font pas l'objet d'approches de quantification normalisées. L'impact de l'application du biochar sur la santé des sols et la biodiversité est encore incertain. En ce qui concerne les pratiques de gestion forestière améliorée, il s'est avéré difficile de démontrer l'additionnalité dans les mécanismes existants qui créditent les absorptions du dioxide de carbone. En outre, on craint que le changement climatique et les événements extrêmes ne compromettent le potentiel d'atténuation et la permanence des absorptions du dioxide de carbone, ainsi que les problèmes de concurrence entre les terres pour l'alimentation et la biomasse. Des absorptions incertaines, surestimées ou non additionnelles liées à l'UTCATF compromettraient l'intégrité environnementale d'un AgETS+Removals: par exemple, si des absorptions non additionnelles remplacent des réductions d'émissions, il y aura plus d'émissions dans l'atmosphère que si les absorptions n'avaient pas été liées à l'AgETS. La méthodologie du CRCF, qui est encore en cours d'élaboration, vise à gérer et à contenir ces risques.

Décisions clés en matière de conception dans le cadre d'une politique AgETS+Removals

L'intégration des absorptions liées à l'UTCATF dans un système AgETS+Removals élargit les options dont disposent les émetteurs pour remplir leurs obligations de conformité au SEQE. Elle peut donc conduire à la substitution de certaines réductions d'émissions agricoles ; l'ampleur de cette substitution dépendra des coûts relatifs des absorptions liées à l'UTCATF par rapport aux réductions d'émissions agricoles. L'ampleur de cette substitution dépendra des coûts relatifs des absorptions par rapport aux réductions d'émissions agricoles, ce qui, à son tour, dépend de la rigueur du plafond de l'AgETS et du prix du carbone qui en résulte dans le cadre de l'AgETS : plus le prix est élevé, plus la question devient pertinente. L'intégration de crédits internationaux dans le SEQE montre qu'elle peut faire baisser considérablement les prix du marché et donc les coûts de mise en conformité, tout en diminuant l'incitation à l'atténuation nationale par les émetteurs couverts par le SEQE. Cette situation serait problématique, en particulier si elle exacerbait les dépendances existantes et donnait l'impression que le maintien du status quo et les absorptions seraient une alternative aux changements structurels nécessaires pour réduire les émissions de manière significative. Lors de la fixation du plafond du **AgETS+Removals** absorptions, toute contribution attendue des absorptions doit donc être prise en compte, de même que les réductions d'émissions attendues des sources couvertes par le AgETS ; ces hypothèses doivent être réexaminées et, le cas échéant, révisées périodiquement. De cette manière, les régulateurs doivent gérer les risques pour s'assurer que les incitations à la réduction des émissions agricoles restent suffisantes, par exemple en ne liant pas directement les absorptions à l'AgETS, en augmentant la rigueur du plafond AgETS+Removals, ou en limitant (quantitativement ou qualitativement) l'utilisation des absorptions liées à l'UTCATF.

Du point de vue de l'atténuation du climat, les absorptions liées à l'UTCATF diffèrent des réductions d'émissions agricoles, en particulier parce que les absorptions sont impermanentes et risquent de s'inverser. Ce risque est particulièrement élevé pour le piégeage du carbone dans le sol, qui peut être rapidement et facilement inversé. En revanche, les réductions d'émissions agricoles sont, par définition, permanentes : une tonne d'émissions évitée aujourd'hui ne peut jamais être "relâchée" dans l'atmosphère, contrairement aux absorptions liées à l'UTCATF. Le risque de non-permanence peut être quelque peu géré, par exemple par des restrictions d'éligibilité, des crédits temporaires (comme le propose le CRCF) avec une fonction de décroissance intégrée ou une validité limitée, la responsabilité de l'acheteur et du vendeur en cas d'inversion, et l'actualisation ou l'assurance. Cependant, ces approches de gestion ne peuvent que gérer les risques associés à la non-permanence, elles ne résolvent pas la cause fondamentale de la non-équivalence. Certaines parties prenantes de l'atelier et de l'enquête menés dans le cadre de cette étude ont donc fait valoir que l'intensification des activités d'absorption devrait être traitée comme distincte et complémentaire des réductions d'émissions, exprimant ainsi leur forte opposition à un système dans lequel les réductions d'émissions et les absorptions sont interchangeables.

Dans une perspective dynamique, l'absorption devrait être renforcée, en particulier à moyen et long terme (par exemple dans les années 2040 ou après 2050), afin d'équilibrer les émissions résiduelles difficiles à éviter. Pour que l'absorption remplisse ce rôle, elle doit augmenter progressivement, tout en faisant progresser les technologies, en réduisant les coûts, en normalisant les protocoles (par exemple, MRV) et en encourageant la concurrence. Certaines parties prenantes préconisent de traiter l'absorption séparément des réductions d'émissions afin d'atténuer les risques. D'autres considèrent que l'augmentation de l'absorption du carbone est positive. L'objectif principal est de trouver le bon rythme dans les politiques afin d'encourager l'absorption sans risquer l'impermanence ou la dissuasion des émissions. Cela nécessite une intégration progressive de l'absorption dans le système AgETS, avec un suivi et des ajustements minutieux.

Modèles de politique d'éloignement à relier à un AgETS

Cinq modèles politiques différents ont été évalués pour lier un système de récompense des activités d'absorption à un système AgETS, chacun présentant des forces et des faiblesses différentes pour augmenter les absorptions liées à l'UTCATF. Ces modèles politiques sont définis selon trois approches globales, reflétant la manière dont ils sont liés à l'AgETS :[113]

- **Pas de lien : marchés déconnectés"** - Les absorptions sont séparées de l'AgETS, le gouvernement utilisant les revenus générés par l'AgETS pour financer les enlèvements (pas d'impact sur le plafond de l'AgETS).
- **Lien indirect : Interconnecté : par l'intermédiaire du gouvernement" -** Le gouvernement se situe entre les pollueurs du AgETS et les responsables de l'absorption dans le sectur de l'UTACTF, en servant d'intermédiaire entre la demande de crédits d'absorption du AgETS et l'offre de l'UTCARF, en finançant les absorptions à l'aide des revenus ou de la demande du AgETS et en libérant en retour des quotas dans le AgETS correspondant aux absorptions (c'est-à-dire en influant sur le plafond du AgETS).
- **Lien direct :** Le pollueur AgETS achète des crédits d'absorption directement de l'éliminateur, les crédits d'absorption affectant le plafond AgETS. Trois modèles ont été envisagés :
    - **Interconnecté : Déductions**" - les pollueurs AgETS réduisent leur obligation de conformité AgETS en réalisant des absorptions liées à l'UTCATF sur leurs propres terres dans le cadre d'un AgETS sur l'exploitation ou dans leur propre chaîne d'approvisionnement dans le cadre d'un AgETS en aval. Dans ce modèle, l'auteur de la réduction et le pollueur sont la même entité.
    - **Interconnecté : Crédits externes**" - Les éliminateurs peuvent vendre des crédits directement aux pollueurs de l'AgETS ; les éliminateurs participent volontairement et sont externes à l'AgETS.
    - **SCEQE intégré** - Les entreprises d'absorption de carbone sont intégrées dans l'AgETS en tant qu'entités de conformité obligatoire. Les participants sont récompensés par des quotas en échange d'absorptions certifiées de carbone, qui augmentent le plafond de l'AgETS.

Les différents modèles de politique d'absorption explorés dans cette étude présentent des avantages et des désavantages différents en tant qu'outils permettant d'atteindre de manière efficace, efficiente et équitable l'augmentation des absorptions liées à l'UTCATF et l'atténuation dans le secteur agricole et de l'aménagement du territoire. Le choix du modèle de politique d'absorption détermine la capacité des politiques à atteindre leurs objectifs. Le choix entre différents modèles de politique implique souvent un compromis entre différents objectifs (par exemple, efficacité / intégrité environnementale contre efficacité / faibles coûts d'absorption), comme le montre le tableau A. Pour naviguer dans ces compromis, il faut avant tout clarifier les objectifs et éventuellement leur pertinence changeante au fil du temps : alors que l'efficacité / intégrité environnementale semble primordiale à tout moment, on peut également soutenir qu'une plus grande

[113] Le pollueur désigne les entités chargées de la mise en conformité dans le cadre d'un SETA. Les éliminateurs désignent les entités qui mettent en œuvre des activités d'absorption du carbone dans le cadre de l'UTCATF.

efficacité aujourd'hui peut permettre une plus grande ambition plus tard, si le coût (politique ou économique) diminue au fil du temps.

Tableau A Évaluation théorique du modèle de politique d'éloignement

		Aucun lien	Lien indirect	Lien direct		
		Pas de lien : Marché "déconnecté	Interconnectés : par le biais du gouvernement	Déductions	Interconnectés : Crédits externes	SEQE intégré
Efficacité	Augmentation des aménagements du territoire					
	Déménagements de haute qualité					
Efficacité	Efficacité statique					
	Efficacité dynamique					
	Efficacité à l'échelle de l'économie					
	Frais administratifs					
	Coûts de transaction des participants					
Cohérence	Match AgETS					
Faisabilité politique/juridique	Absence d'obstacles juridiques/politiques					

Un suivi continu et une évaluation régulière sont importants pour réduire l'incertitude considérable associée à toute inclusion des absorptions dans un marché AgETS, quel que soit le modèle de politique d'absorptions. Cela peut permettre de tirer des leçons des erreurs commises et de limiter les risques associés. Tous ces modèles impliquent un apprentissage par la pratique : au fur et à mesure que les méthodes de suivi, de déclaration et de vérification s'améliorent, ou si l'expérience initiale avec l'AgETS+Removals démontre qu'ils produisent de manière rentable les effets d'atténuation souhaités, des modèles plus intégrés (tels que l'interconnexion par l'intermédiaire du gouvernement) pourraient être envisagés. Une autre considération importante est la possibilité d'appliquer différents modèles de politique pour différentes activités d'absorption, en fonction, par exemple, des risques d'impermanence associés à ces activités.

Compte tenu des risques identifiés ci-dessus, les régulateurs devraient commencer par les modèles politiques les plus simples et les moins risqués. Le modèle de **marché déconnecté** est le modèle le moins risqué car les revenus de l'AgETS sont utilisés pour financer les absorptions liées à l'UTCATF, mais les absorptions ne peuvent pas être utilisées pour se conformer à l'AgETS, et les crédits d'absorptions ne peuvent pas non plus être échangés dans l'AgETS. Le **modèle des déductions comporte un** risque de substitution des réductions d'émissions, mais comme la participation au modèle est limitée aux installations déjà couvertes par le plafond de l'AgETS, le risque serait moindre que dans les autres modèles. Le **modèle de SEQE intégré** présente des risques importants et implique des coûts administratifs élevés. Il devrait représenter tout au plus une orientation à long terme plutôt qu'une option concrète AgETS+Removals suppression pour l'avenir à court terme.

Les activités des parties prenantes menées dans le cadre de cette étude ont révélé que le soutien diffère largement pour les modèles de politique d'absorption en combinaison avec les options AgETS étudiées. Toutes les options AgETS - à la ferme, en amont (par exemple, obligations ETS pour les importateurs d'aliments pour animaux et d'engrais) et en aval (par exemple, obligations ETS pour les transformateurs de lait et de viande) - peuvent être combinées avec tous les modèles de politique d'absorption, à l'exception du modèle de déduction avec un AgETS en amont, en raison de difficultés pratiques. L'AgETS en aval combiné au modèle "Aucun lien : marché déconnecté" et au modèle "Lien direct : déductions" a reçu le plus fort soutien des parties prenantes interrogées dans le cadre de cette étude, comme le montre le tableau B. En revanche, les combinaisons du modèle "Lien indirect : interconnecté par le biais du gouvernement" ou du modèle "Lien direct : crédits externes" ont été les moins appréciées par les parties prenantes, en particulier lorsqu'elles sont combinées à un système d'échange de quotas d'émission à la ferme ou à un système d'échange de quotas d'émission en amont. En général, les parties prenantes se sont opposées à un système d'échange de quotas d'émission dans les exploitations agricoles dans presque toutes les combinaisons.

Tableau B Préférences des parties prenantes pour les combinaisons entre les options du AgETS et les modèles de politique d'absorption

	Options de l'AgETS		
Modèles politiques pour relier les absorptions de carbone liées à l'UTCATF	**Système d'échange de quotas d'émission dans les exploitations**	**Système d'échange de quotas d'émission en amont**	**Système d'échange de quotas d'émission en aval**
Pas de lien : Marché déconnecté	+/-	+/-	++
Lien indirect : Interconnecté par l'intermédiaire du gouvernement	--	-	+
Lien direct : Déductions	--	+/-	++
Lien direct : Crédits externes	--	-	+
Lien direct : ETS intégré	-	+/-	+

Note : ++ = fortement préférée, +/- = ni préférée ni non préférée, -- = fortement non préférée.

Une politique AgETS+Removals doit s'accompagner de changements sectoriels et économiques plus vastes afin d'assurer la transition du secteur de l'UTCATF vers la durabilité. Il sera essentiel d'accroître l'ambition climatique de la politique agricole commune (PAC) pour réduire de manière synergique les coûts d'opportunité liés à la mise en œuvre de l'absorption du carbone pour les agriculteurs et pour aider ces derniers à développer les compétences et les connaissances associées à l'absorption du carbone. En outre, un important potentiel de réduction reste inexploité tout au long de la chaîne de valeur agricole. Le rôle de l'absorption évoluera avec le temps : dans un premier temps, la priorité sera accordée à l'accélération de la réduction des émissions et à la mise en œuvre des changements structurels nécessaires, l'absorption ne jouant qu'un rôle relativement limité. Ce rôle est appelé à prendre de l'importance à mesure que l'économie se rapproche de la neutralité climatique dans les années 2040, et des émissions nettes négatives dans la seconde moitié du siècle. La réglementation et l'incitation à l'absorption étant un domaine nouveau qui nécessitera un apprentissage par la pratique, il est d'autant plus important d'entamer ce processus d'apprentissage dès maintenant, afin de disposer d'un marché bien compris et bien réglementé pour les activités d'absorption au moment où l'on en aura besoin.

Cette étude exploratoire fournit une analyse de fond pour l'évaluation d'une politique AgETS+Removals (si cela devra être l'orientation future de la politique), bien que de nombreuses

questions restent encore ouvertes. L'étude identifie un certain nombre de questions ouvertes et de domaines nécessitant des recherches plus approfondies, notamment :

- Comment la forme finale des méthodologies CRCF (qui sont encore en cours de développement) s'adapte aux modèles de politique d'absorption discutés dans ce rapport ;
- Il est nécessaire de poursuivre les recherches sur les courbes de coûts marginaux de réduction des émissions liées à l'UTCATF au niveau de l'UE afin de mieux comprendre l'offre potentielle d'émissions dans l'UE;
- Une évaluation de la nouvelle PAC (2023-2027) et de sa capacité à réaliser des réductions de l'UTCATF, ainsi que de la manière dont celle-ci pourrait interagir avec toute politique AgETS+Removals ;
- Poursuivre les recherches sur les effets du biochar, par exemple en ce qui concerne le changement d'affectation du secteur de l'UTCATF, la santé des sols et la biodiversité ;
- La nécessité de poursuivre le développement des approches en matière de suivi, de déclaration et de vérification afin de tenir compte des incertitudes et des hypothèses importantes inhérentes à leur application ;
- Le développement des modèles politiques en options politiques concrètes de AgETS+Removals à évaluer en fonction de leurs impacts économiques, environnementaux et sociaux.

1. Introduction

This second part complement the first part: Pricing agricultural GHG emissions along the value chain via emissions trading (AgETS Study), which focuses on the design of an emissions trading system for agricultural emissions (“AgETS”). Throughout this part of the study, we refer to the first part of the study as the “AgETS Study”

An emissions trading system for agriculture would generate revenue or allowance demand that could be used to reward additional climate mitigation in the land sector. In the first part of this study, the AgETS Study, we proposed and evaluated emissions trading system designs to price emissions in Europe’s agriculture and land-use sector (we refer to these throughout the report as “**AgETSs**” – unless otherwise stated, any mention of “ETS” in this report refers to AgETSs, and not to the existing European Emissions Trading System).[114] In addition to incentivising reduced agricultural emissions, an AgETS could finance other mitigation in the land sector: AgETS allowances could be auctioned, with revenue earmarked for further climate action in the agriculture or land sector, or allowances could be generated by climate action outside the AgETS.[115]

In addition to reducing agricultural emissions, the agriculture, forestry and land-use (AFOLU) sector can mitigate climate change through increased carbon removals. While rapid emissions reductions are the first priority to keep global warming below 1.5°C, removing carbon from the atmosphere will also be essential – not as a replacement for reduced emissions but a complement (IPCC 2022). In this report, our focus is on incentivising land-based carbon removals, specifically by linking them to an AgETS. In this report we focus on LULUCF removals; policy options to avoid emissions from agricultural land are discussed in the AgETS Study.[116] While we focus on carbon removals, the policy models we describe here could also be used to promote other types of climate mitigation in the land sector.

This need to deliver removals is matched by numerous EU policies that aim to enhance removals in the LULUCF sector, which nevertheless need bolstering. The European Climate Law (EU 2021/1119), which sets the goal of climate neutrality by 2050 into law, provides an overarching guidance for the development of carbon removal frameworks. It furthermore introduces a back-stop provision for the intermediate target of -55% in 2030 by limiting the contribution of net removals to this target to 225 Mt CO_2-e. Furthermore, the recent amendment to the Land Use, Land Use Change, and Forestry (LULUCF) Regulation (EU 2023/839) introduces binding net removal targets for the LULUCF sector in both the EU and individual Member States (the overall target is -310 MtCO_2-e by 2030). This will require a reversal in current LULUCF removal trends, which have seen net annual removals fall from 322 Mt in 2010 to just 230 Mt in 2021 (EEA 2023). The Common Agricultural Policy (CAP) aims to promote climate-friendly soil measures by setting minimum requirements for funding and offering certain subsidies and incentives. The effectiveness of these measures at reducing net emissions has, however, been questioned by the

[114] Note: while the AgETS study only considered an emissions trading scheme in detail in the study, other policy options could also be used to implement polluter pays in agriculture, including e.g. taxes or quotas.
[115] Revenue could also be used to address costs of the AgETS policy for vulnerable communities within or outside of the sector, e.g. revenues could support a Just Transition Fund for low-income farmers, or a social fund (similar to the Social Climate Fund) to reduce costs for e.g. low income households.
[116] The polluter pays incentives that are the focus of the AgETS study generate incentives for avoiding emissions from soils and biomass, in so far as soils and biomass are included in the scope the AgETS. This is assessed in particular in AgETS Study Policy Option 3 – Peatlands study.

European Court of Auditors (2021). They concluded that “CAP measures did not lead to an overall increase in carbon content stored in soils and plants”, with little protection of carbon stored in grasslands, little uptake of effective mitigation measures on arable land including limited agroforestry or afforestation implementation (*Ibid.*).[117] A number of EU strategies and policies also generally support and encourage carbon removals in the LULUCF sector, such as the EU Soil Strategy, Farm to Fork Strategy, and the EU Forestry Strategy, the Nature Restoration Law, and the proposed Soil Health Law.

The EU climate policies make it clear that LULUCF removals will need to be increasingly scaled up over time. Long-term strategies illustrate that in the 2040-2050s, they will be essential to balance out residual emissions that are very hard to avoid, including from agriculture (European Commission 2018). Therefore, one priority for EU policy is to support the long-term scaling up of LULUCF removals, including through policy piloting, learning-by-doing, and developing the necessary skills, technologies, and long-term incentives. More than three quarters of the stakeholders surveyed for this study also indicated that more policy action is needed to increase carbon removals in the LULUCF sector.

The European Commission’s proposed carbon removal certification framework (CRCF) (COM 2022/672) aims to support the scale up of carbon removal activities, including LULUCF removals. The CRCF will establish a Europe-wide voluntary framework for certifying different types of carbon removals, including LULUCF removals (referred to as “carbon farming”). The framework establishes principles for the certification of removals. To be certified, removals must meet the so-called “QU.A.L.ITY” criteria – that is, be robustly quantified, additional, long-lasting, and contribute to sustainability.[118] A procedure for certification is also proposed: removals activities would need to be certified by a voluntary public or private certification scheme that has been approved by the Commission. The proposed framework is still under development: it proposes high-level principles and approaches for assessing removals, but leaves detailed descriptions of how QU.A.L.ITY criteria would apply to different carbon removals to later delegated acts. Previous experience developing similar methodologies, e.g. under the Clean Development Mechanism, illustrate that the development of certification methodologies will be challenging. The development of the certification methodologies that will be established by these delegated acts will be supported by an Expert Group, who first met on the 7 March 2023.[119] The proposal is concurrently being discussed by the European Parliament and European Council, with a final framework not expected before 2024. The proposal does not establish the use of the certified removals, i.e. whether they are for offsetting in voluntary carbon markets, public financing, labelling or other uses. Once in place, the framework and the carbon farming certification methodologies could also be applied to quantify and certify carbon removals in the policy models we evaluate in this report.[120]

1.1. Structure of this report

This report draws on literature and expert interviews to discuss the design of an AgETS+Removals policy: a policy that takes revenue or allowance demand from an agricultural emissions trading

[117] The EU Commission responded to some European Court of Auditors’ criticisms in an official reply, available at https://www.eca.europa.eu/Lists/ECAReplies/COM-Replies-SR-21-16/COM-Replies-SR21_16_EN.pdf
[118] See Section 3.2 for a more detailed description of the CRCF criteria.
[119] More information on the Expert Group can be found here: https://climate.ec.europa.eu/eu-action/sustainable-carbon-cycles/expert-group-carbon-removals_en. Note Ecologic Institute is an institutional member of the 70+ member Expert Group.
[120] The details of the certification methodologies will determine whether they are appropriate for the policy models discussed in this report. For instance, some certification approaches could be less appropriate for a ‘Direct Link: External crediting’ model but may propose sufficiently cost-effective MRV processes to e.g. maximise uptake in a No-link: Disconnected Market model. We discuss this issue of “non-equivalency” in detail in Section 0; policy models are discussed in detail in Chapter 5.

system (AgETS) to incentivise LULUCF carbon removals.[121] As illustrated in Figure 13, an AgETS+Removals policy is characterised by four components, which we address in the report in turn:

- The scope and design of the AgETS policy that the removals are linked to, which determines the **demand for removals**
- The scope of removals, i.e. what removals solutions are permitted and what monitoring, reporting, and verification is applied to measure them, which determines the **supply of removals**
- Specific **design elements**, i.e. rules, regulations, policy approaches that are applied to manage the AgETS+Removals policy.
- The **removals policy model**, i.e. what type of policy links AgETS demand or revenue to removals

Given the exploratory nature of the report, we consider each of the components in isolation. The report is modular, with the reader able to consider each component separately. We do not present or assess any concrete potential AgETS+Removal policy options but instead identify key issues and insights related to each component that must be considered when developing such a policy.[122]

Figure 13 AgETS+Removals policy components

Ch. 2 Demand for removals: AgETS policy option
(i.e. what AgETS are LULUCF removals being connected to?)

- **On farm all GHGs** (all gases; all sources; farm-level; large coverage)
- **On farm livestock** (all gases; livestock; farm-level; medium coverage)
- **On farm just peatlands** (all gases - mainly co2; soil emissions; farm-level; small coverage)
- **Downstream** (CH4/N2O; livestock; processor level; medium coverage)
- **Upstream** (all gases; livestock emissions and fertiliser; upstream; medium coverage)

Ch. 3 Supply of removals: LULUCF removals
(i.e. what removals activities and actors will be incentivised, and how will they be measured?)

Forestry
- Afforestation/reforestation
- Improved forest management

Agriculture
- Agroforestry
- Soil carbon

Biochar
- Biochar

Ch. 4 Design elements
(i.e. what rules, regulations, and design decisions should be applied to the removal policy?)

ETS-related decisions
- Managing emissions reduction deterrence
- Liquidity
- Funding different types of removal
- Managing non-equivalence

Other design decisions
- Sustainability impacts
- Policy coherence
- Avoid double counting
- Distributional/political acceptability issues

Ch. 5 Removals policy model
(i.e. what policy model should be applied to use AgETS demand/funding to incentivse removals?)

- **Disconnected market** (government uses AgETS revenue to procure removals; removals stay out of AgETS)
- **Interconnected: through government** (government uses AgETS revenue to procure removals; sells removal credits into AgETS)
- **Deductions** (AgETS polluters can reduce emissions liability through removals)
- **External credits** (removals sold as external credits into AgETS)
- **Integrated ETS** (removals part of AgETS)

Any AgETS+Removals policy will feature a combination of each of these components. The linking of removals to an AgETS effectively creates a new "market" for removals, with the demand for removals determined largely by the AgETS design, and the supply of removals determined by the scope of LULUCF removals covered. Accordingly, in Chapter 2 of this report we first summarise the

[121] While this report focuses on the use of AgETS revenue or allowance demand to incentivise LULUCF removals, it could also be used for other sources of mitigation, e.g. to incentivise agricultural emissions reductions not covered by the ETS.
[122] In this way, the report differs somewhat from the AgETS study, which identified and evaluated five concrete AgETS policy options.

options for AgETSs (evaluated in detail in the AgETS study). We identify the key characteristics relevant for removals policy option design, including the types of gases they cover, sectoral coverage and points of obligation, and the level and type of demand for emissions allowances, all of which determine the demand for removals units. Also important for removals policy design are the characteristics of the LULUCF removals themselves; in Chapter 3 we provide an overview of EU LULUCF removal options and their relative suitability for integration into an AgETS and potential scale; these elements determine the supply of removals into any AgETS+Removals. Here, we also focus on a key requirement for LULUCF removals: the monitoring, reporting and verification (MRV) of removals, which is essential to quantify removals that occur and ensure that they are of acceptable environmental integrity, and discuss how the CRCF proposes to address this.

For each removal policy model, policy makers have considerable latitude in the specific rules and regulations for implementation – their design decisions can have potentially large impacts on the effectiveness of the removal policies. In Chapter 4, we focus on a set of particularly relevant design decisions for any AgETS+Removals policy. These cross-cutting issues include pressing emissions trading-related issues, including managing AgETS emissions reduction deterrence, managing liquidity and facilitating net negative removal caps, and incentivising different types of removals with differentiated prices. We also focus on a key challenge: the non-equivalence of LULUCF removals and AgETS emissions reductions – we identify the risks for environmental integrity as well as options for managing (but not completely getting rid of) the risk. We also consider other key AgETS+Removals decisions, including ensuring that carbon removals also deliver environmental and social co-benefits, alignment with national inventories, avoiding double-counting, and options for increasing political and social acceptability of AgETS+Removals policy.

A specific focus of this report is on understanding potential removal policy models that link removals to the AgETS. In Chapter 5 we provide an overview of potential policy models. We identify five theoretical model types:

- The *'No link: Disconnected' markets* model uses AgETS revenue to fund LULUCF removals but keeps LULUCF removals and AgETS emissions reductions separate.
- The '*Indirect link: Interconnected' through government* model features the government as an intermediary, funding LULUCF removals using AgETS revenues or demand and in return releasing allowances into the AgETS corresponding to the LULUCF removals (i.e. affecting the AgETS cap).
- The three *Direct link* models we consider are typified by AgETS polluters purchasing removals credits directly from LULUCF removers, affecting the AgETS cap:
  - The *Deductions* model allows AgETS polluters to reduce their compliance obligations by implementing LULUCF removals themselves;
  - The *External credits* model features voluntary LULUCF removers selling certified credits into the AgETS;
  - The more complex *Integrated ETS* model integrates LULUCF removals providers into the AgETS as compliance entities of ETS, with no limits on the trading of removals units to AgETS polluters.

Each of these policy models offer different ways to incentivise removals and have different strengths and weaknesses of the removals policy option and its ability to deliver removals and support mitigation more broadly. We theoretically evaluate each of these policy models against one another, considering objectives and a set of evaluation criteria that we identify in Section 1.2.

To gather practical insights and learn from existing international examples of AgETS+Removal policies, in Annex A, we also review eight existing policies for practical lessons on implementing a removals policy option in our context. In addition to the literature review supporting the report, we also interviewed academics, policy makers, and those with practical expertise. This was further complemented by a technical workshop held in a hybrid format (in Brussels and online) with stakeholders and a public stakeholder survey that ran from June 15th until July 28th, 2023.[123] These insights are integrated throughout the text.

Overall, the report identifies different policy options for incentivising LULUCF removals by linking to an AgETS, but also highlights a number of challenges and risks that must be addressed. Chapter 6 concludes, emphasising that any linking of removals to an AgETS must be done cautiously, reflecting in particular on the MRV and challenges, especially impermanence, associated with LULUCF removals. Policy makers must balance the benefits of incentivising LULUCF removals and learning-by-doing against the real risks of reducing incentives for agricultural emissions reductions. Here, taking a step-wise and differentiated approach may be appropriate, with early policy prioritising low-risk removal options and emphasising learning-by-doing and incentives for innovation**.**

1.2. Setting objectives and criteria to evaluate removals policy options

The overarching aim of the AgETS+Removals policy options outlined herein is to cost-effectively increase the amount of EU land-based carbon removals to support achievement of the EU Climate Law's 2050 net zero GHG emissions target. In this section, we expand on this overarching goal to identify specific objectives that a removals policy option will need to meet to achieve this. These criteria are applied in our evaluation of theoretical removals policy designs (in Chapter 5) but we present them here to provide context and direction for all discussions.

The objectives and criteria for removals policy options principally build on the **AgETS Policy Options** (see Box 14). The objectives identified in the AgETS study also apply to this study, though we adapt the criteria used to assess their attainment to better fit the particulars of the LULUCF removals context.

Box 14 Objectives for an AgETS (from AgETS Study)

The AgETS study identified the following objectives. To adapt the objectives to this study, we have made small language adjustments to reflect the LULUCF removals context (additions to AgETS objectives are indicated in italics).[124]
Objective 1: a policy option should aim to minimise the burden of implementation, and once implemented, balance the costs and benefits of the system
Objective 2: a policy option should be based on reliable but cost-effective MRV.
Objective 3: a policy option should provide safeguards against the risk of carbon leakage.
Objective 4: a policy option should provide financial incentives for innovation and changes in agricultural production *and land use* in this transition.
Objective 5: a policy option should be designed in a fair and inclusive manner so that no stakeholders or vulnerable Europeans feel left behind.

[123] The summary reports of the Technical Workshop and Stakeholder survey results report are separate document accompanying this study.
[124] For example, the AgETS policy objective 4 text reads: a policy option *applying the polluter pays principle* should provide financial incentives for innovation and changes in agricultural production, support farmers in this transition, and leave no one behind.

Like the AgETS Assessment criteria, we draw on the EU Better Regulation Toolbox[125] (EC, 2021c). The Toolbox offers guidance on how to conduct Impact Assessments of proposed EU legislation. While this report is not an impact assessment within the meaning of the Better Regulation Toolbox, wherever appropriate, we follow EU Commission Impact Assessment guidance to ensure consistency with EU Commission approaches.

Below, we drawing on the Better Regulation toolbox guidance for evaluations and identify how the evaluation criteria of effectiveness, efficiency, policy coherence, relevance, and EU added value can be adapted to assess removals policy options. We summarise these below and identify more specific potential indicators in **Table 29**.

The relative importance of each criterion is a political choice. A decision maker must decide, e.g. whether they prioritise policy models that score highest in terms of the effectiveness criteria (e.g., deliver the greatest quantity of high-quality carbon removals) or those that score highest in terms of efficiency (i.e. achieved at lowest possible cost). As this is not a technical question, in this report, we provide guidance on each criterion, leaving it to the decision maker to consider the relative weight of different criteria and indicators.

Evaluation criteria

Effectiveness: The removals policy model must be effective in increasing the amount of land-based carbon removals within the EU in line with LULUCF targets and the 2050 climate-neutrality target enshrined in the EU Climate Law. It is essential that these removals are of high quality, that is, real, long-term, additional (i.e., go beyond statutory requirements and common practices in response to the incentives generated by the removals policy option), and contribute to long-term sustainability (including biodiversity enhancement, water pollution and availability, and other externalities generated by LULUCF removals).[126] Of particular relevance for the promotion of LULUCF removals, is the need for removals to be long-lasting: non-permanent carbon removals generate little climate benefit, and will cause climate harm if they reduce emissions reductions now or in the future.

Efficiency: Efficiency is concerned with the resources required to achieve objectives. There are different dimensions of efficiency that removal policy options can be measured against:

- **Simple static efficiency:** Removals policy models should increase land-based carbon removals at lowest possible cost. To achieve this, from the range of removal options available, they should aim to incentivise first the least-cost carbon removals (and subsequently more expensive removals).
- **Dynamic efficiency:** Removals policy should provide an ongoing incentive to lower costs of the selected removal options further over time, and to make more removal options available. This also includes avoidance of lock-in effects, and reaping economies of scale and learning curves.
- **Economy-wide efficiency:** This suggests that the costs of removal activities should remain aligned with the costs of abatement, e.g. by linking removal markets to the cost of abatement in the AFOLU sector and the rest of the economy. This is important for efficiency and for perceptions of equity.

[125] https://commission.europa.eu/system/files/2023-07/BR_toolbox_Jul_2023_en.pdf
[126] If the CRCF is used to certify removals in these policies, these issues will largely depend on the requirements established in that policy.

Administrative efficiency[127] and **low participant transaction costs:** It is important that the policy options are designed in a way that keeps the administrative costs under control for the enforcement agency. Policy options should also minimise transaction costs for participants, especially Small and Medium-sized Enterprises. This is particularly important given the large numbers of farmers and foresters who would potentially be involved in any AgETS+Removals policy.[128]

Policy coherence: The removal policy model must be implementable alongside the AgETS policy options. In addition, it is important that any removals policy options are compatible with the existing suite of EU policy, in particular key climate (e.g. LULUCF Regulation – especially LULUCF geographic-explicit inventories) and CRCF, (renewable) energy and land-sector policies, especially the Common Agriculture Policy (CAP), and the Corporate Sustainability Reporting Directive. We assess coherence with AgETS policy options in Chapter 5; coherence with other EU policies is discussed in Section 0.

Political and legal feasibility[129]**:** There may be legal or political reasons that act as a barrier to successful implementation of removal policy options. Given the potential for different removals policy options to create winners and losers, significant political support or opposition is to be expected and should be considered and mitigated as part of removal policy options design.

Other criteria

The following criteria are also important, but do not differ across the policy models that we assess in Chapter 5. For this reason, we exclude them from the policy model evaluation in Chapter 5 and instead discuss them elsewhere in the report, as indicated.

EU Added Value: To justify EU intervention, the removal policy option should deliver added value compared to interventions by individual Member States. The inclusion of removals into an AgETS would create opportunities for trade, increasing efficiency of achieving overall mitigation across the whole of the EU at lower costs and higher market liquidity.

Relevance: The EU Better Regulation Toolbox also proposes "relevance" as an evaluation criterion. We do not include in our evaluation as this criterion is principally backwards looking, i.e. it aims to assess whether a policy intervention and its drivers are still relevant at the time of the evaluation. Given we are carrying out an ex-ante evaluation, "relevance" questions are captured by the other criteria.

Table 29 Removals policy options: Assessment criteria

Removals policy option: Assessment criteria	
• Effectiveness	• Increased land-based removals: (indicated by) coverage of potential removals, size of incentive, effectiveness of incentive in inducing action, speed of implementation • High quality removals: conservative quantification, duration of carbon storage, likelihood of additionality, expected biodiversity impacts
• Efficiency	• Static efficiency: Low-cost removals options incentivised; scope of removals covered • Dynamic efficiency: Support for future low-cost removals, avoidance of lock-ins • Economy-wide efficiency: Removal costs aligned with AgETS abatement costs and costs in the rest of the economy

[127] We assume that all costs of funding removals are covered by revenue (or allowance demand) generated from the AgETS, so the cost to government of incentivising removals is zero across all removals policy models. However, the administrative costs of implementing the policies will differ across the different policy models, which we assess and discuss in Chapter 5.

[128] See Section 3.2.2 Reporting and Verification for overview of forestry size and ownership in EU; for an overview of farm numbers and size, see AgETS Study Section 3.1.2.

[129] This is not a criterion used in the Better Regulation toolbox but will be useful for selecting which removal policy models should be developed as removal policy options.

	• Administrative costs: simple to implement, low ongoing costs for administrators • Participant transaction costs: low complexity, aligned with existing requirements and data/knowledge
• Coherence	• AgETS match: implementable alongside AgETS, matching definitions and points of obligations
• Political/legal feasibility	• Absence of significant barriers: absence of significant legal or political barriers

2. Demand for removals: AgETS summary

The design of an AgETS+Removals policy option depends in part on the policy that it is linking to, i.e. the AgETS policy options. The AgETS policy options determine the overarching shape of the policy (i.e. that it is an emissions trading system). They also establish the type of gases, activities and points of obligation, as well as establishing the cap and allowance allocation rules, which all collectively contribute to determining how much supply of and demand for allowances there will be within the AgETS.

Depending on the removal policy model that is implemented, the AgETS will effectively generate the demand for removals (or funding for removals). This demand would then provide a financial incentive for farmers and foresters to implement removal activities. Indeed, three quarter of the surveyed stakeholders for this study indicated that they believed that financially rewarding carbon removals in the LULUCF sector could be an effective way to incentivise carbon removals in that sector. This also reflected the call from stakeholders from the land sector during the study workshop that any form of funding for removal activities would be a positive development.

To understand the impacts of linking removals to the AgETSs, we need to understand the demand that may exist in the AgETSs. The AgETSs are presented in detail in the AgETS study. In this section, we present a succinct summary, focussing on the key design elements relevant to the design of the carbon removals policy option. We discuss each key AgETS design element in turn, reflecting on what the AgETS design choices mean for removals policy option design.

Table 30 Overview of AgETS policy options (from AgETS study)

	On farm (all GHGs)	On farm (livestock only)	On farm (peatlands)	Upstream	Downstream
Policy type	Emissions trading system				
Scope: coverage[130]	426 Mt CO_2e	245 MtCO_2-e	~95 MtCO_2-e	305 MtCO_2-e	245 MtCO_2-e
Scope: Emissions sources	All: livestock, peatlands and other soil emissions, fertiliser	Livestock emissions	Drained peatlands	Livestock emissions, fertiliser and urea use	Livestock emissions (meat, dairy)
Scope: Gases	CO_2, CH_4, N_2O	CH_4, N_2O, potentially CO_2	CO_2, CH_4, N_2O	CH_4, N_2O, CO_2	CH_4, N_2O
Point of obligation	Farm-level (farmers, landowners)	Farm-level (farmers, landowners)	Farm-level (farmers, landowners)	Manufacturers and importers of fertilisers, feeds	Processors (meat, dairy)

[130] This data comes from the AgETS study based on 2021 emissions, see the study for full discussion of the data. There are some uncertainties due to different years of data collection, with particular uncertainty regarding peatlands data.

Policy type

All AgETS policy options are economic pricing instruments, specifically emissions trading systems. In cap-and-trade based emissions trading systems, the government sets a cap and regulated entities must surrender an allowance for each emission, which they can either source from the regulator (either through free allocation or auctioning) or purchase from another actor.

Implications for AgETS+Removals: ETSs offer the potential to generate incentives for removals by either directly linking removers to polluters (who may, in practice, be the same entity), or indirectly through an intermediary (such as the government).[131] Direct incentives would occur if AgETS compliance entities (hereafter referred to as the "polluter")[132] were allowed to meet or reduce their compliance obligations by procuring allowances or removals credits[133] from removers (or alternatively, polluters could carry out their own removals and have those credited against their compliance obligation); that is, allowance demand would create incentives for removers to carry out removals. This would require removals to be quantifiable, so that they could be converted into units that can be traded within the emissions trading system. Alternatively, the AgETS could generate incentives for removals indirectly, if an intermediary (e.g. government) funded removals using revenue generated by auctioning of AgETS allowances. These removals could then either be fed back into the AgETS (e.g. through auctions or free allocation of allowances) or could be kept separate from the AgETS (implications for an AgETS cap are discussed in 5.1.1).

Scope: Coverage

The overall land-related emissions in the EU are around 442 $MtCO_2$-e/year (EEA 2022), which sets an upper limit on the potential demand for allowances.[134] The different AgETS policy options outlined in the AgETS study each have different potential coverage of emissions, as each option covers a specific set of emissions sources. For example, the first on-farm AgETS option covers all GHG emissions, thus its coverage is equivalent to the overall EU emissions total of 442 $MtCO_2$-e.[135] Both the on-farm livestock AgETS and the downstream AgETS are focused on emissions related to livestock (enteric fermentation, manure management), and thus have a coverage of 230 $MtCO_2$-e. Similarly, the peatlands AgETS is focused on peatlands drained for agricultural use, which covers 94.5 $MtCO_2$-e, and the upstream AgETS covers enteric fermentation and emissions from fertiliser use, totalling around 251 $MtCO_2$-e.

Implications for AgETS+Removals: The scale of emissions covered by the AgETS is important to consider when developing removals policy options, as they provide some insight into the maximum potential demand for removals under each option. Alongside the relative cost of reducing emissions and

[131] See Section **Error! Reference source not found.** for more in depth discussion of removals models.
[132] The AgETS compliance entity is the point of obligation from the AgETS. For farm-level ETSs, this would be the farmer; for downstream ETS, this would be the dairy or meat processor; for the upstream ETS, this would be fertiliser or feed manufacturer or importer. They are the actor who has an obligation to cover the emissions occurring at the farm (the agricultural emissions). For brevity and clarity, in the rest of the report, we refer to this actor as the "polluter", i.e. the actor who faces payment obligations under the AgETS related to the agricultural emissions associated with their farm (or upstream/downstream supply chain).
[133]"Allowances" refers to a fully fungible emissions units that a polluter can surrender to the regulator to meet their compliance obligation; "credits" may have some restrictions placed upon them meaning they are not fully fungible; "units" is the catch-all term.
[134] This data is discussed in detail in AgETS study. The emissions figure includes all land -related emissions, including CO2 fluxes from farmland (cropland and grassland). It is based on EEA data on LULUCF and agriculture emissions. However, as discussed in the peatlands section of the AgETS study, peatland emissions data is uncertain, with different sources reporting a range of data; the peatlands emissions estimate (and this total emissions estimate) should be treated with caution.
[135] The potential coverage numbers here report maximum possible scopes, if all agricultural emissions in the sub-sector were covered by the ETS; however, as the AgETS study proposes thresholds for farm inclusion/exclusion, the realistic scope is likely to be smaller.

generating removals (the marginal abatement costs) and the setting of the AgETS cap, the scale of the AgETS will help determine market price and the level of removals incentivised in an AgETS+Removals.[136]

Scope: Emissions sources

There is a wide range of emissions sources in agriculture, which are captured to varying degrees in the different policy options proposed. The most important emissions are methane (CH_4) from enteric fermentation and N_2O emissions from managed agricultural soils, which together represent over 80% of agricultural emission in the EU. Other sources of emissions include CH_4 from manure management, soil carbon emissions from organic and mineral soils. The AgETSs cover different scopes of emissions sources.

Implications for AgETS+Removals: Linking removals to the AgETSs implies a degree of equivalency; that is, that it is reasonable to trade removals for emissions reduction. This equivalency need not be one-to-one: rules could be established that, for example, require two units of removals for one unit of emissions reductions. To establish these rules and to justify equivalency, we need to consider the characteristics or the emissions reductions that are being traded for removals. Of particular importance is the certainty with which the emissions reductions can be quantified. Some sources can be more confidently calculated than others (e.g. methane emissions from enteric fermentation can be relatively accurately estimated at the farm level, while emissions from manure management are less accurate, and peatland emissions pose greater uncertainty in their calculation). These must be taken into consideration when considering the scope of removals that are to be linked: if the uncertainty of removals quantification is greater than that of the sources included in the AgETS, their inclusion will decrease the overall certainty of mitigation through the AgETS. To balance this, some removals options may need to be excluded, or limits or other rules (such as buffer accounts or discounts) may need to be built into removal policy designs. We discuss this issue of equivalency between AgETS emissions and removals in Section 0, which also identifies design decisions that can manage this issue.

An additional issue to consider is overlap between the AgETS and removals. If the AgETS includes emissions from land (i.e. LULUCF emissions such as the releases of carbon stored in e.g. soil), then there is the potential for significant overlap with the removal policy design (which focus on net CO_2 fluxes from land, summing up gross removals and gross emissions across several carbon pools). This would mean that treatment of CO_2 in the removals option design would need to closely align with the AgETS framework, especially with regards to the quantification of the removals and MRV. To reduce risk of double-counting the net GHG effect of a sink enhancement as both a reduction under the AgETS and creditable removal activity, the simplest solution would be to ensure that LULUCF fluxes are only covered by the removals policy. If this is not desirable, the risk of double-counting could be reduced by ensuring that MRV, system boundaries, and or definition of compliance entities match across the policies. This could be achieved by ensuring that the removals policy option follows the same MRV methods as the AgETS policy options, using the same data and tools, aligning reporting and verification timing, etc. This issue of double-counting as it relates to removals is discussed in detail in Section 0.

Scope: Gases

The three important gases emitted in agriculture are methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2). These greenhouse gases each have different effects on the climate and thus different

[136] See AgETS Study Section 2.3.5.

global warming potential (GWP), which is the amount of heat absorbed by the gas in the atmosphere, relative to CO_2. At a 100-year time horizon, the GWP of CO_2 is 1, CH_4 is 27, and N_2O is 273 (Forster et al, 2021). To break this down, this means that an emission of one tonne of CH_4 causes the same global warming over 100 years as 27 tonnes of CO_2. Also relevant here is the lifetime of the different gases, which tells us how long the gas remains in the atmosphere. The lifetime of CO_2 is difficult to estimate, due to a range of processes that remove it from the atmosphere (e.g. plant growth, dissolved in the ocean), however, some estimates place the figure between 5-200 years. CH_4 has a lifetime of 11.8 years, and N_2O is 109 years. Looking at these figures, we see that while methane (CH_4) may have a short lifetime in the atmosphere, it has a significantly higher GWP than CO_2. Furthermore, N_2O has both a long lifetime and high GWP.

Implications for AgETS+Removals: if the types (and characteristics) of gases removed from the atmosphere differ considerably from the emissions reductions that they are replacing, the impact on the climate would differ. For example, if carbon removals are used to counteract (offset) methane emissions reductions, we would expect to see relatively higher short term warming impacts (due to the high warming potential of methane relative to carbon, especially over short time periods) (Allen et al. 2021).

Point of obligation

The point of obligation refers to the type of actor within the agricultural value chain that is made a compliance entity under the emissions trading system, who is responsible for calculating and meeting a compliance obligation. The three on-farm AgETS options occur at the farm-level, and thus the obligation is tied to the farmers or landowners. In these instances, the farmer or land-user is a compliance entity within the AgETS, responsible for calculating the emissions associated with their production and meeting compliance obligations. The upstream AgETS is tied to manufacturers and importers of farm inputs that cause emissions, such as feed and fertiliser. Finally, the downstream AgETS is applied to processors of meat and dairy products, based on carbon embodied within the products they send to market (i.e. also encompassing the upstream emissions). In the upstream and downstream options, participation in the AgETS and meeting of compliance obligations would fall to these upstream or downstream actors. It is important to note that for these upstream/downstream AgETS options, the emissions covered are the agricultural emissions associated with agricultural production indirectly associated with their products or the products they process (not the GHG emissions directly generated by the upstream/downstream actors themselves).

Implications for AgETS+Removals: The point of obligation will have some impact on the types of removal policy model that can be employed. To decrease administrative and participant transaction costs, it may be more efficient to have the same actors or same types of actors participating in both the polluter and removals sides of the markets. For example, the farm-level AgETSs will feature many participants, justifying the development of automated administrative systems that could also be utilised on the removals side of the market.

3. Supply of removals: LULUCF removals overview

The design of the removals policy option must also reflect the reality of potential LULUCF removals in Europe. To do so, it is important to understand what types of removals could be incentivised by a removals policy option and their key characteristics.

Section 3.1 provides an overview of LULUCF removals and their appropriateness for including in a AgETS+Removals. Numerous recent studies have evaluated LULUCF carbon removals globally and in Europe, e.g. Smith et al (2023), Bey et al (2021), Roe et al (2019), Fuss et al (2018) and Griscom et al (2017). In this section, we draw primarily on Bey et al (2021) but update those with results where appropriate by drawing on additional publications. Given their wide and detailed discussion elsewhere, in this section we provide an overview of LULUCF removals solutions in Europe, focussing on key elements and characteristics relevant for removals policy option design.

Section 3.2 focuses on monitoring, reporting, and verification (MRV), which refers to the process of quantifying and validating removals, i.e. assessing how many tonnes of carbon have been removed from the atmosphere, and ensuring that they align with requirements. MRV poses a significant challenge for nature-based solutions, as quantifying nature-based removals can be costly and uncertain (McDonald et al. 2021a). The current state and challenge posed by MRV differs per removal type. At the EU level, the proposed Carbon Removal Certification Framework has suggested a quality standard made up of four criteria: Quantification, Additionality, Long-term storage and Sustainability (QU.A.L.ITY). In Section 3.2 we introduce the proposed CRCF criteria, and then consider each LULUCF removals option against these criteria.

Section 3.3 contextualises the removals discussion for the design of an AgETS+Removals emissions trading system. Here, we discuss further evidence on the likely "supply" of removals into an AgETS+Removals policy, which will be determined by the amount of removals available at different prices, as well as policy scope and design. We present additional evidence on marginal abatement cost curves for removals options.

3.1. LULUCF removals within the EU: an overview

Carbon removal options can be split between nature-based solutions (NBS)and technology-based solutions (TBS). In the scope of this study, we are focused on "land-based removals," all of which fall under the category of NBS (Bey et al. 2021).[137] We further narrow our focus to removals that occur on either agricultural or forest and other land and that can be implemented by actors from the agriculture or land-use sectors. This is a broader focus than the AgETS study, which focussed exclusively on agricultural land, i.e. land in productive agricultural use. In this study, we expand the scope to include not only agricultural land, but also consider potential removals from forestry and other land; this scope is referred to as LULUCF.[138]

[137] We do not consider NBS that cannot be carried out on AFOLU land or principally implemented by AFOLU actors, e.g. blue carbon removals solution options or harvested wood products. Peatland rewetting principally delivers emissions reductions, with only minor additional carbon removals; accordingly, it is addressed in the AgETS study.
[138] We do not follow the definition of "carbon farming" removals used in the EU Commission's Framework for Carbon Removal Certification. In particular, unlike that Framework, we do not consider emissions reductions caused by rewetting peatlands as a removal; instead, these are classified as emissions and considered under an AgETS. The

Given the broader LULUCF scope, we identify five key carbon removal options within the EU that could be incentivised by a removals policy option:

- **Afforestation & reforestation[139]:** Afforestation is either the planting of trees or establishment of forests in areas where there were previously no trees. Reforestation involves the same process but takes place on land that once was forested but has been converted to another land use. In this approach, carbon is removed from the atmosphere and stored in soil and the tree biomass.
- **Agroforestry**: This involves planting trees, hedges, and other woody biomass on agricultural land to remove carbon from the atmosphere, whilst still allowing productive agricultural use (either for growing crops or maintaining animals).
- **Forest management**: Appropriate management of forests as a means of improving economic, social, and environmental value can increase the forests potential for re-moving carbon from the atmosphere. Some examples of such management approaches include the extension of rotation length, lowered thinning, and reduced harvest intensity (Böttcher et al. 2022)
- **Increase in soil carbon (on mineral soils):[140]** A high amount of European croplands and grasslands are in mineral soils, which contain relatively low organic matter but all together it is still a high amount of carbon. Certain management techniques, like cover crops, crop rotations, and land conversions, can all increase the carbon content of these soils.
- **Biochar**: This refers to the incorporation of charcoal into soils. Producing biochar involves heating biomass (e.g., from organic waste or natural feedstocks) with little or no oxygen (pyrolysis). The output can then be mixed into soils where it can be a stable store of carbon.

These carbon removals options present a number of challenges when considering the link to ETSs. Mismatches between AgETS characteristics and removals characteristics may mean some removals policy options are inappropriate or risky, or that any linking of removals to an AgETS would have to be accompanied by additional rules and protections to manage risks.

The stakeholder survey showed that respondents were particularly concerned about biochar, indicating that there are still unknown factors on land-use change, soil toxicity, biodiversity impacts, limited feasibility in some areas that need further research. In the survey, respondents therefore felt that the inclusion of biochar as a removal policy option of moderate importance. The other carbon removal options were considered of relative high importance to be included. Stakeholders in the technical workshop shared a similar opinion, where there was a consensus that a holistic approach on carbon removals should be embraced considering factors such as permanence, scalability, and environmental impact, without having rigid hierarchical approach that favours one removal method over another.

In Table 31, we describe the following characteristics of each carbon removal solution:

- **Scope**: Different removals solutions can be implemented on different types of land: some are only implementable on agricultural land, others on forestry, or on all LULUCF land.
- **Total mitigation potential**: The amount of removals (in t CO_2-e) potentially achievable by each removals option within Europe (EU27). There is some uncertainty in these figures due to

timeline of policy design for our proposed policy approaches is different to the EU Commissions Framework, which aims to incentivise action in the very near term (in the next few years).

[139] Forest restoration could fall under this category or under forest management.

[140] We focus here on mineral soils as organic soils are principally covered under an AgETS, as the key mitigation action for organic soils is rewetting (which decreases emissions). Rewet organic soils will also lead to some carbon removals over long timescales, but this will be considerably smaller than the avoided emissions (Bey et al 2021).

different literature's reporting of potential: some estimate maximum technically feasibly removals, others estimate economically feasible removals at different carbon prices (e.g. ranging from €50-150/t CO_2-e), and with different timescales (present, 2030, 2050); accordingly, we report ranges. Given the practical challenges facing widespread implementation of these removal options (discussed as a separate characteristic, see below), the upper range should be considered absolute maximum mitigation potentials.

Maturity: All nature-based removals options are mature options, already implemented widely across Europe and achieving high technological readiness levels (TRLs). The one exception is biochar, which is less widely implemented (i.e., applied to soils)..

Quantification of removals and monitoring, reporting, and verification[141]: The quantification of removal solutions poses a potentially significant challenge for removal policy design. If removals are to be linked to an AgETS and used as mitigation instead of AgETS emissions reductions, then it must be possible to robustly quantify the mitigation impact of removals activities. Where MRV of removals is more uncertain than that of AgETS emissions reductions, then linking removals into the ETS will increase the uncertainty of overall mitigation. Different removals options pose different degrees of MRV uncertainty, in part depending on intrinsic elements of the removal solution (e.g. soil carbon sequestration occurs underground and is therefore more challenging to identify than above-ground biomass sequestration through afforestation) and partly due to the amount of existing MRV approaches that have been developed and iterated for each removal type. In **Table 31**, we describe existing MRV approaches for each removal as an indicator of the certainty of removals quantification, including identifying IPCC national inventory approaches.[142]

Additionality: Removals are additional if they are caused by a removals policy incentive; that is, they would not have occurred without the removals policy. The importance of additionality depends on what the removals are used for. Additionality is important for cost-effectiveness reasons (funders will be able to achieve the most removals for their budget if they fund only additional removals, and do not fund removals that would have occurred anyway). However, it is especially important if removals will be used as mitigation instead of AgETS emissions reductions: if non-additional removals replace emissions reductions, there will be more emissions in the atmosphere than would have occurred if removals had not been linked to AgETS, thus imperilling the environmental integrity of the system. On the other hand, Additionality is notoriously challenging to assess, with some removals options being more challenging to assess than others due to the difficulty of observing new removals options being implemented, and the challenge surrounding establishing baselines with robust, disaggregated data.[143] A range of "tests" of additionality exist, including requiring regulatory additionality (i.e. the action goes beyond regulatory requirements and other policy incentives); financial additionality (i.e. that removal payments are decisive in the profitability of the project), and assessing, for example, that the removal project is not already common practice (Cames et al.

[141] Many of the elements in this table match the QU.A.L.ITY criteria proposed in the COM proposal for a Framework for Carbon Removals Certification: in addition to this element (quantification), the QUALITY criteria also include additionality, permanence (the framework refers to this principle as "long-lasting"), and co-benefits and negative externality (the framework refers to this as "sustainability"). See Section 3.2 for introduction of the CRCF QU.A.L.ITY criteria.

[142] Increasing understanding of removals MRV approaches and removals quantification uncertainty will be central questions for the development of removals policy options.

[143] Simplified approaches can be applied to assess additionality at lower costs (e.g. standardised approaches). However, these can be associated with lower accuracy; trade-offs must be considered in light of the "use" of the removals, e.g. if they will be used instead of emissions reductions then higher confidence regarding additionality will be required.

2016). As mentioned, the proposed QU.A.L.ITY methodology of the CRCF aims to develop and implement best practices and certification approaches to additionality.

Cost: The cost of carbon removals will be a key determinant of how many removals are incentivised by any removals policy option. For nature-based solutions, in addition to implementation costs, a key determinant of cost are foregone profits of alternative management; this so-called opportunity cost differs considerably across different geographic and economic contexts and even individual actors, as farms and farmers can be quite different from one-another. In part due to this variability, there is limited data on costs of removals, and ranges are wide. We draw on the data presented in Bey et al (2021), which focuses where possible on the EU context. We supplement this with data from the Smith et al (2023) report, which while globally focussed provides a more up-to-date summary of cost data. We discuss costs of removals options in more detail in the following section.

Permanence: Nature-based approaches to carbon removals face challenges with regards to permanence, or the longevity of the stored carbon. This means that there is a risk of reversibility, which can emerge from natural factors (e.g. drought, fire, disease) or management issues (i.e. change in land use). Different removals options pose different risks of non-permanence, making them more or less appropriate for replacing AgETS emissions reductions, which are permanent.

Practical challenges: Carbon removals also face practical challenges to their implementation, which must be considered in removal policy design. This can include for example concerns over land availability, implementation and transaction costs, requirements for new skills, or even simply a lack of interest.

Leakage risks: Leakage occurs when the intended removals within the project area cause a decrease in removals elsewhere (or increase in emissions elsewhere), leading to an overall reduction of the mitigation effect. Activity leakage occurs when the removal shift their emissions-producing activities outside of the monitored project boundary, e.g. farmers shift agriculture/animals to neighbouring fields that are outside the project boundary.[144] Market leakage occurs when the removal actions generate economic incentives for others to act in ways that decrease removals (or increase emissions elsewhere), e.g. if actions taken to increase soil carbon (such as no-till) decrease crop output, this decreases supply of crops, leading to higher crop prices, inducing other actors to increase their crop production. If this increased production causes soil carbon releases (or increased emissions), then market leakage has occurred. Different types of removals actions pose different degrees of leakage risk: leakage will be higher if the displaced production moves to regions with higher carbon footprints, or for products that are sold in markets with suppliers who are highly responsive to price changes (supply is price elastic), or demanders are unresponsive to price changes (demand is price inelastic), among other determinants (Filewood and McCarney 2022).[145] Generally, any removals action that decreases production poses a market leakage risk. Leakage would be problematic if it resulted from removals policy design, as it would reduce mitigation.

[144] Filewood and McCarney (2022) argue that activity leakage can be relatively straightforwardly controlled, as the actors responsible for the leakage are those monitored and rewarded for their actions, and their actions are observable.

[145] Most AFOLU products are sold into highly competitive global markets, with high supply price elasticities, with potentially high leakage. Filewood and McCarney (2022) summarise evidence on market leakage for nature-based mitigation options. They identify that measuring market leakage is challenging and results are context- and method-specific. For afforestation projects, they present evidence of leakage of <43%, for less studied non-forest methods, they report leakage in crop conversion projects of 15%, and 20% for conservation projects.

Leakage can be somewhat managed or controlled for through policy design but is also an element of the removal action itself.[146]

Co-benefits and negative externalities: Implementing carbon removals will have impacts beyond climate mitigation. These impacts can be positive (co-benefits) or negative (negative externalities). Key externalities to consider include biodiversity impacts, water quality and use, climate adaptation impacts, among others. These additional impacts can increase or decrease the benefit of removals being incentivised and are therefore important to consider as part of removal policy design. Interviewees noted that, given the need to adapt implementation to local contexts, care must be taken when generalising about co-benefits and negative externalities at the general level of removal types.

[146] MRV design across the removals and ETS instruments is particularly key given the risk of leakage with the potential for emission increases and removals reductions occurring outside of the project. The boundaries of what is to be monitored and reported under an ETS are inherently linked to leakage, as any emissions not within the system boundary are outside the scope of the policy and thus potential for leakage. The risk of leakage can be managed by including quantitative leakage assessments in the design of an MRV approach. If payments are being made for removals, deductions from gross removals based on calculated/estimated leakage impacts can be applied. McDonald et al (2021) provide an overview of current carbon removal certification programmes which include deductions for leakage based on quantitative assessments, including the Verra Carbon Standard, the Clean Development Mechanism, and MoorFutures.

Table 31 Carbon removal options: overview table. Unless otherwise indicated, data comes from Bey et al (2021)

Option	ation & reforestation	Agroforestry	Forest management	Increase in soil carbon (on mineral soils)	Biochar
• **Scope**	• Agriculture (any land except existing forestry land)	• Agriculture	• Forestry	• Agriculture	• Agriculture and forestry
• **Total mitigation potential**	• EU: 36 $MtCO_2$/yr • (2050, assuming carbon price of 150 EUR/t). Some uncertainty.	• EU: 7.8 - 234.9 Mt CO_2/yr (current potential)	• EU: 35 - 400 Mt CO_2/yr (2050)	• EU: 9 – 116 $MtCO_2$/yr (2050)	• EU: 79 $MtCO_2$/yr (2020-2050)
• **Maturity**	• TRL = 9, existing wide-scale deployment	• TRL = 9, existing wide-scale deployment	• TRL = 9, existing wide-scale deployment	• TRL = 9, existing wide-scale deployment	• TRL biochar production = 9; biochar application = 7-8
• **Quantification of removals and MRV**	• MRV frameworks covered by IPCC GL Vol.4 Ch. 4 and LULUCF Regulation. • • Also many existing voluntary methods (Woodland Carbon Code, Australian ERF, Label bas Carbon) and New Zealand Emissions trading system.	• Limited existing examples of MRV systems for agroforestry except in specific research projects, generalised IPCC GL methods, and LULULCF Regulation.	• MRV frameworks covered by IPCC Guidelines Vol. 4 Ch. 2 and 4, and LULUCF Regulation. • • Numerous examples of methods in voluntary (e.g. VCS, Label bas Carbone) and regulatory systems (NZ ETS). Some risk of non-additionality.	• MRV frameworks covered by IPCC Guidelines Vol. 4 Ch. 2 and LULUCF Regulation. • • Numerous voluntary methodologies (e.g. VCS, Gold Standard) and small projects; however, relatively high uncertainties.	• Revision of the 2006 IPCC guidelines included a specific Annex on estimating biochar impacts on soil carbon. • Theoretically would be included in LULUCF accounting (in related land accounting category). Voluntary methods for biochar production exist, e.g. Puro.Earth (no method for application).
• **Evidence of additionality**	• Medium - can use satellite or other data to identify areas of new tree planting, combined with other assessments (e.g. financial additionality)	• Medium - can use satellite or other data to identify areas of new tree planting, combined with other assessments (e.g. financial additionality)	• Difficult - challenging to identify baselines; dependent on MRV and other assessments.	• Difficult - challenging to isolate individual actions, or establish baselines; dependent on MRV and other assessments.	• Simple - can assume that biochar would not be produced except for climate reasons, can be assessed at biochar production stage

• Cost (EUR/tCO_2)	• EU: Approx. 25Mt CO_2/y sequestration at €50/t and 237ilvoar. 40Mt CO_2/yr at €150/t (EU) • • 0-240 USD/tCO_2 (Smith et al., 2023)	• Little evidence available, costs differ per system, local context, etc. • • Insufficient data (Smith et al., 2023)	• Evidence not available, costs vary • • Insufficient data (Smith et al., 2023)	• Varies significantly depending on local context. • • -45-100 USD/tCO_2 (Smith et al., 2023)	• 90-120 USD, though high range and uncertainty regarding costs (due to diverse biomass sources, and limited evidence on application). • • 10-345 USD/tCO_2 (Smith et al., 2023)
• Permanence	• Vulnerable to both natural and human-induced disturbances (including climate change). • Long-term land contracts and other legal restrictions can support permanence.	• See afforestation & reforestation	• See afforestation & reforestation	• Soil carbon retention time can be short to long-term, depending on management and climate, as well as biophysical conditions. High reversibility concerns; appropriate management is required to avoid reversal.	• Biochar is a relatively stable, long-lasting store of carbon. Risk of reversibility is considered low, especially in dry soils, however there are few long-lasting studies of biochar application and permanence.
• Practical challenges	• Availability of land (competition of land uses); overlap with other policies (e.g. CAP); keeping transactions costs low enough to encourage uptake; relatively high up-front investment cost and initial slow sequestration rates.	• Limited interest among farmers due to need for developing new skills, new outputs markets, up-front investments and differing rotation length. • • Challenging to generalise MRV due to diversity of agroforestry types and impacts. Relatively low carbon removal intensity per ha or participant makes it difficult to cover MRV costs.	• Diversity of forest management approaches: most effective and cost-effective management options will depend on local context. • • Significant public ownership of forest land (54% across EU)	• Long commitment period poses substantial barrier for landowners. Risks associated with changes in production systems, lack of advisory services and available information on economic and productivity benefits of sequestration options. Farmers that lease land have little to no incentive to invest in soil carbon.	• Biomass availability, limited amount of bio-char production facilities, uptake by farmers. Multiple stages in the biochar process pose governance challenges, as do uncertainty of MRV of soil carbon impacts.
• Leakage risks	• Potential leakage due to afforestation of productive land, with commercial activities shifting else-where (can be	• Low risk of leakage since agroforestry does not fully replace existing arable/animal	• Leakage affects are low, as forest management occurs on existing forest land and has	• Leakage impacts will depend on the specific measure implemented. Those that decrease production pose leakage	• Leakage can occur if biochar biomass production competes with other land uses. Biochar application poses no

	managed by targeting non-productive land).	production (although small impact on output).	only small impacts on timber production.	risks; those that increase efficiency decrease it.	leakage risks unless it reduces production.
• **Co-benefits and negative externalities**	• Differ per project; afforestation that results in monodominance could reduce biodiversity, but by focusing on e.g. degraded lands or biodiversity-friendly afforestation has significant co-benefits.	• Significant positive impact on biodiversity, reduced soil erosion and improved soil health, flooding protection and reduced nitrate leaching.	• High co-benefits, including ecosystem and biodiversity preservation, as well as water quality and water quantity benefits.	• 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. • • Some concerns about impacts on soil health if off-farm organic inputs are used. There may be trade-offs with N_2O emissions.	• Unclear impacts on worms and soil fauna, or broader impacts on biodiversity. • • Expected co-benefits are uncertain but expected to be relatively small; im-proved soil structure, water holding capacity, reduction in nutrient losses from soils, stabilisation of heavy metals and other toxins.

3.2. Monitoring, reporting, and verification of removal options

Monitoring, reporting, and verification (MRV) will be essential for any results-based carbon removal policy methods, as it ensures the accuracy and reliability of the carbon removal claims of the project. As such, the quality of the MRV effort is crucial to understanding the climatic equivalence of a project. In the context of this study, effective MRV is critical to assess whether carbon removals are sufficiently equivalent to emissions reductions in an AgETS. Low quality MRV may result in carbon removals that are non-additional, overestimated, or impermanent acting as replacements for emissions reductions. Stringent MRV offers one potential route to reducing the risk of this outcome, which we investigate in this chapter. Improving MRV for carbon removals is one of the central objectives of the CRCF; in **Box 15** below, we describe the proposal's QU.A.L.ITY criteria.

The importance of MRV of removals was also stressed in the stakeholder survey. Improvements to the availability, accuracy and robustness data on the carbon removed from the atmosphere was rated among the top policy enablers for a successful reward system for LULUCF removals (alongside involvement of removers in the policymaking and limiting leakage risks). Some respondents indicated that by improving the quality, accuracy and implementing feasibility of the MRV and accounting system, the issue of additionality can be better addressed. In the context of additionality, some stakeholders stressed that any system should acknowledge and reward the actions of "early movers".

Depending on the removals solution, the approach used for MRV varies in terms of maturity, costs, and accuracy. Furthermore, the costs associated with MRV can present a barrier as they reduce some of the incentive level for the removers, i.e. they are a "transaction cost".

In order to review MRV considerations comprehensively but also concisely for the removals options discussed in this study, we have chosen to group removals options according to their primary domain. The first section below covers the two agriculture-focused removal options: agroforestry and soil organic carbon (SOC)-enhancing management practices in mineral soils; the forestry section covers afforestation/reforestation and improved forest management practices; the final section covers the use of biochar as a removal option. In each instance, both the similarities and differences in MRV considerations between the specific removals options are highlighted. Alongside the issue of quantification, this section also discusses additionality, carbon leakage, permanence, and sustainability impacts associated with the removal options

Box 15 Proposed Carbon Removal Certification Framework minimum standards for certification (COM 672/2022)

The EU's proposed Carbon Removal Certification Framework (CRCF) has developed a set of minimum standards (QU.A.L.ITY criteria) to establish a robust certification system. The specifics of how MRV will be implemented for each carbon removals option are still be to developed (the methodologies will be developed by the Commission and the Expert Group on Carbon Removals) and written into implementing acts. However, the CRCF proposes that carbon removals can only be certified if they meet the following criteria:

- Quantification (Article 4): carbon removals are measured and quantified accurately and deliver unambiguous benefits for the climate. The proposal calls for removals to be quantified in a "relevant, accurate, complete, consistent, comparable and transparent manner", accounting for uncertainties. Specifically, it calls for removals to generate a positive net benefit. This is computed by comparing removals to a baseline, that is, the amount of removals that go beyond the "standard carbon removal performance of comparable activities in similar… circumstances and take into account the geographical context", and by subtracting any increase in direct or indirect GHG emissions.
- Additionality (Article 5): certificates are only granted to removal activities that go beyond standard practices or legal requirements and occur due to the incentive effect of the certification. This criterion is assumed to be complied with if the removal activity goes beyond a standardised baseline (that

corresponds to, "the standard carbon removal performance of comparable activities in similar social, economic, environmental and technological circumstances and take into account the geographical context"), or, where a standardised baseline is not established, if additionality is demonstrated through specific tests.

- Long-term storage (Article 6): certificates are for actions that "aim at the long-term storage of carbon". Operators must monitor and mitigate the release of stored carbon during a specified monitoring period and be liable for any releases. For carbon farming removal options (i.e. the LULUCF removals we consider in this section), the CRCF proposes temporary crediting of removals, such that "the carbon stored by a carbon removal activity shall be considered released to the atmosphere at the end of the monitoring period". Monitoring periods are not defined in the CRCF as they will be defined in the delegated acts with the certification methodologies specific to different carbon removal activities.
- SustainabilITY: removal activities are required to have a neutral impact on broader sustainability objectives or to generate co-benefits. This includes climate change mitigation and adaptation, protection and restoration of biodiversity, transition to the circular economy, pollution prevention and control, and sustainable use and protection of water and marine resources. Specific minimum requirements will be established in the CRCF certification methodologies.

At the time of publishing this report, this framework is not yet finalized and legally binding. Its implementation will be further developed in collaboration with the Expert Group on Carbon Removals and realised in a series of delegated and implementing acts.[147]

Agriculture

Quantification

Monitoring activities in existing carbon credit schemes involving **agroforestry** focus on changes in the above-ground woody biomass as a key indicator for the delivered carbon sequestration outcomes (COWI, Ecologic Institute & IEEP 2021b). Carbon storage in above-ground biomass can be assessed using methods applied in afforestation projects, based on observable characteristics and in a relatively cost-effective way (Bey et al. 2021). Ultimately, carbon sequestration values depend on the agroforestry system design, the end-of-life use of timber, and the baseline setting approach. Agroforestry will also affect soil organic carbon (see discussion of SOC quantification below). Generally, existing agroforestry credit methodologies do not calculate SOC robustly (COWI, Ecologic Institute & IEEP 2021b).[148]

There is a wide variability of carbon sequestration outcomes across different geographies and types of vegetation, crop and animal species. Estimating carbon removals through modelling requires that emission factors are developed for a matrix of variables. While some areas and agroforestry approaches have been the subject of research that could be built on to develop such models, the resulting carbon stock and stock change data are accompanied by uncertainty and may not consider the impacts of specific practices employed by farmers (e.g. the management of the crop around the woody component in silvoarable systems) (LIFE Medinet 2018). Overall, the varying degree to which results can be replicated and the challenges in identifying changes beyond the 'noise' linked to climatic conditions, annual variability in growth rates, and previous land management are a source of significant uncertainties and underscore the challenges of setting up a credible MRV system for agroforestry as well as soil-based carbon removals (Kay et al. 2019, Fornara et al. 2018, Felicianoa et al. 2019, Upson 2016, in: COWI, Ecologic Institute & IEEP 2021b).

147 https://climate.ec.europa.eu/eu-action/sustainable-carbon-cycles/expert-group-carbon-removals_en

148 While existing schemes may incorporate soil carbon considerations in their design, SOC levels are not used as a result indicator due to monitoring challenges. E.g. in the Woodland Carbon Code, soil carbon is taken into account in calculations of emissions associated with the establishment of agroforestry systems to focus on sites where additional soil carbon accumulation is most likely. Under the Swiss Coop scheme there is a conservative, specific GHG emission reduction allocated per tree. However, monitoring on site is based on the measurement only of above ground biomass results (COWI, Ecologic Institute & IEEP 2021b).

While innovation in technology and methodologies holds some hope for the future, robust **quantification of SOC sequestration in mineral soils** currently remains challenging.[149] Soil carbon can vary significantly over small spatial areas (e.g. even within a field), depending on the inclusion of water and nutrient availability, slope, soil type, climate and management conditions) (Oldfield et al. 2021; Bey et al. 2021). This variability poses a significant challenge for MRV. Soil carbon sampling is considered the most accurate method for quantifying SOC changes, but due to the spatial variability of SOC, accuracy demands multiple samples, which is costly (Smith et al. 2019). Modelling approaches, either alone or in combination with some sampling, are proposed in many existing soil carbon crediting mechanisms (e.g. VCS, Nori, Australian Emissions Reduction Fund, Gold Standard). However, Oldfield et al. (2021) conclude that “currently, there is little evidence that existing models can accurately capture net GHG reductions at the field level under all proposed management interventions for all combinations of soils and climate).” Further uncertainties also remain, including in relation to the limited understanding of factors that influence SOC quantity and stability, time of sampling, sampling depth, processing of data, assumptions and input data in the modelling of SOC stock changes (COWI, Ecologic Institute & IEEP 2021b). New technologies do offer some hope for quantifying SOC changes at lower costs and with higher accuracy in the future, such as soil spectroscopy, remote sensing, or combination approaches (van der Voort et al. 2023). Significant investment in researching and developing improved monitoring approaches as well as increased attention from current policy developments (e.g. CRCF proposal) could lead to improved and more cost-effective monitoring.

Importantly, the monitoring of soil carbon sequestration should consider all relevant GHG emissions associated with soil management (McDonald et al. 2021b). Accounting for the whole GHG balance is key as the climate benefits of carbon removals are likely to be counterbalanced to some degree by non-CO2 emissions associated with certain carbon farming practices. In particular, the interlinkage between N2O emissions and increased SOC storage may result in mitigation potential being overestimated and requires further research (Guenet et al. 2020). The system boundary of SOC quantification will need to be carefully considered if SOC is to be integrated into or promoted alongside an AgETS to ensure that there is no overlap between the gases and activities considered in calculating (net) removals and those emissions quantified as part of the AgETS.

Additionality

If removals are going to be linked to an AgETS, agriculture-based carbon removals should be additional, i.e. go beyond the legal baseline and result in enhanced carbon sequestration over the long-term that would not have occurred in the absence of the AgETS incentives (COWI, Ecologic Institute & IEEP 2021b). In the EU context, the introduction of the Soil Health Law, CAP reforms (especially changes to GAEC standards) may impact the additionality of carbon removal activities during their implementation and monitoring period. It will be important to clearly define how additionality may be considered and adapted in these circumstances in case they lead to the AgETS recognising erroneously legally required actions as additional and rewarding them (Willard 2022). Care should also be taken to avoid perverse incentives for policy development, which risk weakening CAP, soil health, and other policies due to the negative impact this would have on AgETS additionality.

[149] Soil carbon sequestration in organic soils (e.g. peatlands) generally predominantly reduces emissions, with only small additional sequestration; accordingly, SOC in organic soils is discussed in the AgETS study.

Additionality is often established by comparing outcomes to a counterfactual baseline scenario. However, even where there is sufficient confidence that the counterfactual is most appropriately represented by a business-as-usual scenario, technical issues relating to data availability may still present a challenge. Whether using a measurement- or modelling-based approach to baseline setting, historical information on management practices is required. Given the variability of soil carbon across different sites and over time, one-year baselines can be misleading (Bey et al. 2021). FAO's GSOC MRV protocol (2020) considers a five-year baseline period as a reasonable framework prior to the implementation of carbon farming practices, with the BAU scenario defined based on historical activity data across a large number of indicators including yields, species, irrigation, fertiliser, tillage and harvest data. Existing voluntary carbon methodologies often rely on specialist advisors to set baselines based on information collected during site visits. This is beneficial from the point of view of combining MRV efforts with the provision of technical advisory, needed especially in the case of agroforestry, but is likely to drive the cost up for either farmers or administrators, depending on the policy set-up.

Carbon leakage

The risk of carbon leakage, both in the case of agroforestry and introduction of SOC enhancing management techniques, is highly context-specific. While agroforestry systems with high mitigation potential may result in decreased output and therefore pose leakage risk, the changes in yield and the potential displacement or intensification of production will depend on the biophysical conditions, the design of the system, as well as the farmer's ability to market and sell products associated with the woody component (COWI, Ecologic Institute & IEEP 2021b). Any removal solution that reduces production is at risk of generating carbon leakage. For example, in the UK context, poplar silvoarable systems have been shown to result in reduced output for both arable crops and trees (García de Jalón et al. 2017), whereas in the Mediterranean region, silvoarable systems were found to be more productive than both cereal monocrops and pure tree plantations in the context of the increasingly frequent early heat events during the year (Arenas-Corraliza et al., 2018). In some circumstances, the expected reduction in output may be mitigated at larger scales by enabling more efficient use of nutrients, improving microclimate and reducing damage from droughts and other impacts of climate change (McDonald et al. 2021b). It is also difficult to generalise regarding SOC enhancing management techniques. While output reduction can be expected in cases of conversion of arable land to grassland or extending the perennial phase of crop rotations, yields may improve due to improved soil quality and health, avoiding carbon leakage (Bey et al. 2021). To manage the risk of leakage, participating farms could be required to keep records of outputs and yields, and account for significant yield changes (see e.g. the GoldStandard Framework Methodology). Some methodologies require land use to remain the same, and output to be at least maintained in order to avoid leakage (e.g. VCS Methodology for Improved Land Management – Verra 2020)

Permanence

Carbon sequestration through agroforestry and SOC enhancing practices is highly reversible, whether due to a change in management or extreme weather events and other consequences of climatic changes, such as pest outbreaks. In the case of agroforestry, the permanence of the carbon sequestered depends on the type of trees and their end use (Bey et al. 2021).

Carbon sequestration through SOC enhancing agricultural practices pose particular non-permanence concerns, as SOC management actions (e.g. reduced tillage or adjusted cropping patterns) must be maintained to avoid re-emission (Bey et al. 2021). Climate change will also create risks for the permanence of sequestration outcomes by affecting growing seasons and biomass growth, and generally increasing the complexity surrounding management and permanence (Bey et al. 2021). Carbon storage capacities are highly dependent on different climate change trajectories and may result in vastly different outcomes as a consequence of carbon-cycle feedback loops. Models developed by the Hadley Centre show significant and widespread soil carbon release under a business-as-usual scenario after 2050, with the biosphere turning from an overall carbon sink into a source (Cox et al. 2000).[150]

Sustainability

Agroforestry and SOC enhancing agricultural practices have important co-benefits for biodiversity, soil health and climate adaptation and potential negative impacts are limited. Nevertheless, safeguards are needed to manage possible sustainability risks. For agroforestry systems, risks may result from the planting of non-native tree species/genotypes near existing semi-natural woodland or the introduction of short-rotation coppicing systems on farmland with existing high biodiversity value (McDonald et al. 2021b), even if the influence of climate change may be taken under consideration when defining most appropriate species. This underscores the importance of specialist technical advisory to ensure new agroforestry systems are locally appropriate. Agroforestry should also not be introduced on peat soils given the risk of GHG emissions during tree planting (COWI, Ecologic Institute and IEEP, 2021b). In the context of SOC enhancing management practices, the potential polluting effects of applying off-farm organic inputs, as well as the impact on the water balance of agro-ecosystems, in particular under arid conditions, should be taken under consideration (Bey et al. 2021). Some of these risks may be managed through lists of excluded activities, as in the case of the Australian Emission Reduction Fund system (COWI, Ecologic Institute and IEEP 2021b).

Reporting and verification requirements

Examples of reporting and verification requirements offered by existing voluntary certification schemes typically involve the verification of SOC build-up through soil sampling and analysis. In schemes such as HUMUS+, Positerra and Carbocert, soil samples are taken by certified experts and analysed in an independent, accredited laboratory. All of these schemes involve at least two rounds of sampling: at the start of the project to determine the baseline value and, subsequently, after three years (Carbocert), three to five years (Positerra), or five to seven years (HUMUS+). In the case of the latter two mechanisms, participating farmers are allowed to decide when samples should be taken within the indicated timeframes. These schemes also involve a third check to verify that carbon stocks have been maintained over an additional five-year period. Laboratory testing allows for the measurement of humus content which in turn is used to calculate the amount of carbon sequestered in the soil. In addition, farmers participating in the Positerra scheme are required to document measures taken to enhance SOC and report those to the scheme administrators on an annual basis. In the case of the CARBON AGRI method, developed as part of the Label Bas Carbone framework, landowners are required to record data on farm characteristics and management across a range of low-carbon practices, including carbon sequestration practices, at the start and end of the project's five-year duration period, as well as store any supporting documentation. The data is inputted into CAP2ER, a farm carbon audit tool which calculates carbon emissions and removals on an intensity basis. For the reductions to be recognized by the Label Bas Carbone governance body, verification must be requested by the project developer. External audits are carried out on a sample of farms (0.5 x √total number of farms),

[150] Methods for managing non-permanence are discussed in Section **Error! Reference source not found.**.

with any reduction differences identified by the auditor to be applied in proportion to the total emissions reductions in the follow-up report.

Forestry

Quantification

Carbon removal potential from forests depends on a wide range of factors including: the amount of land available, location, forest type and management, and other economic and biophysical constraints. Furthermore, the carbon removal potential of **afforestation and reforestation** projects will be influenced by the timing of planting, choice of tree species, soil type, and other factors. As such, current removal quantification approaches often rely on look-up tables and calculation spreadsheets that estimate the amount of carbon sequestered in an area of forest based on these descriptive factors. Existing certification approaches also often distinguish between smaller and larger afforestation/ reforestation efforts, with larger ones requiring a more intensive MRV process. Afforestation has been included in New Zealand's Emissions Trading Scheme since 2008, indicating that quantification methods have been demonstrated in comparable policies (see Annex A.1 for more information).

Quantification of carbon removals through **improved forest management** is generally carried out by estimating the change in carbon storage potential through modelling forest growth and yields. The carbon removal potential of such projects depends on the initial forest type and management, deforestation rates, and the forest age structure. Quantification can also be carried out without modelling, by comparing the change in stock (i.e. measurements of biomass and deadwood) within the project area versus plots outside. The establishment of the baseline for forest management methods is especially important, as systematic underestimating baselines can lead to overcrediting. For example, in California's forest carbon offset program, Badgley et al. (2021) identified systematic overcrediting of carbon removals through the program's design. This occurred as a result of significant offset credits being given to improved forest management projects with carbon stocks well above the regional averages. The study showed how statistical and ecological decisions (e.g. averaging dissimilar species in arbitrary geographic regions leading to adverse selection) led to an overcrediting of almost one-third of the analysed credits (30 million tCO_2e), which are therefore not representative of real climate benefits.[151]

Additionality

Forestry-based carbon removal efforts must also demonstrate additionality, that is surpassing natural and legal baselines in terms of the sequestration that would have occurred in the absence of the project.

Satellites or other recorded data can help to identify the additionality of afforestation and reforestation by identifying areas where trees have been planted. Satellites cannot identify whether a forester would have planted the forests without the AgETS incentives (e.g. if they were required to by regulation), so satellite monitoring must be supported by some additional assessments. These additionality assessments can be individualised to the project, such as financial or regulatory additionality tests or barrier assessments; or they can be standardised assessments for a type of

[151] Additional detail on the California Air Resources Board Compliance Offset Program can be found in Section A.2.

activity, such as market penetration evaluations, performance benchmarks, or financial additionality evaluations (Siemons et al. 2023). Identifying additionality from forest management options based on project-specific baselines is much more difficult. External observers cannot easily see evidence of changed management from a distance and must instead rely on other additionality tests. To address this, there is a need for increased experience with different approaches to establishing robust standardised baselines so that these methodologies can continue to improve.

Carbon leakage

Land competition is also a consideration when considering the carbon removal potential of forests. If afforestation occurs on degraded land or is reforestation of land which has no foreseen alternative economic or social use, leakage risks are low. Leakage due to activity shifting may occur if, for example, previously productive land is converted to forest, meaning that this land use is moved elsewhere (Pan et al. 2022). The risk of leakage from forest management approaches is low, as the land remains forested and there are generally low impacts on any existing timber production.

Permanence

Permanence concerns arise from both natural and human disturbances: forests are vulnerable to wildfires, floods, droughts, and pests, as well as deforestation and degradation. Common approaches for managing these impermanence risks in forested areas include the creation of long-term land contracts and land deeds, to avoid changes to the forest structure in the short-term. Other legal restrictions can also be developed to support permanence. See Section 0 for broader discussion of regulatory and other approaches for managing non-permanence risks. Climate change poses a threat to the ability of forests to act as carbon sinks. The aforementioned disturbances and impacts are projected to increase and become more unpredictable as a result of climate change, and are expected to negatively affect forest growth and health, reducing the size of the future forest carbon sink (Anderegg et al., 2020).

Sustainability

Sustainability effects will vary by project. Afforestation and reforestation projects can have positive impacts on biodiversity and soil health, while also reducing flooding and erosion. Care must be taken, however, that such projects do not result in species monodominance, which would have negative impacts for the ecosystem. For example, the New Zealand ETS has been criticised for incentivising exotic plantation forestry at the expense of native bush (MPI & MfE, 2022). Improved forest management projects can offer numerous co-benefits for the forest ecosystem, with improvements to biodiversity as well as water quality and quantity but should be evaluated.

Reporting and verification requirements

Existing voluntary carbon market and regulatory policies offer examples of how reporting and verification can be done. For afforestation and reforestation projects, certification mechanisms such as the NZ ETS (see Section A.1) and the Woodland Carbon Code rely on the aforementioned look-up tables and calculation sheets, and their reporting and verification approaches are adapted to this. Developers submit information on their project (timing, species, soil type, etc) to calculate an amount of carbon removals over time. Both mechanisms also distinguish between small and large projects, offering simpler requirements for smaller projects (NZ ETS separates landowners with over 100ha; Woodland Carbon Code has different quantification methods for small projects below 5ha). In the case of the Woodland Carbon Code, projects submit a baseline assessment upon registration, which notes if any activity shifting may occur. This is then deducted from the overall removal calculation. The IPCC Guidelines for afforestation and reforestation projects propose a calculation method based on the change in area multiplied by various emissions factors.

The number, size, and ownership structure of EU forests varies. There are a total of 16 million private and public forest owners. Within the EU, 60% of European forest ownership is publicly owned, with the remaining 40% in private ownership (EUROSTAT 2010). Private ownership is higher in Northern Europe (around 70%), with public ownership significantly higher in the East and South (Pulla et al. 2013). Private forest size varies widely, with 90% of private forest holdings smaller than 10 ha (EFI, 2023); Schmithüsen and Hirsch (2010) evaluated size of private forest holdings in nine EU countries and found that 61% were smaller than 1ha, with 7% greater than 10ha, including 1% of holdings over 50ha.[152]

At the European level, the Label Bas-Carbone in France outlines a verification methodology grouping afforestation, reforestation, as well as the conversion of coppice into a forest of high stands. For the latter, the baseline is established using the reference scenario based on the maintenance of the simple coppice via a clear cut of the coppice once it reaches maturity. Verification is carried out through the submission of documents, i.e. no site visit is required. Another example is the detailed methodology laid out by the Verified Carbon Standard, which contains calculations for the establishment of a baseline scenario, as well as data tables and parameters for verification.

Biochar

Quantification

There are two aspects of biochar to be considered in the discussion of MRV. A first step is the creation of biochar through pyrolysis, which involves heating biomass in the absence of oxygen (or gasification, under low-oxygen conditions). Here, the quantification issue surrounds how much biomass is converted into charcoal. A second step is the application of biochar to soils, where quantification is concerned with how this changes the amount of carbon stored in the soil. With regards to the MRV of biomass sourcing and production (Bey et al., 2021), the European Biochar Certificate (used by Puro and Carbonfuture) provides guidelines to identify a positive list of biomass feedstock sources (limited to waste products, e.g. wood processing offcuts, manure, etc). The method then focuses on the production process, setting minimum standards for the production (i.e. fossil-fuel heating is prohibited, a minimum of 70% of excess waste-heat must be utilised – e.g. to dry biomass or for district heating); these elements are assessed by an independent verifier inspecting the production facility. The method also sets minimum standards for the resulting biochar, e.g. that stable carbon content must be over 50%, and that certain indicators of stability exceed minimum standards. The quantification of removals is calculated using lifecycle analysis, including everything up to and including the biochar production (feedstock, transport and processing, production process); these methods result in estimates that approx. 3 tCO_2e are removed per tonne of biochar. The method excludes subsequent transport of biochar and emissions from end use (e.g. application of biochar), and is conditional on biochar not being burnt for energy. Lifecycle Analysis (LCA) shows that, overall, biochar provides GHG emissions reductions of varying degree, depending on the feedstock used and the pyrolysis system employed (De Gryze et al. 2010).

[152] An approximate and conservative back-of-the-envelope calculation (assuming that there are 16 million private owners, i.e. assuming relatively few public owners, and that Schmithüsen & Hirsch's (2010) forestry size ownership structure applied across Europe), would suggest that the EU has 160,000 private forestry owners with plots larger than 50ha and, 1.12 million private forestry owners with forestry plots larger than 10ha.

The MRV of biochar application (Bey et al. 2021) is more uncertain, with questions surrounding e.g. the stability of soil carbon sequestration in fields treated with biochar (American Carbon Registry, n.d.). It is not officially excluded in the accounting of the LULUCF Regulation. However, so far, no MS are known that explicitly report biochar application in their national GHG inventories. The IPCC provides guidelines on the Estimation of Soil Carbon Stock Change from Biochar. GHG accounting of carbon sequestration through biochar soil incorporation is complex due to the vast number of scenarios in which plant biomass can be used and the numerous ways biomass is converted into biochar and incorporated into an agricultural soil.

Additionality

To meet additionality criteria for crediting sequestration from biochar, it is necessary to determine what would have happened to the biomass used in the production of biochar in the absence of a project. In most cases, it will be challenging for a third-party verifier to verify any statements made by project proponents on the exact feedstock of biochar, and the level of emissions associated with production and transportation of biochar. To address these concerns, a carbon credits protocol should focus on a limited set of project types for which the baseline disposition of feedstocks can be determined with sufficient certainty (American Carbon Registry, n.d.).

With regards to the application of biochar, additionality depends on whether there is an overall positive impact on soil carbon and whether there may be other reasons to justify the application of biochar (i.e. nutrient balance, irrigation, etc).

Carbon leakage

This complexity surrounding quantification of removals makes it challenging to comprehensively account for secondary emissions and possible activity-shifting leakage effects through land-use change. Challenges of indirect land use change due to feedstock production are similar to those found in any bioenergy approach (American Carbon Registry, n.d.).

Permanence

Biochar is a relatively stable, long-lasting store of carbon. Risk of reversibility is considered low, especially in dry soils. Modelling studies commonly assume that 80% of carbon persists beyond 100 years Nonetheless, there are few long-lasting studies of biochar application and permanence therefore, there are uncertainties (Bey et al. 2021). Biochar stability in soils is central to its effectiveness in sequestering carbon and delivering other important benefits. For the purposes of a carbon credit protocol, the proportion of stable biochar would need to be determined for each manufacturing process and feedstock type (De Gryze et al. 2010).

Sustainability

There are concerns about biochar's impact on soil health and soil biodiversity, with some uncertainty about impacts, which can depend in part on biochar feedstock and pyrolysis temperature (Frelih-Larsen et al. 2022). However, biochar can also deliver other potential non-GHG benefits in agricultural systems (such as enhanced soil fertility, improved soil physical properties, higher plant productivity, reduced leaching of nutrients, reduced GHG emissions, tighter nutrient cycling in resource poor agricultural systems, better water infiltration, and lower irrigation costs) (De Gryze et al. 2010). Care must be taken to ensure that sourcing of biomass does not negatively impact biodiversity. An interviewee from an environmental NGO also raised concerns about the energy requirements of biochar as a removals solution.

Reporting and verification requirements

Some examples of reporting and verification approaches can be found through existing methodologies. Since 2019, Puro.earth has provided a carbon removal crediting methodology for biochar. The Puro Standard issues CO_2 Removal Certificates (CORCs) to carbon removal suppliers, which can be then purchased by companies to offset their emissions. Carbonfuture developed a certification scheme based on the guidelines of the European Biochar Certificate (via the Ithaka Institute) and provides guidelines on certification across the production, post-production treatment and use of biochar. Currently, the European Biochar Certificate is a voluntary industry standard in Europe. In Switzerland, however, it is obligatory for all biochar sold for use in agriculture. Climate Action Reserve is developing a Biochar Protocol for the US and Canada through a stakeholder working group process and is scheduled to be presented for approval in June 2023. Verra has also released a methodology for quantifying greenhouse gas (GHG) emission reductions from producing biochar.

Box 16 Considerations with regards to integration of biochar in AgETS+Removals

Biochar differs from the other LULUCF removals options discussed in this section. This is reflected in the State of CDR report (Smith et al. 2023), which categorises biochar as a fundamentally different carbon storage reservoir to the other LULUCF options described above: biochar is as a “product”, while soil and trees are “land-based” reservoirs. This is also reflected by EU policy: the LULUCF regulation does not cover biochar.

These examples illustrate a potential issue for integrating biochar into an AgETS+Removals policy: most existing reporting and verification approaches focus on the producer of biochar, rather than an AFOLU actor from withing the food value chain (e.g. farmer applying biochar to soil). Some methods, such as the Puro.Earth biochar methodology, set system boundaries for quantification that explicitly limit quantification of mitigation to the sourcing and production of biochar, excluding net emissions associated with the end use of biochar (e.g. associated with application by a farmer). However, the farmer that applies biochar would become the steward of the carbon stored in the biochar, and thus impacted by any potential liability arrangements for carbon permanence and reversal. This could have distributional impacts, where if included in a AgETS+Removals, funding from the AFOLU sector would be directed out of the sector to the producers of biochar while farmers could be liable for the risk related to non-permanence.

3.3. Linking removals to the AgETS: expected supply of removals

The level of removals that we would expect to result from linking LULUCF removals to an AgETS depends on both the demand for removals and supply of removals. In this section, we review the evidence on supply of removals. Alongside the evidence provided in Section 2, this section presents existing evidence on the marginal abatement cost curves for LULUCF removals in Europe, drawing on research and evidence from existing removal mechanisms. This can be compared with the evidence on the demand for removals, in Chapter 2, to get an understanding of the potential supply and demand for removals in a linked ETS.[153] Section 0 discusses how integrating removals into an AgETS will affect the AgETS cap and emissions reduction incentives, and how this can be managed.

European Commission modelling related to revising the LULUCF Regulation provides some evidence on the expected supply of removals (EC, 2021b). The LULUCF regulation sets a net removals target for the LULUCF sector in 2030 of 310 $MtCO_2$/yr, an increase from 2021 annual net removals of 230 $MtCO_2$/yr (EEA 2023). The baseline scenario presented in the impact assessment accompanying the LULUCF Regulation show that under current policy, the LULUCF sector is not expected to achieve this target but

[153] See detailed discussion of AgETS cap setting in Chapter 2 of the AgETS study.

instead would only increase net removals to 288 $MtCO_2$/yr in 2030. This means that additional policy would be required to deliver the additional 42 $MtCO_2$/yr removal to reach the -310Mt target.

The data we presented in Table 3 (Section 2) provides some indication on how LULUCF supply could develop in the future, up to 2050, though with significant uncertainty. Using the figures from Table 3 from Bey et al (2021), we can calculate a rough estimate of the technical mitigation potential of the five removal options for the EU to be between 167-866 $MtCO_2$/yr by 2050.[154] The European Scientific Advisory Board on Climate Change (2023) provides a somewhat narrower estimate of 2040 and 2050 LULUCF net removal potential based on an evaluation of climate scenarios. They present three iconic pathways (illustrating three possible different futures), which suggest net LULUCF removals in 2040 could range from 323-601 $MtCO_2$, and from 312-669 $MtCO_2$ in 2050.

The LULUCF Regulation impact assessment modelling (EC 2021b) provides further evidence on the supply of removals in 2030, including on a key determinant of the supply of carbon removals, the cost of removals. **Figure 14** (from EC 2021b) presents the marginal abatement cost curves for different removal options, i.e. the additional cost of mitigating another tonne of carbon. It will be profitable for removers to implement LULUCF removals when they are paid at least as much as the marginal abatement cost. Accordingly, the marginal abatement cost curve can be read as the amount of removals that will be (technically) available at any given market price. **Figure 14** provides some additional evidence that can help us estimate carbon removal supply. It must be interpreted with some caution for this study,[155] but it indicates that in 2030 removals through afforestation, improved forest management and soil carbon (excluding emissions reductions on peatlands) could deliver approximately 80 $MtCO_2$/yr of LULUCF removals in 2030 at costs under €100/tCO_2e (i.e. excluding emissions reductions on organic soils, which are within the scope of the AgETS). These estimates are considerably lower than those reported in **Table 31**, which report on the supply in 2050.

[154] Technical potential refers to the biophysically possible mitigation level, calibrated to rules make it more realistic. However, this can be quite different from the economic potential, i.e. the amount of mitigation that will be implemented by rational actors at a specific carbon price. Economic potential can be considerably lower, due to economic barriers to implementation such as learning and transaction costs, among other barriers.

[155] One issue is the misalignment of definitions of removal options with our definitions. For example, the chart below includes emissions reductions from "organic soil", which we consider an AgETS emissions source, rather than a removal; similarly, it is not clear from the chart what proportion of forest management mitigation is a removal, and what is emissions reductions. Additionally, agroforestry and biochar are absent from the chart. Furthermore, the timeframe of this chart refers only to 2030, which is relatively short term compared to the timeframes we are examining in this study.

Figure 14 Marginal abatement cost curves for removals solutions (reproduced from European Commission, 2021c)[156]

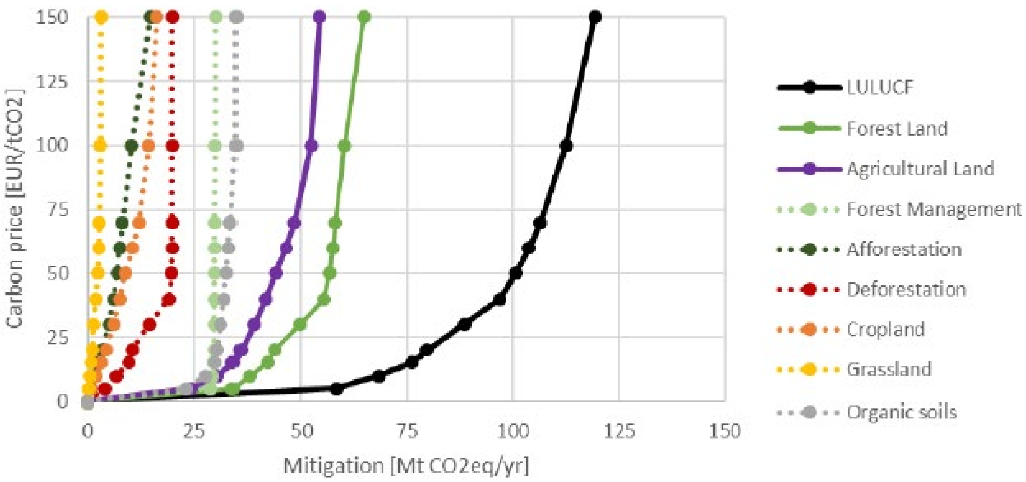

Figure 13 – Marginal abatement costs curve for the MIX scenario in 2030 for actions modelled in GLOBIOM and G4M for main LULUCF land use categories and CAPRI for organic soils on agricultural land. Mitigations were estimated for carbon prices [y-axis] shown in dots. LULUCF is the aggregate of Forest land, and Agricultural Land. Forest land is the aggregate of mitigation by Afforestation, Deforestation, and Forest Management which correspond to "land converted to forest land", "forest land converted to other land uses", and "forest land remaining forest land" on mineral soils, respectively. Agricultural land is the aggregate of mitigation from Cropland and Grassland on mineral soils and organic soils under cropland and grassland combined. Mitigation measures by carbon prices on other LULUCF categories (Wetlands, Settlement, Other land, Harvested Wood Products) were not explicitly modelled.

The data in Figure 14 gives some information on the cost of removal options. The Commission modelling suggests that forest management is the cheapest option; it clearly has the highest predicted mitigation potential at each carbon price. Afforestation and soil carbon sequestration on cropland appear to be next most affordable, with grassland removals the most expensive.

There is also some limited data available on marginal abatement costs at national level. These national marginal abatement cost curves reflect local context, so care must be taken when extrapolating to the EU scale. However, they can still provide useful insight regarding removals supply. For example, Lanigan et al. (2023) develop a marginal abatement cost curve for Ireland. One key takeaway is that under some scenarios, up to 30% of mitigation can be attained at negative cost (i.e. options where farmers would not face costs, but rather would profit, from their implementation). The cheapest (negative) options fall into the category of soil carbon sequestration e.g. through grassland management and crop rotations, though the ordering of least cost options is likely to be specific to the Irish context.[157] The Irish marginal abatement cost curve suggests that at the EU level there could be significant low cost LULUCF removals available. However, as noted by Eory et al (2018), care must be taken in interpreting marginal abatement cost (MAC) curves for agricultural mitigation, as MAC curves often present maximum technical potential (i.e., full implementation by all farmers), and fail to adequately recognise non-financial barriers and adequately capture full costs of implementing actions for farmers.

[156] Note that this chart includes emissions reductions (i.e. is not purely LULUCF removals), including from organic soils and croplands.

[157] The mitigation cost curve also includes emissions reductions, rather than just LULUCF removals.

Finally, some evidence on LULUCF removals supply can be gleaned from the voluntary carbon market and existing regulatory markets.[158] A 2019 review identified nine LULUCF-related voluntary carbon markets in Europe (Cevallos, Grimault & Bellassen 2019). The majority of these voluntary markets are small scale, with the exception of the Woodland Carbon Code, which rewards voluntary afforestation in the UK. As of June 2023, already registered Woodland Carbon Code projects were projected to generate 6.5 Mt of carbon removals at prices ranging from €11.65- 23.30/tCO_2e (Woodland Carbon Code 2023a; 2023b).[159] Since the publication of that report, among other new voluntary schemes, the French domestic voluntary carbon scheme Label Bas Carbone was established. It now features 13 methods for certifying mitigation, including five that are related to LULUCF removals; in total the 670 projects that have registered so far are expected to mitigate 2 Mt CO2-e (it is not clear what share of these are from LULUCF removals, or the price) (Ministry of Energy Transition 2023).

International voluntary carbon markets offer further evidence. Between January and August 2021, the largest sector of the global voluntary carbon market was mitigation through forestry and land-use, which delivered 115 Mt of mitigation at an average price of €4.38/tCO_2e; mitigation by the agriculture sector was 3.4 Mt at an average price of $1.26/t$CO_2$e (Ecosystem Marketplace 2023). This data should be interpreted with caution, as the quality of certification is unknown and this reported data mixes emissions reductions (e.g. avoided deforestation) with the LULUCF removals that we discuss in this chapter (e.g. afforestation).[160]

Some insight on the costs of LULUCF removals can also be gained from existing regulatory markets. In the New Zealand Emissions Trading Scheme (NZ ETS) (see Section A.8), afforestation generated 5.6 Mt of removals in the 2021/2022 year, equivalent to 53% of all 2021/2022 mitigation under the NZ ETS (NZ EPA 2022). Prices in the NZ ETS in 2023 ranged around €41-51/tCO_2e (Commtrade 2023). The California Air Resources Board Compliance Offset Programme (see Section A.2) allows improved forest management and afforestation offset credits to be sold into the California cap-and-trade-system, as of 2020, credits equivalent to 156 Mt CO2-e of removals had been sold, with market prices of $13.67/t$CO_2$e (Badgley et al. 2021).[161]

It is challenging to interpret the evidence from the voluntary and compliance markets due to the differences in certification requirements and the accompanying wide variation in the quality of removals (in terms of permanence, additionality, quantification etc.). Alongside demand, the stringency of certification substantially determines the price of the credits, as it defines what specific practices and protections must be implemented to ensure that the removals are permanent, additional, etc.[162] Given the low price, the average quality of the international voluntary carbon market credits may correspondingly be expected to be low. Even the regulatory markets have faced significant criticism in terms of credit quality, e.g. Badgley et al (2022) estimate that 29% of the forestry credits

[158] This evidence must be interpreted with care: the prices reported are market prices that depend not only on supply of LULUCF removals, which is our interest, but also on demand for the credits.
[159] If similar levels of uptake and mitigation occurred across the EU (land area: 4,324,000 km^2) as in the UK (land area: 244,000 km^2), this would imply carbon removals of approximately 115 Mt CO_2-e/year. Note: this should be interpreted with caution, as the EU context is likely to differ considerably from the UK.
[160] Indeed, Ecosystem Marketplace (2023) do report that those credits in their dataset marked as “removals” had an average market price of €7.40/t CO_2-e, while those marked as “emissions reductions” had a price of €1.59/tCO_2e; this data cannot be disaggregated to removals types as not all respondents identified whether their credits were removals or emissions reductions.
[161] The California system rewards a significant proportion of forestry credits ex ante based on expected emissions reductions over 100 year project timelines.
[162] For example, many certification rules that are applied to decrease the risk of non-permanence effectively discount the removals, meaning removers must supply more per reward (see Section 0 for discussion).

certified by the California Offset Programme are not backed by real climate benefits. Indeed, the low or uncertain quality of removals certified by voluntary markets was one of the drivers for the European Commission's CRCF proposal. Without seeing the final form of certification that will be applied within the EU (e.g., if the final CRCF methodologies are to be used for an AgETS+Removals policy), we do not know what prices are likely to apply. However, the evidence from the voluntary and regulatory markets suggests at prices as low as €10/tCO_2e there is likely to be supply of some removals, with more significant supply likely at the prices approaching €50/tCO_2e seen in the more robustly certified NZ ETS.

Overall, it is difficult to determine the likely supply of LULUCF removals. In particular, this will depend on the requirements for removals established by the certification methodologies and other AgETS+Removals rules, with more stringent certification rules reducing supply. Nonetheless, it is essential to ensure that certified removals are backed by real climate benefits. Further research into abatement costs and the potential EU quantity of supply of removals at different carbon prices will help to understand the impact of linking different scope removals policies to an AgETS. However, the evidence collected does suggest that with a timeframe of up to 2030, forest management, agriculture, and afforestation removals could be supplied at prices below €25, with more significant supply likely to be available at higher prices.

4. Removals policy models: design elements

The ability of the AgETS+Removal policy to meet its objectives will depend on specific design decisions. These design decisions are equally important to the functioning of the AgETS+Removal policy as the AgETS policy design (summarised in Chapter 2), the supply of removals (discussed in Chapter 3), and the removal policy model selected (i.e. Chapter 5). Indeed, design decisions can help to address MRV challenges with the supply of removals or to ameliorate the weaknesses of the removal policy model that is selected. The cross-cutting issues discussed in this section must be considered, regardless of what scope of removals or which policy model is implemented. As explored in the text below, the selection of policy model and removals scope will interact with and call for particular design decisions to be implemented to ensure that the overall AgETS+Removals policy is effective and efficient.

When developing an AgETS+Removal policy, alongside scope and policy model, numerous design decisions must be made. For example, the World Bank's 2016 handbook for emissions trading system design identifies ten steps that are required for developing an ETS: Decide the scope, Set the cap, Distribute allowances, Consider the use of offsets, Decide on temporal flexibility, Address price predictability and cost containment, Ensure compliance and oversight, Engage stakeholders, communicate, and build capacities, Consider linking, Implement, evaluate, and improve (Partnership for Market Readiness and International Carbon Action Partnership 2016). Each of these steps requires regulators to make numerous individual design decisions on the specific implementation design.[163]

In this section, we focus on the most important design decisions for the AgETS+Removals context.[164] For each design decision, we describe the key issue at hand, discuss why the design decision is important (i.e. the potential implications of the design decision for policy objectives),

[163] Indeed, despite the ETS handbook document stretching to 200+ pages, a follow up 116 page report was published focusing just on one step (Consider the use of offsets) (Partnership for Market Readiness 2021).
[164] Some "design decisions" are also discussed in detail elsewhere in this report, e.g. trade-offs and options related to monitoring, reporting and verification (MRV) are discussed in Section 3.2.

suggest potential approaches for managing the issue, and identify how these issues interact with the different scopes and removals policy models.

4.1. Emissions trading-related design decisions

Emissions trading systems are complex policies that can take different shapes depending on specific design decisions taken. Crucial features of any ETS relate to the stringency of the cap (that is, how many emissions allowances are made available, which sets the environmental target), as well as the availability and allocation of free allowances (which influence the distribution of costs across different actors); these decisions are discussed in detail in the context of the AgETS Study. The linking of removals allowances into an AgETS poses additional risks and challenges that must be managed through policy design.[165]

In this section, we discuss design options related to three key issues. The first is the challenge of managing emissions reduction deterrence, which we discuss alongside other trading market design issues (including the potential for net negative caps). The second is options for policy makers to fund removals options at prices other than the market price (e.g. through carbon contracts for difference). The third is the issue of managing the non-equivalence of LULUCF removals and AgETS emissions reductions, which was raised in Chapter 3. Here, we focus particularly on the issue of non-permanence, which we use as an example to explore to what extent this non-equivalence can be managed by market design.

Managing agricultural emissions reduction deterrence

Linking LULUCF removals to the AgETSs poses a number of challenging questions for market design. A key risk is that, depending on the policy design, linking will decrease the mitigation effort that is required from the emission sources covered by the AgETS (i.e. the emissions reductions in the agricultural sector) as they will instead be able to purchase removals credits. We refer to this effect as "reduction deterrence", as the availability of any removal options at a cost below the market price in the AgETS deters other mitigation efforts. It can occur in all policy models where carbon removals are linked to polluters in an integrated or interconnected market, so long as removals options are available at a price below the AgETS market price.[166] The effect will arise regardless of how this link is made, whether it is by expanding the AgETS compliance entities to include removers (as in the integrated ETS, Section 0), whether polluters can purchase external credits or deductions (interconnected ETS models, Section 0), or if the government, as an intermediary, purchases removals credits to sell or allocate to polluters (Section 0), with an impact on the supply of allowances: in all of these cases, polluters have the option to purchase removals credits or to reduce their emissions. According to economic logic, they will choose whichever option is cheapest. In this subsection, we lay out the theoretical issue (with evidence from practical examples) and identify options for managing this risk.

The degree of agricultural emissions reduction deterrence will depend on a number of factors, above all the marginal cost of emissions reductions, marginal cost of removals, and the stringency of the cap.

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[165] Accordingly, the ETS-related design decisions discussed in this section are not important for those policy options that do not involve the trading of LULUCF removals into an AgETS, i.e. they do not apply to the No link: Disconnected market model discussed in Section 0).

[166] If there were no removals available at a price below the AgETS market price, there would be no market for them, and the issue of agricultural mitigation deterrence would not apply. However, there would be no reason to link the AgETS and removals if this was the case. Accordingly, we would expect that such a link would only be made if it was expected that some removals were below the AgETS market price, and that these would be traded and therefore deter some agricultural emissions reductions.

Given the considerable uncertainties involved, both regarding the demand for removals (see Chapter 2) and supply of removals (see Section 3.3), it is impossible to predict whether / which removal options would be competitive in a linked AgETS+Removals market. This applies above all to the expected price range on the yet-to-be-established AgETS. It is however notable that some removal options are expected to be viable at a price of less than 25 Euros per ton of CO_2e – a price level that is well within the range of conceivable outcomes for the AgETS, if the price expectations in the current EU ETS and the planned ETS2 can provide any orientation (Pahle et al 2022). In other words, it is plausible to assume that at least some of the cheapest removal options would be able to compete in a future AgETS; a scenario where removals are available but do not find a buyer is less likely to persist.

These considerations, however, describe a static moment: the moment when removals are integrated into the AgETS, with a given ETS cap and a given set of technologies and costs. These will change over time as AFOLU markets and policies shift, as the required mitigation efforts increase, as technological options mature and mitigation costs change. For example, on the one hand, technological innovations in agricultural feed additives could decrease the costs of reducing livestock emissions, reducing the demand for removals. On the other hand, increasing standardisation and use of digital tools could reduce the cost of MRV for removals, and thus bring down the overall cost and increase the demand for removals.

A dynamic perspective is also warranted for the process of setting the cap. This includes several drivers: to meet the increasingly stringent mitigation ambition over time, the AgETS cap will be required to contract over time. Expectations of falling abatement costs enable higher ambition, as does the expectation that political opposition to the AgETS will subside over time, as covered actors become used to the AgETS. Finally, and crucially, the (expected) availability of removals will also factor into the process of setting the cap: either implicitly, in that removals complement the spectrum of available (mitigation) options, and hence factor into the expected cost of meeting the emission reduction objective. Or explicitly, if the cap is set with the specific and explicit objective of creating demand for removals, i.e., the regulator assumes that a certain share of the (net) reduction effort is to be delivered in the form of removals. In this consideration, the supply of removals is endogenized into the cap setting decision, the cap is no longer exogenously given, but rather becomes endogenous, as the decision on the future cap would consider the possible contribution from removals (and their cost). In both cases, the expected contribution of removals should be factored in when setting the AgETS cap, or when revising it for later trading periods. Otherwise, emission reduction deterrence can undermine the environmental integrity of the AgETS, as exemplified in the EU ETS and NZ ETS described in Box 17. Whether the envisaged contribution from removals materialises would then be determined by the market: some design options (described in Chapter 5) would allow greater control, others less so.

Box 17 Evidence from practical examples of emission reduction deterrence

For the inclusion of removal credits into the AgETS, some insights can be conferred from the use of international emissions credits in the EU ETS, i.e. credits generated through emission reductions outside the EU through the Clean Development Mechanism (CDM), or in sectors not covered by the EU ETS through the Joint Implementation (JI) mechanism, particularly in Central European Member States. The use of such credits was allowed from the second phases of the EU ETS, and progressively restricted in the third phase. In phase 2 (2008-2012), installations covered by the EU ETS could meet a certain share of their compliance obligation with such credits. The limits differed between Member States, but for the EU as a whole amounted to 13.4% of the cap (Verde & Borghesi 2022). The use of credits was restricted further in phase 3 (2012-2020), limiting both the allowable amount of credits, their type, as well as countries from which they originated. For instance, the EU ETS did not allow specific types of international credits due to concerns about low environmental integrity (e.g. those related to HFC-23 gas destruction or from nitric acid) (*Ibid.*). Furthermore, as of 2013, only credits from projects in least developed countries were allowed for compliance. This excluded in particular credits originating from Chinese projects, which had represented the bulk of all credits. As of 2021, international credits can no longer be used for compliance in the EU ETS. As the supply of international credits was initially limited and since it was uncertain how the supply would develop, credits initially were traded at prices close to the price of EU allowances. As the supply of international credits matured, however, and as compliance entities were approaching the limits for credit use, the credits became notably cheaper. Eventually, with saturated demand for credits and low prices of EU allowances, prices of international credits fell to close to zero after 2013 (Hintermann & Gronwald 2019). For compliance entities in the EU ETS, access to low-cost credits – on top of free allowance allocation – was clearly beneficial and may even have resulted in windfall profits (Hermann et al. 2010). For the EU ETS as a whole, it suppressed EU ETS prices, decreasing incentives for mitigation (Verde & Borghesi 2022), and by allowing credits with low environmental integrity also undermined the EU ETS.

In a similar way, New Zealand ETS's linking to low cost (and low-quality) international credits provides an example of how a large number of low-cost removal units can significantly impact a market: the abundant supply of low-cost credits depressed prices in New Zealand's ETS to below €5/tonne in 2012-13, resulting in very little domestic mitigation until the ETS was delinked from international units (Leining, Kerr, & Bruce-Brand 2020). It is important to note that integrating LULUCF removals into a AgETS would not be the same New Zealand's situation, i.e. EU LULUCF removals would not be unlimited or as low-cost as the low quality international credits that were accepted into New Zealand's ETS, and must be subject to much stricter quality controls. However, as detailed in Section A.1, the New Zealand ETS has been criticised for generating only limited emissions reductions, placing no control to reduce emissions reduction deterrence and with 73% of NZ ETS mitigation in 2020 generated by forestry credits (i.e. removals) rather than emissions reductions (Carver et al. 2022).

Whether emissions reduction deterrence is considered problematic depends on the assumed policy objectives and their (implicit) hierarchy:

- If the AgETS is understood as a policy to change the structures and practices in EU agriculture towards more climate-friendly outcomes, allowing removal credits would lower the incentive (and pressure) to do so.
- If the objective is to create demand for removals, in order to develop a market for them and in the process help the technologies mature and costs to come down, increased supply (and use) of removals would be a positive outcome.
- If the objective is to lower the net emissions of the land sector at least cost, then the mix of removals and emissions reductions may be less of a concern, so long as the sector reaches its (net) emission target. With this objective, incentivising a mix of emissions reductions and removals could be seen as a positive outcome, expanding options for climate action and lowering the cost of reaching the emissions target.

In practice, all three objectives are relevant – and they will all be reflected in the process of setting the cap. It may therefore be too simplistic to posit that the AgETS is supposed to guarantee a certain amount of reduction to happen within the sector, and that the introduction of removals undermines this function. Moreover, the relative weight of the objectives will evolve over time. Initially, the function of the AgETS+Removals will likely be to provide a strong incentive for emission reductions from the covered emission sources, to ensure that the covered sectors contribute adequately to the EU's emission targets, and embark on the necessary structural transformation to climate neutrality. Over time, however, as the EU edges closer to climate neutrality, emissions trading will become a mechanism to ensure that any remaining agricultural GHG emissions that cannot be abated (for technical or economic reasons) are compensated by a corresponding amount of carbon removals (see below on net negative emissions from agriculture and land use).[167] By this time, the technologies and market for removals needs to have matured sufficiently to provide a viable alternative.

While all competing objectives need to be considered together (and are considered in the cap-setting process), this does not take away that different strategies and solutions also compete for political attention, efforts and funding. This was also reflected in the responses of stakeholder survey, where there was no clear consensus whether emissions reduction deterrence should be considered a major challenge. Concerns raised in the stakeholder workshop were primarily related to deterrence risks due to non-equivalence of carbon removals (see Section 0), rather than the risk of emission reduction deterrence in general. Some stakeholders indicated that the challenge of emission reduction deterrence could be partly mitigated through improved MRV, ensuring the principle of additionality and a stringent AgETS cap. However, others advocated for constraining the use of removals in an AgETS. Some removal policy models therefore offer ways to limit the risk that the inclusion of removals diverts too much attention and effort away from emission reduction efforts. They function by constraining the use of removals along different dimensions.

The risk of emissions reduction deterrence can be managed through substantive restrictions on the use of removals, including both quantitative and qualitative approaches:

- Quantitative restrictions, i.e. a limit on the percentage of removals that emitters can use to meet their compliance obligation, are a straightforward and familiar option that has been tried and tested in offset programmes (see e.g. California Air Resources Board Compliance Offset Program, Section A.2). In this instance, the limit on the share of allowable removal units will need to be introduced at a low level to reduce risk and from there could increase over time, as the emissions from covered entities continue to decline, and hence the share of removals in the residual emissions increases. Eventually, as the EU approaches climate neutrality, it could be feasible for removals to correspond to 100% or more of covered emissions.
- Qualitative restrictions (e.g. on the eligibility of certain removal types to be used for compliance) – are also an established feature from governing international credit. These restrictions can relate to different types of removal credits that are deemed eligible (or not), but also to other standards that need to be met (e.g. sustainability / biodiversity criteria). For example, the CRCF proposal states that removals will only be certified if they "do no significant harm" to other environmental objectives (COM 2022/672).

Beyond these substantive constraints, there are also procedural constraints that can be used to manage the risk of emissions reduction deterrence. While these approaches primarily manage the non-equivalency of LULUCF removals credits and AgETS emissions (see Section 0), each of these elements would reduce emissions reduction deterrence by making removals more costly (relative to the case where these constraints do not apply). Based on the assumption that removal credits will (eventually) be cheaper than other mitigation options, this cost increase would delay the increase in the role of

[167] This follows a pattern that can also be observed in other discussions about the preferred pathway to climate neutrality. Confronted with the need to achieve a drastic reduction of GHG emissions in very limited time, virtually all scenarios and pathways postulate a hierarchy of different mitigation options: efficiency / energy conservation is paramount, followed by substitution of fuels (from fossil to renewable), often in the form of electrification. Removals – as well as CCU/S as well as many hydrogen-based solutions – are reserved for emissions that are "hard to abate", as these technologies are (at least for the foreseeable future) relatively costly, their potential limited, and their feasibility uncertain. A counterargument to this would be that "hard to abate" is rarely the expression of a technological inevitability, but more of an economic trade-off. Which suggests that the decision which emission are "hard to abate" might also be left to the market.

removals rather than preventing it: eventually, removal projects would also be expected to become economically competitive even with constraints in place:[168]

- Limited validity period of removal credits: For example, the CRCF proposes that removals would only be considered stored for the duration of the monitoring period, after which it would be considered released to the atmosphere. An alternative would be a limited duration of variability, i.e. a built-in decay function. Cullenward et al. (2020) investigate the total cost of repeatedly buying temporary credits to achieve permanence compared to the one-off cost of permanent removals (or emissions reductions). Their calculator[169] illustrates that the total cost of repeatedly buying temporary credits is lower for temporary credits with longer project durations, lower project risk, lower cost, and, crucially, the discount factor.
- Discounting or conversion factors would function as an inbuilt safety margin for removals. It would mean, for instance, that only a given percentage (e.g. 50, 70, 90%) of the claimed removals are issued as credits. The rest is retained as a safety margin, which can be invoked e.g. if a permanence risk materialises, or if assumptions turn out to be overly optimistic (see 0 for more detailed discussion of discounting).
- Risk spreading: this would establish a requirement that removal credits are bundled together across different (eligible) removal types or geographies, to contain e.g. cluster risks of impermanence (if all soil carbon credits / all credits from a particular region suffer from the same risk). Removals units from different origins would first be pooled together, and then from this pool new removal credits would be issued. This option could also be combined with the discounting / “safety margin” above: margins from all projects would in this case be pooled across projects, and dished out as needed (central insurance across geographies and project types). Pooling removal units from different geographies and vintages could be one function of a carbon central bank (see below under Section 5.2).

Liquidity on the AgETS market and facilitating net negative removals

A benefit of linking removals to an AgETS could be increased liquidity on the AgETS market and the ability to set net-negative caps.

Depending on the specifics of the implementation (see Chapter 5), adding removals to the AgETS can increase the number of participants active on the market, as well as the number of emissions units in circulation. This would increase the liquidity on the AgETS market, thereby ensures better price discovery and may increase price certainty (La Hoz Theuer et al 2021). Second, the inclusion of additional actors also decreases the risk of overly concentrated market power on the AgETS market, reducing the risk of market abuse.

The inclusion of removals may also allow the setting of net-negative caps in emissions trading systems. As argued above, this feature will gain importance starting from the 2040s, as the EU approaches climate neutrality (Rickels et al 2021). To achieve climate neutrality for the EU as a whole, agriculture, forestry and land use as a sector will need to become net-negative, i.e., land based removals exceeding the remaining emissions from agriculture, forestry and land use. At this point, the net-negative

[168] This point, however, may be more difficult to reach if and where learning costs are involved: many removal technologies will need to be implemented at sufficient scale for costs to come down; in the context of LULUCF removals, a key focus will be improvement of standardised monitoring and implementation procedures and tools. In this case, imposing too high additional costs from the outset will not only delay the learning, but may prevent them from becoming economically viable. To what extent learning costs are relevant for the successful scaling of removal technologies, however, requires closer investigation.

[169] https://carbonplan.org/research/permanence-calculator-explainer

emissions can offset the residual, "unavoidable" emissions in other sectors, such as process emissions in certain industrial processes, for which no feasible abatement options exist.[170] In this way, eventually, technical and / or land-based removals could take on the role of the "backstop technology", which determines the price also in other ETSs (the current EU ETS for energy, industry, aviation and shipping, and the upcoming ETS2 for buildings and road transport), or in a future joint ETS (Pahle et al. 2023). Particularly in the second half of the 21st century, removals will play a key role in the emissions trading landscape: at this point, many of the currently emission-intensive processes will likely be completely decarbonised, e.g. electricity generation, private transport, space heating etc. The function of an ETS in this net-zero economy could be to manage the balancing of the residual emissions with a corresponding amount of GHG removals – or even to ensure an adequate contribution of negative emissions towards a net-negative economy, with GHG removals exceeding emissions e.g. to compensate for a temporary overshoot.

Funding different removals with differentiated prices

As described in Chapter 3, different types of removals differ in cost.[171] Some of the removal policy models we consider are able to offer differentiated prices to different removal types. At the outset, it may seem inefficient to pay more for an option that delivers the same benefit as cheaper alternatives do. There are, however, at least two potential justifications for such differentiation: first, it may be the *dynamically* efficient thing to do, if it supports removals types that are currently underdeveloped but that will, with increasing scale, over time become cheaper than current alternatives. Second, removals that deliver co-benefits could command a premium, such as adaptation, biodiversity provision, or support community outcomes (see discussion in Section 0 for other ways to promote co-benefits). Such differentiation is more likely to be the result of a deliberate choice by the regulator (and thus a policy model where the government acts as central buyer), but a premium for co-benefit could, in principle, also be paid by private buyers.

Specific rules or design elements could be employed to provide differentiated rewards to removers. One option that would be applicable in the Direct link removal policy models would be carbon contracts for difference (CCfD). CCfDs can establish differentiated prices for different types of removals by setting an agreed "strike" price that the remover will be paid for their removal. If the allowance market price that eventuates is lower than the strike price, then the government tops up the market price up to the strike price (LIFE CarbonFarmingScheme 2021). Different strike prices could be set for different types of removals to encourage a range of removals options, rather than just those below market price. CCfDs can also increase participation by providing price certainty to removers. Other options would include minimum purchase requirements for AgETS polluters, where AgETS polluters would be required to meet their compliance obligation using at least some minimum number or

[170] Feasible, in this context, will usually be a combination of technological, economic or political factors: it may be technologically difficult to replace emitting activities since alternative, non-emitting technologies are not available (or not available at the necessary scale) (e.g. carbon-capturing concrete); these technologies may be excessively costly (e.g. many applications involving green-hydrogen derivatives as a fuel or feedstock), or there may be overriding political motivations that render them infeasible: for instance, in order to reduce emissions, there is always the option to discontinue the emitting activity, but this may not be politically palatable.
In light of these considerations, there is no single, binary classification of which emissions can be considered as "hard-to-abate", not least since the relevant criteria are all dynamic: technologies evolve and mature, costs come down, and political acceptance for certain measures is also wont to change over time. What was considered hard-to-abate yesterday may be seen as a low-hanging fruit tomorrow, as witness e.g. by the proliferation and falling costs of solar PV, wind or electric vehicles. Therefore, the notion that removals should be reserved for those emissions that are "hard to abate" is theoretically justified, but difficult to implement in practice. Turned around, this gives yet more justification for a staged approach, in which removals are phased in gradually over time, and play an increasingly prominent role in the emissions trading architecture.

[171] The costs reported in Chapter 3 are average cost estimates. We would expect the range of costs per removal to vary across different actors.

percentage of removals units (Rickels et al 2021); different minimums could be set for different removal types. However, all of these options will increase the complexity of the market, which in turn can increase participant and administrator costs, as well as uncertainty and opportunities for "gaming" the system.

It also must be considered whether there are justifications for differentiated pricing of nature-based solutions: CCfDs have commonly been proposed in underdeveloped markets to support innovation; given that the removals solutions are already mature, this may not be justified.

Managing the non-equivalence of LULUCF removals and AgETS emissions reductions: the example of non-permanence

As identified in Chapter 2, removals are different to agricultural emissions reductions. This non-equivalency poses a fundamental challenge to any policy that trades removals for emissions reductions, such as the AgETS+Removals. Stakeholders in the survey and workshop held for this study therefore considered non-equivalence as the biggest challenge that needs to be overcome. Some stakeholders (mainly NGOs and environmental organisations) even argued that there is no assured way to overcome the challenge of non-equivalence, and therefore advocated for a strict separation of carbon removals and emission reductions. In this subsection, we discuss how and the extent to which policy design can manage the non-equivalence challenge. This includes how the European Commission's proposed CRCF aims to ensure that certified removals will be of a consistent quality.

The reasons why LULUCF removals are unlikely to be equivalent to agricultural emissions reductions include:

- **Non-permanence risk**: While a tonne of emissions avoided by a polluter is permanent (i.e. that tonne of emissions will never be in the atmosphere), the same is not true of removals, which may be released in the future, either due to intentional changes in management or unintentional reversals caused by e.g. drought or fire. If removals replace emissions reductions and then are later re-released, then the total amount of GHGs in the atmosphere will be higher than if the removals had not been linked to the AgETS. This fundamental issue is explored in more detail below.
- **Quantification uncertainty**: As explored in detail in Section 3.2, it can be more challenging to quantify removals than emissions reductions, due to the nature of the processes (e.g. soil carbon sequestration is more difficult to estimate than cattle methane emissions). Replacing more certain emissions reductions with uncertain removals units decreases the certainty that the cap is being adhered to and mitigation targets are being achieved.
- **Greenhouse gases**: Carbon removals remove carbon dioxide from the atmosphere. This will have different warming impacts to emissions reductions that would be covered under an AgETS, which are primarily methane or nitrous oxide emissions (see Chapter 2 for discussion of different gas impacts).
- **Sustainability impacts:** There is also the potential for positive non-equivalency: many removals options offer significant biodiversity co-benefits. In this case, replacing emissions reductions with removals may help to achieve biodiversity objectives.

There are arguments for accepting (some degree of) non-equivalency, e.g. it could be economically justified if it resulted in significant cost savings or ability to achieve greater levels of overall mitigation. However, a number of authors have raised concerns about whether specific nature-based removals should substitute for emissions reductions, arguing that the above issues pose serious risks to the environmental integrity of emissions trading systems (e.g. Zakkour et al. unpublished; Paul et al. 2023), with a key argument being concern that removals will substitute for emissions reductions and then fail (e.g. due to impermanence, or due to additionality/quantification failures). However, t**he impact of non-equivalency can be to some degree mitigated through policy design**, for example, permanence and quantification uncertainty risks can be somewhat managed through buffer accounts or discounting (e.g. requiring two units of removals to balance out one unit of emissions reductions).

The European Commission's CRCF regulatory proposal (COM 2022/672) proposes a certification system for carbon removals which features some rules to address this risk of non-equivalency. By establishing minimum quality criteria for removals, the CRCF aims to deliver removals that are of consistent quality, that is, that meet minimum standards of additionality, long-term storage, sustainability, and conservative quantification. It is not yet possible to ascertain whether the removals certified by the CRCF will be equivalent to agricultural emissions reductions under an AgETS, as this will depend on the details of the carbon removal option-specific methodologies that will be developed by the Commission and the Expert Group on Carbon Removals over the coming years.

The issue of non-permanence offers a practical example of the options and challenges of managing non-equivalence through policy design decisions. As discussed in Chapter 3, LULUCF carbon removals are not permanent. They represent carbon removed from the atmosphere and stored in biomass, where they remain until they are released either intentionally (i.e. due to a change of management practice or mismanagement) or unintentionally (i.e. due to natural events, such as drought, fires, or disease). The mitigation benefits of LULUCF carbon removals only exist as long as the carbon is stored.[172] The expected storage time depends on many factors but also differs per LULUCF removal option: forestry removals are expected to have lifetimes around decades to centuries, soil options years to decades, and biochar decades to centuries (see discussion in Chapter 3). This represents a fundamental difference from agricultural emission reductions (i.e. those covered by the AgETS), which if reduced pose no future risk of re-release, i.e. are permanent.[173]

The incorporation of non-permanent removals into an AgETS with (permanent) emissions reductions poses risks and challenges. The key risk is that instead of reducing (permanent) emissions, farmers purchase allowances or credits generated from carbon removal activities. If these were to be reversed in the future, it would increase the amount of GHGs in the atmosphere relative to the case where removals were excluded from the AgETS (Schneider & La Thoz Heuer 2019).

Existing private and public markets have identified a number of approaches for decreasing the risk of impermanence or reducing the risk it poses to environmental integrity. These include the following approaches (drawing on McDonald et al (2021a) and practical examples gathered in Annex A of this report):

[172] Kalkuhl et al (2022) review the economic literature on and model the value of non-permanent removals and conclude that non-permanent removals are welfare enhancing, as they reduce transition costs (i.e. they allow more time now to reduce emissions). The conclusion can be assumed to also apply to the agriculture/land sector, i.e. removals can reduce the overall costs of mitigation by reducing transition costs. The paper does not assess the optimal policy to achieve this within the agricultural sector.

[173] This is true for agricultural emissions (i.e. livestock and fertiliser emissions); if land-use emissions are included (e.g. emissions from drained organic soils), then the same non-permanence risks apply (as avoided emissions from organic soils could be released in the future).

Temporary credits: The CRCF states that, in the case of carbon farming and carbon storage in products, the "carbon stored by a carbon removal activity shall be considered released to the atmosphere at the end of the monitoring period" (COM 2022/672).[174] This limitation to the validity of carbon farming units aims to avoid that farmers and foresters need to commit to too long monitoring periods, while ensuring transparency on the duration of the carbon storage and providing incentives to prolong the monitoring period. Under such approach, buyers of carbon farming units would then be required to retire and repurchase allowances at the end of the credit monitoring period (e.g. if soil carbon removals are monitored for 25 years, then at the end of the 25-year period, the credits expire and the buyer is required to purchase a replacement unit or carry out an additional unit of permanent emissions reductions at that point). This is facilitated by having units with vintage and expiry dates. When buyers sequentially purchase temporary credits over time as they expire, this is sometimes referred to as "horizontal stacking". There is still a risk of future non-compliance (e.g. due to bankruptcy or policy change). Temporary credits/buyer liability may also reduce buyer demand, as it implies greater obligations and complexity for buyers; the World Bank (2011) reports that temporary crediting under the UN Clean Development Mechanism was challenging for buyers, as there was significant uncertainty about the supply (and price) of replacement credits, making it difficult to sell temporary credits.

Buyer liability: Buyer liability creates incentives for the buyer of credits to ensure that the credits they purchase are of high quality. For example, in the California offset programme, buyer liability applies such that any ETS entity who purchases and surrenders credits to cover their emissions obligations is responsible for replacing any invalidated credits. Regulators can invalidate credits before or after they are surrendered if they determine that the credit is not of sufficiently high quality (e.g. due to over-issuance, double-counting, or a failure to conform with regulation) (ICAP 2023).

Eligibility restrictions: Excluding especially short-lived removal actions or actions or actors at high risk of reversal. This approach can be relatively low cost for administrators but will mean there are no incentives for non-eligible removals, reducing the supply of removals.

Seller liability and ongoing monitoring[175]: The seller of the removal unit is liable for any reversal of removals (i.e. in the case of reversals, they must either regenerate the removals on their own lands or purchase units to cover these through the AgETS+Removals). An example is provided by the NZ ETS, where the seller of units generated through growing forests becomes a compliance entity under the NZ ETS, is liable for any emissions from their land in the future and is obliged to monitor and report in perpetuity. Some mechanisms (e.g. Australian ERF) apply seller liability but limit this to the lifetime of the project, which can range from 25-100 years; the California Air Resource Board Compliance Offset program has "permanence" requirements of 100 years. This is reliant on ongoing monitoring and compliance obligations, which can be costly and a barrier to farmer participation. The SbTI requires companies to only record removals if they are under ongoing monitoring. Risks remain in the case of seller/company bankruptcies, and there is still a fundamental non-equivalence between permanent emissions reductions and non-permanent removals (even if the carbon is only released into the atmosphere in 101 years, this still means that GHGs will be 1 t higher in the atmosphere in 101 years). Contractual obligations and ongoing monitoring requirements are used to monitor and enforce these requirements.

[174] The CRCF does not state how long the monitoring period will be; this will be determined by the methodologies.
175 The CRCF proposes either temporary credits or ongoing monitoring, with carbon farming removals "assumed to be released into the atmosphere, unless the economic operator proves the maintenance of the carbon storage through uninterrupted monitoring activities" (preamble 13).

Discounting/buffer accounts: A number of approaches have been proposed which effectively discount removals relative to (permanent) emissions reductions. Effectively, this means that buyers must purchase multiple (temporary) removals to achieve an assumed equivalence with a (permanent) emissions reduction. A major challenge is the calculation of the non-permanence discount, i.e. how many non-permanent removals are equivalent to one permanent emissions reduction? Answering this question requires the use of uncertain future models of the climate system and an acceptance of some degree of impermanence. Discounting often takes the form of contributions to a buffer account, where a set percentage of removals are put aside into an account that is meant to buffer against any future reversals.[176] The Australian ERF (see Section A.3) offers an example of the difficulty (and arbitrariness) of the calculation of discounts: 100-year projects have a 5% permanence buffer discount, while 25-year projects have an additional 20% discount, implying that, given expectations about reversals, removals with a 25-year level of permanence is equivalent to 75% of a permanent unit of mitigation today, and that removals with 100-year level of permanence are worth 95% of a permanent unit of mitigation today. The calculation of these discount rates is not discussed. These approaches are sometimes referred to as "vertical stacking", i.e. how many non-permanent removals (stacked on top of one-another) are equivalent to a permanent unit of mitigation?[177] Finally, there are general concerns around the effectiveness of such buffer pools. In the case of the California cap-and-trade system, recent wildfires used up over 95% of the program's buffer contributions which were intended to cover fire risks for 100 years (Badgley et al. 2022).

Insurance: Insurance approaches have also been proposed, where buyers or sellers of removal credits purchase insurance against reversals.[178]

Non-permanence is not the only issue related to non-equivalence, however. Experience with previous policies integrating LULUCF removals into regulatory markets show that ensuring additionality of LULUCF removals is also problematic. Cames et al (2016) find that 73% of certificates produced under their sample of Clean Development Mechanism projects have a low likelihood of additionality due to informational asymmetries between project developers and regulators and uncertainties, posing risks of low environmental integrity if non-additional credits are accepted into a compliance ETS (as they were in early phases of the EU ETS). The risk of low-quality certification leading to low-quality external credits has also been identified in other such programmes, such as California's forest carbon offset program: Bagley et al (2021) find that 29% of forest offset credits are not matched by real, additional sequestration, resulting in a total of 30 million tonnes of over crediting. This underlines the importance of robust MRV of removals as discussed in Section 3.2, which is one of the central issues that the CRCF aims to resolve.

4.2. Other design decisions

Beyond emissions trading-specific design decisions, policy makers must also consider a number of other design options that will affect the AgETS+Removal policy's ability to meet its objectives. In this section, we focus on four key design options that are particularly relevant to the objectives of *Policy coherence*

[176] Buffer accounts differ as to whether they cover reversals during the project lifetime or after project lifetimes.
[177] Tonne-year accounting offers a related approach: it aims to quantify the climate benefit of storing carbon out of the atmosphere for one year, and issues fractional amounts of credits for each year that carbon is stored (i.e. an extreme discounting approach that equivalises one year of storage to a unit of permanent emissions reduction).
[178] See e.g. https://aon.mediaroom.com/2022-09-20-Aon-and-Revalue-Nature-to-Accelerate-Global-Decarbonization-Efforts

and *Political and legal feasibility* and the specifics of the LULUCF context: how to ensure removals support other sustainability objectives, how to align with LULUCF and national inventory reporting, managing the risk of double-counting, and design decisions to support the political and social acceptance of the policy.

Ensuring that carbon removals support other sustainability objectives

There is a risk that a narrow focus on climate mitigation achieves climate impact, whilst other ecosystem- or social services are neglected or even damaged. For example, some have criticised the NZ ETS for promoting exotic afforestation at the expense of indigenous forests, negatively impacting biodiversity, adaptation, and social value (see discussion in Carver et al. 2022). Instead, the protection and restoration of ecosystems is crucial to achieving climate mitigation targets while social objectives are necessary for farmers and communities' acceptance. Therefore, there is a clear need to integrate social and environmental safeguards and deliver positive sustainable development impacts at the same time as mitigating climate change (The Integrity Council 2023, Scheid et al. 2023). The sustainability objectives could include among others biodiversity, climate change adaptation, water quality and availability, pollution, animal welfare, transparency requirements, involvement of local stakeholders, etc. In the technical workshop of this study, stakeholders particularly highlighted the importance of prioritising carbon removal methods that offer **co-benefits for** biodiversity. At the same time, they also emphasised that further data collection and comprehensive monitoring are imperative to fully understand the potential impacts of carbon removal activities on biodiversity preservation.

In addition to paying differentiated prices (see Section 0), one option would be to define quality criteria covering environmental and social impacts, which need to be considered by carbon removal methodologies. An example is provided by the CRCF proposal, which states that carbon removal activities should comply with minimum sustainability requirements and encourages co-benefits (Article 7). As laid out in Scheid et al. (2023), these sustainability requirements could be implemented through general sustainability requirements (such as the SDG framework or the "Do no significant harm"-principle), transparency requirements, positive/negative lists, monitoring requirements (qualitative, quantitative) and optional additional payments. Another set of environmental and social quality criteria are defined by e.g. the Carbon Credit Quality Initiative (2022).

Ensuring coherence with LULUCF and national inventories

An AgETS+Removals policy should be designed in such a way that it ensures alignment with existing EU policy, in particular the LULUCF Regulation. The LULUCF Regulation is currently the primary piece of EU legislation governing removals in the land sector, establishing EU and Member State net removal targets, such as the requirement that Member States achieve "no debit" 2021-25 (LULUCF accounted emissions are offset by at least an equivalent amount of accounted removals), and an EU-wide net removal target of -310 Mt CO_2 in 2030. The EU target is disaggregated to national-level LULUCF targets for Member States. The LULUCF Regulation also establishes requirements for Member States to improve their reporting of removals, while following IPCC rules for national GHG inventory reporting. Such improvements generally relate to the quality of monitoring applied to the land sector, the quality and refinement of emissions factors applied to various carbon pools across different land use categories, and the quality control procedures applied to data handling and management.

Alongside the previously discussed Framework for Carbon Removal Certification, the LULUCF Regulation can have close interactions with the design of, and effectiveness of, methodologies for quantifying removals at the project-level. Ultimately, the performance of the EU and Member States against the LULUCF Regulation goals is measured according to the reported national GHG inventories compiled by each of the EU27, and aggregated into the EU's national GHG inventory. Thus, the MRV systems at project-level (e.g., activities undertaken at the level or an individual farm or forest) and national-level (i.e., national GHG inventories) need to be well-aligned in order for an emission reduction or enhanced removal action taking place at the project-level to contribute towards the national and supra-national policy goals.

However, in the EU, national GHG inventory reporting for the LULUCF sector, especially soil carbon sequestration, is subject to significant uncertainties. The European Union (2019) National Inventory Reporting estimates the reported uncertainty of LULUCF net emissions in the EU to be 32%, with particularly high uncertainty estimates for croplands (48%) and grasslands (374%) (as quoted in Böttcher et al 2019). Böttcher et al (2019) point to the low sophistication of data sources and methodologies applied by Member States in calculating their LULUCF net emissions, with most Member States using Tier 1 approaches (i.e. default emissions factors) for many reporting categories (carbon pools across different land categories), with Tier 2 approaches (i.e. country-specific emissions factors) only being commonly applied to the above- and below-ground biomass in the forested land category. Siemons et al (unpublished) point in particular to the gaps in quantifying and reporting emissions from the mineral soils on grasslands and forest soils. The majority of Member States currently assume no change in the carbon stored in each pool from year to year (with no calculation or monitoring). With the revised LULUCF Regulation, the Commission will require all Member States to increase the sophistication of their LULUCF reporting, at least implementing tier 2 (i.e. country-specific) approaches by 2026, and implementing tier 3 (i.e. models) approaches by 2028 in specific areas (high carbon stock areas, restored or protected areas, areas subject to adaptation challenges). There is potential that any AgETS+Removals policy would create incentives for improved monitoring tools, methodologies, and data availability.

However, at present these uncertainties pose the risk that project-level actions will not be effectively recorded in national GHG inventories due to the asymmetry between methods used to compile the two sets of accounts. As a result, localised actions to enhance carbon stocks in many types of carbon pools will not necessarily be reflected and visible at the national and supra-national level (Prag, Hood and Barata, 2013; Zakkour et al, unpublished); Schneider et al. (2022) referred to this phenomenon as "inventory visibility".

Yet, for a project-level certification mechanism to be of political utility for Member States (and their LULUCF net removal targets) and for the EU (and its climate targets, including net zero), any mitigation incentivised through an AgETS+Removals must (eventually) be reflected in national GHG inventory reports.[179] In these respects, Schneider et al. (2022) identify that the LULUCF sector poses a high risk of lacking "inventory visibility". Such an outcome undermines the ability of countries to use domestic project-based mechanisms to effectively achieve national mitigation goals; in this particular case: for Member States to use CRC-F supported actions to meet their LULUCF net removal targets and for the EU to achieve its climate neutrality target.

[179] Short-term "invisibility" of AgETS+Removals mitigation may be acceptable in the period while improved national reporting methodologies and data are developed and implemented in line with as required by the LULUCF Regulation.

Zakkour et al (unpublished), in considering this mis-match problem for the environmental integrity of the CRC-F, identified the following potential options to mitigate against such misalignment.

METHOD 1 – Align MRV methods:

The AgETS+Removals system could methodologically align with national GHG inventory compilation approaches (i.e. emissions factors and activity data). This approach would have some benefits, but also some significant challenges. Positively, it would be more straightforward to reflect removals that are achieved through the AgETS+Removals in national GHG inventories, and to control double-counting (discussed in Section 0). However, as discussed above, the approach to national GHG inventory compilation (in particular the availability of real-time areal land use data for activity data) and the reliability/quality of national inventory emissions factors is, in many cases, low. As such, national level systems may not meet the standard necessary to ensure robust quantification and climate equivalence with agricultural GHG mitigation measures – both emissions reductions or removals – measured at the field, farm or even regional level. In other words, in most Member States, emissions factors applied in national GHG inventory compilation are typically quite generalised (Tier 1 or 2), variable across different carbon pools (e.g. differing Tiers for different carbon pools), and are therefore only useful for the transparent and consistent estimation of national-level emissions and removals. Few, if any are considered to be sufficiently granular to support use for the accurate quantification of farm- or project-level emissions and removals. Rather, these call for specific emissions factors and models that reflect local context.[180] Further, while national GHG inventory compilation tends to value transparency, completeness and consistency over accuracy, project-level quantification (e.g. within existing voluntary carbon markets as might be anticipated as models for AgETS+Removal methodologies) seek to apply accuracy and conservativeness as key criteria (i.e. to avoid over crediting and to ensure high levels of environmental integrity relating to the use of any resultant credits or certificates). Accordingly, simply seeking to align methods between the two approaches may not be appropriate nor desirable.

Regardless of whether alignment of methods is pursued, it should be noted that as project-level methods and data improve, they can also be used to support more accurate national GHG inventory systems (e.g. by providing more and more granular data). This will need to be accompanied by the evolution of removals certification methods in step with progress in developing and harmonising of Member State national GHG inventory compilation methods. Likely to be decisive here will be the quantification methodologies developed to implement the CRCF. While the specific use case for removals certified under the CRCF are yet to be specified, it is likely that these will establish EU-wide standards for removals for different uses, potentially including regulatory uses such as a AgETS+Removals.[181] These quantification methodologies are still under development but the CRCF text suggest that quantification methods that are more sophisticated than those currently used to estimate LULUCF emissions and removals for national inventories will be applied ("Carbon removals generated by carbon farming should be quantified with a high level of accuracy to assure the highest quality and minimise uncertainties" (COM 2022/672, preamble 10).

[180] See the AgStudy Section 2.3.2 on the proposed Certified method for further considerations on specific emission factors and models.

[181] The CRCF proposal states that removal certificates should "underpin different end-uses, such as the compilation of national and corporate greenhouse gas inventories, including with regard to Regulation (EU) 2018/841 of the European Parliament and of the Council, the proof of climate-related and other environmental corporate claims (including on biodiversity), or the exchange of verified carbon removal units through voluntary carbon offsetting markets" (COM 2022/672, preamble 21).

METHOD 2 – Align outcomes:

If methods cannot be readily aligned between AgETS+Removals and national inventory reporting, and alternative would be to apply ex post “internal adjustments” to reported national GHG inventories in order to take account of and reflect GHG mitigation measures realised through the AgETS+Removals at the project-level. Further research and dialogue are needed to consider how this could be implemented in the LULUCF sector.

METHOD 3 – Manage claims:

If neither methods nor outcomes can be aligned, then issued certificates will not align with national measurements of GHG reductions/removals, leading to ongoing concerns over environmental integrity. Asymmetry in MRV and claims between, on the one hand, certificate users and, on the other, national authorities, will significantly challenge political credibility insomuch as the acquiring entity may be able to make claims that are not reflective of the measured GHG mitigation benefits accruing to the host government; as noted by Zakkour et al (unpublished), any quantification method should ensure strong, symmetrical alignment between certified project activity level removals and recorded removals at the national GHG inventory level for it to make meaningful contributions to the climate neutrality goal. If the asymmetries cannot be corrected, then there will have to be at least acceptance of the situation with the understanding that certified activities at the project-level may or may not deliver some measurable, “visible”, reductions and removals at the level of national GHG inventories (MS and EU). Such considerations would tend towards favouring the indirect or no link removal policy models discussed in Chapter 5.

Policies and methodologies certifying reduction and removals in the land sector will need to retain a strong level of coherence and alignment with other EU policies. Along with the overarching EU climate legislation (including legislation related to ETS, ETS2, and LULUCF), alignment with CAP will be important to manage.[182] Other policies that will require alignment include the Corporate Sustainability Reporting Directive (EU 2022/2464), which establishes rules for corporate reporting on environmental issues; to decrease administrative and participation costs, data gathered under removals policy options should also support reporting under this directive. Similarly, data should be consistent with that required under the EU Taxonomy (EU 2020/852) and delegated acts accompanying it. Other EU policy areas mentioned in the stakeholder survey include the Biodiversity Strategy, Farm-to-Fork strategy and Soil Carbon Law.

Avoiding double-counting between ETS and other policy targets

Design decisions can help to reduce the risk that AgETS+Removals policies do not lead to double-counting when removals are traded. Double counting occurs when the same removals are counted more than once towards mitigation targets (Schneider et al 2017). Double-counting can occur as double issuance of credits (when credits are issued more than once for the same GHG removals), double use (when the same credit is used twice to compensate for GHG reductions), or double claiming (when two different entities use the same carbon credits to compensate for their emissions). Any of these types of double-counting can undermine the environmental integrity of credits generated from carbon removals given the potential for counting the same removed carbon against more than one emissions reduction target. The linking of the AgETS and LULUCF removals into an AgETS+Removals poses a double-counting

[182] See Box 5 in Section 0 for discussion of how a No link: Disconnect market model for AgETS+Removals could link with CAP.

risk if the AgETS policy option covers LULUCF emissions from land, which may create an overlap with LULUCF fluxes considered in the removal policy design.[183] A second risk is that the same removals credits are sold to multiple buyers (either within the AgETS+Removals or both to an AgETS+Removal buyer and another, e.g. on a voluntary carbon market). Failing to address double-counting undermines environmental integrity: counting the same GHG removal twice means that there will be more GHGs in the atmosphere.

Policy design can reduce the risk of double-counting. Avoiding this risk requires that the key aspects of removals and AgETS+Removals policies are closely aligned. Ensuring alignment between compliance entities within policy scope, system boundaries, and MRV approaches would reduce the risk of double-counting. The CRCF proposal calls for "interoperable public registries in order to ensure transparency and full traceability of carbon removal certificates, and to avoid the risk of fraud and double counting" (COM 2022/672, preamble 26). A stringent registry system will also be essential to manage double-counting risks. A central EU register would help ensure security and transparency around the ownership and final use of certified removals, as well as supporting consistency between national inventories and across key EU legislation, including the Effort Sharing and the LULULCF Regulations. The risk of double-counting can be further managed by introducing restrictive eligibility criteria, inventory-based accounting and third-party verification.

Design decisions to manage distributional impacts and increase stakeholder inclusiveness

The specific design of the removals policy will affect the distributional impacts of the policy, that is which types of actors benefit or bear costs from the policy, which will be important for the social inclusiveness of the AgETS+Removals policy. Recent studies on the public acceptance of payments for removals among agricultural stakeholders and the general public provides some guidance in how the payments should be structured and how the policy can be adapted to maximise benefits to stakeholders.

Part 1 of this study assesses the potential political feasibility of an AgETS for agriculture. The literature review finds that the on-farm options, as well as the upstream and downstream options, could pose significant costs to some farmers (e.g. livestock farmers) (Slade 2017; Weishaupt et al 2020; Grosjean et al 2016). The integration of payments for removals (i.e. an AgETS+Removals) could reduce costs and provide potential revenue sources for farmers. Evidence given in Part 1 of this study does suggest that the earmarking of revenues from carbon pricing towards support for farmers in the deployment of climate friendly equipment and adoption of practices could increase stakeholder inclusiveness (see: Soderholm & Christiernsson 2008; Slade 2017). A potential model for how this could be the Social Climate Fund, which, as outlined in Section A.4, is a funding instrument funded by ETS2 revenue to support some of those who will face costs, including vulnerable households, micro-enterprises and transport users. In addition to targeting vulnerable farmers, such a fund should also protect low-income households to reduce the impact on their net incomes of any additional food costs associated with an AgETS. Such measures will be essential to increase perceptions of fairness and equity of any policies. In addition to design decisions and earmarking of revenues, the stringency of the AgETS cap and the free allocation of AgETS allowances will also be crucial in determining costs for farmers, and helping to increase acceptability, as discussed in the AgETS study.

[183] For example, if the AgETS includes LULUCF emissions, e.g. from drained organic soils.

The literature also provides more specific guidance on how removals payments can be designed to increase uptake and acceptability. The focus within literature is often on the link between the amount of payments for removals, and farmers' willingness to adapt practices. Ma et al (2012) find that this willingness primarily depends on whether a practice 'fits' with the current farming system, while the second major hurdle depends on the payment offer and marginal benefit-cost criteria. Gramig & Widmar (2018) also find that farmers' willingness to accept payments can depend on the level of financial compensation, and that farmers have a preference for government carbon payments rather than a carbon market payment (although care must be taken with interpreting this result, as the payment size considered is considerably lower than those seen e.g. in California or EU ETS carbon markets, or what might be expected under an AgETS+Removals). According to Dumbrell et al (2016), factors that are important in farmers' decisions to change agricultural management practices include the investment costs of the new practice, the impacts of the new practice on farm profitability, the farmer's financial situation, as well as the public co-benefits generated by adopting the practice (Pannell et al. 2006, Kragt et al. 2016, Morgan et al. 2015, Page and Belotti 2015).

Many interviewees emphasised the importance of managing costs for farmers in early stages of the policy to increase buy-in. Following the EU ETS, this could be achieved by freely allocating farmers allowances. One interviewee noted that while free allocation is a useful carrot to achieve buy-in, it can be difficult to wind-down once it is established. It can also lead to windfall profits for some participants. Alternatively, farmers can be made liable for only a proportion of their true emissions, for example, in New Zealand's He Waka Eke Noa approach (see Section A.8), farmers would only be liable for 5% of the cost of their emissions at the outset of the policy.[184]

Interviews and survey results indicated that stakeholders see the scope of the policy (i.e. which sectors are included) as a crucial issue. One interviewee argued that it was important to keep money within the agricultural sector, and that accordingly the AgETS+Removals policy should exclude forestry removals (as this would see agricultural polluter pays revenue going to the forestry sector). Another interviewee countered this position, noting that in some countries (e.g. Ireland), forestry land had predominantly occurred on farm land, so including forestry would still see funding going to farmers. Another interviewee emphasised the importance of only financing removal actions that also enhance biodiversity. The inclusion of forestry in the New Zealand Emissions trading system has been criticised for incentivising exotic forestry at the expense of native forests (which have higher biodiversity and social value, especially for indigenous communities) and for outcompeting agricultural land, leading to reduced food production, employment and export earnings (MPI & MfE 2022). This divergence of opinion on the scope of accepted removals was also observed in the stakeholder survey. Respondents from the agriculture sector were split between allowing all LULUCF removal activities, allowing farm only removal activities or not linking carbon removals to AgETS allowances at all under an AgETS+Removals policy. Other actors in the agriculture value chain (e.g., food processors and manufacturers of agricultural inputs) largely favoured allowing all LULUCF activities.

Evidence also suggests a willingness among the general public to pay farmers for sequestration practices (Kragt et al 2016). Rodríguez-Entrena et al (2014) find that individuals have a positive willingness to pay for carbon farming in Andalusian olive groves. Glenk and Colombo (2011) estimate

[184] This significantly decreases the incentives to mitigate compared to even the case with 95% free allocation of allowances, where farmers would face full incentives (as if they reduce emissions by a unit, they can sell one of their freely allocated allowances).

public willingness to pay values for implementing a soil carbon sequestration program in Scotland, ranging between GBP 4 and GBP 41. In a study on co-benefits from carbon credits in the aviation industry, MacKerron et al (2009) also found positive WTP values for a "sequestration" benefit. Berger et al (2022), however, find that the level of willingness to pay voluntarily for carbon dioxide credits falls dramatically short of current carbon market prices, for example those in the EU ETS.

Other studies stress that willingness to accept payments and willingness to pay depend less on the level of payments, and more so on the values of individuals. While compensation amounts can influence farmers' willingness, the compensation amount is less influential in the decision to adopt practices, compared with positive/negative attitudes towards the practice (Meijer et al 2014; Opdenbosch & Hansson 2022). For the general public, the level of willingness to pay depends on an individual's opinions about climate change: respondents with high levels of concern about climate change demonstrate higher willingness to pay compared to those who are less concerned (Kragt et al 2016). While there is limited research as to the social acceptability of carbon removals as a mitigation approach, a study conducted by Bellamy (2022) finds the public has a preference for nature-based carbon removal methods (habitat restoration, afforestation) compared to technological methods (BECCS and DACCS). These preferences for nature-based removals held against eight technical and social criteria: including effectiveness at tackling climate change; cost effectiveness; social acceptability; and political feasibility (although scores for political feasibility were relatively similar).

5. Removals policy models

The literature proposes a number of different models that could be implemented to link AgETSs with removals, that is, to use AgETS revenue or allowance demand to incentivise carbon removals in the LULUCF sector. We refer to these as removals policy models. In this section, we introduce the literature and based upon that categorise the removals policy models into five different types. We then describe each removals policy model in detail and based on expert judgment and drawing on our literature review, evaluate their strengths and weaknesses, drawing on the objectives and criteria identified in Section 1.2. As described in Section 5.3, the evaluation of the policy models is theoretical and relies on a relative comparison, comparing the models with one another in abstract, without considering which AgETS policy model is implemented (Chapter 2), the scope of removals (Chapter 3), or the design elements (Chapter 4). As such, it provides an initial overview of the different policy models that can help guide more concrete policy design.

5.1. Removals policy models: introduction

Summary of recent literature

Our identification and categorisation of removals policy options draws inspiration from recent literature, including Rickels et al (2021), Jeffery et al (2020), World Bank (2021), MfE & MPI (2022), NZ ICCC (2019), among other literature specifically cited in following sections. We draw particularly on the following sources:

La Hoz Theuer et al (2021) Emissions Trading Systems and Net Zero: Trading Removals: Proposes four options for how a market for emission allowances (i.e. a classical ETS) could be connected to a market for removals:

- Disconnected markets,
- Connected through government,
- Connected with restrictions,
- Integrated markets.

The report also identifies main opportunities/restrictions of the different market designs. The conceptual models are general and do not focus on the specific context of the EU or the agriculture or land sectors specifically.

Zakkour et al (unpublished) CRC-M Task 4 Report: Focuses on the certification of carbon removals within the EU. It considers the EU political context, and identifies and evaluates different design possibilities for certifying removals in the EU:

- ETS integration,
- Partial ETS integration (some types of removal options),
- Partial ETS integration (selected types of removal credits),
- Voluntary market,
- Voluntary or compliance market (storage crediting),
- Certification for other purposes.

The report does not focus specifically on the land sector.

Hickey et al (2023) A review of commercialisation mechanisms for carbon dioxide removal: Reviews existing policies for scaling up carbon removals. Identifies three incentive categories (and five mechanism types):

- Market based (Carbon pricing and markets, Tradable obligation schemes)
- Public procurement (Results-based payments)
- Fiscal incentives (Subsidy, tax credit).

They also identify existing and proposed examples of each mechanism type and their potential scale and expected prices.

Overview of options for market-based policies to incentivise removals

Based on the literature review, we identify five removal policy models for market-based incentive mechanisms to stimulate removals. Each removal policy model uses revenue or allowance demand from AgETS to incentivise removals providers to remove carbon from the atmosphere in the LULUCF sector. The provider of removals would be any eligible AFOLU sector actor, e.g. a farmer, land-owner, corporate entity or other project developer implementing removals on AFOLU land.

The selection of these options is in part driven by the AgETS policy options: all removal policy options must be able to connect to at least one of the AgETSs considered in the AgETS study and described in Chapter 2.[185] All of the policy options considered in the AgETS study to implement the polluter pays principle are agricultural Emissions Trading Systems (AgETSs). Alternatives, such as e.g. carbon taxes, CAP payment deductions, carbon take-back obligations, or others are out of scope for the AgETS study. This choice also limits the policy options that we consider in this report. As all AgETSs are compliance markets, for instance, we do not explicitly consider voluntary carbon markets as an option for a removals policy.

[185] Not all removals design options will be implementable alongside each AgETS policy option; we indicate potential limitations.

A key difference in how the five removals policy models operate lies in whether or how they would be connected to the AgETS; we identify three overarching approaches:

- **No link:** Removals are kept separate from the AgETS, with the government[186] using revenue generated by AgETS to fund removers[187] (i.e. no impact on AgETS cap).
- **Indirect link:** The government sits between AgETS polluters and the LULUCF removers, mediating the AgETS demand for removals credits and the LULUCF supply, funding LULUCF removals using AgETS revenues or demand and in return releasing allowances into the AgETS corresponding to the LULUCF removals (i.e. affecting the AgETS cap).
- **Direct link:** The AgETS polluter purchases removals credits directly from the remover,[188] with the removals credits affecting the AgETS cap. We identify three direct link models, including a "deductions" model (where AgETS polluters reduce their AgETS compliance obligation by carrying out LULUCF removals on their own land or within their own value chain), an external credits model, and an integrated emissions trading scheme model.

In Table 32 we present a summary of the five policy models. In subsequent subsections, we describe each removals policy model in more detail and evaluate each model's theoretical strengths and weaknesses. Here, we follow the assessment criteria identified in Section 1.2 and use a traffic-light system to visualise overarching results (green: strength; yellow: neutral or variable; red: weakness).[189] This evaluation is theoretical, based on the specifics of the removals policy model in isolation (i.e., without defining the other key elements of policy option design, such as the specific AgETS model being linked to, the scope of removals, or the specific rules and design decisions. A concluding section summarises key differences between the policy models.

Table 32 Removals policy models - overview

Link to AgETS	Removals policy model	Description
No link: Disconnected market	Disconnected markets	• Government procures removals from removers using AgETS revenue generated through auctioning AgETS allowances. • Removals do not affect AgETS: while the government uses revenue generated by ETS, removals provision does not affect ETS supply (e.g. through caps or allowance availability). • Procurement through either result-based payments or through other public funding approaches (e.g. grants or subsidies facilitated through CAP). Given that there is no link to AgETS, less stringent MRV may be acceptable.
Indirect link: Polluter - government – remover	Interconnected: through government	• Government procures removals from remover, funded using revenue from AgETS (e.g. by auctioning of allowances or removals credits into AgETS). • Government sells removal credits to polluters (to meet their compliance obligations); that is, there is a link between removals purchases and the AgETS such that removals increase AgETS allowance supply (e.g. by loosening cap or through increased allocation or auction availability). • Removals are procured, generally, through results-based payments, though other procurement approaches also possible. • The government can act as an intermediary to manage the risks to the AgETS and package removal credits in such a way as to reduce risk or price uncertainty, or make them more equivalent to AgETS emissions reductions e.g. removals credits

[186] The government buyer could be an EU or Member State/regional public institution.
[187] The provider of removals could be any eligible AFOLU sector actor, e.g. a farmer, land-owner, corporate entity or other project developer implementing removals on AFOLU land. At this stage, we do not specify who would be obligatorily integrated into the ETS, in particular, whether it would be the landowner or the land-user. The landowner would offer better protections in terms of permanence, while the land-user (when this differed from the landowner, e.g. contract farmers) could offer higher levels of implementation.
[188] Note: either the AgETS polluter or LULUCF remover could be represented by private intermediaries.
[189] Some criteria do not depend on the removals policy model but rather on other design elements (e.g. cap stringency); these are left white.

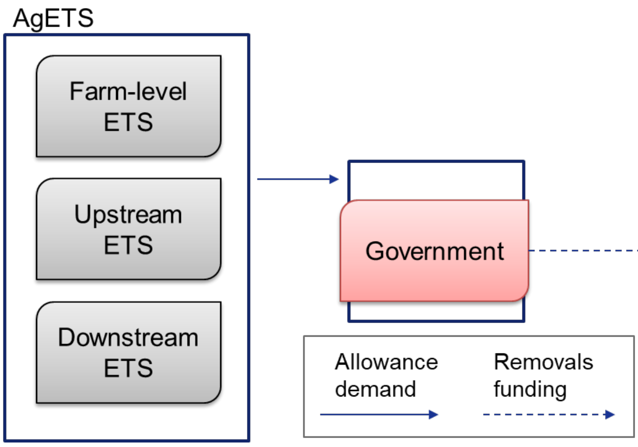
		could be used to form a reserve of removal credits to stabilise the AgETS market, temporary credits could be "stacked" or otherwise managed to lower non-permanence risks (see 0).
Direct link: polluter - remover	Interconnected: Deductions	• AgETS polluters can implement LULUCF removals on their own land (or through insetting withing their own supply chain) to reduce their AgETS emissions liabilities. [190] • Remover is a compliance entity within the AgETS. • The removals are linked to the AgETS: the price incentive for implementing removals will depend on the AgETS price (i.e., if removals are cheaper than reducing emissions, they will be implemented); removals will effectively increase the AgETS cap. • LULUCF removals are not otherwise covered by an AgETS; LULUCF removals only rewarded in the form of deductions.
	Interconnected: External credits	• Removers can sell credits directly to AgETS polluters. • Removers voluntarily choose to participate, i.e. they are not necessarily compliance entities of the AgETS. They implement eligible removals activities in return for being awarded credits. • Polluter procures credits from (eligible) removers. Credits are generally fully fungible with AgETS allowances – can be traded, banked or surrendered by emitters to meet their compliance obligations; any credits effectively increase the AgETS cap. • Restrictions on use of credits possible (e.g. limit on the % of compliance obligations that can be met by external credits, type of credits or vintage).
	Integrated ETS	• Removers are integrated into the AgETS, i.e. become obligatory compliance entities in the AgETS (i.e. LULUCF (sub)sectors[191] fully integrated into an AgETS+Removals). • AgETS+Removals participants are rewarded with allowances in return for certified carbon removals; removals increase the AgETS cap. • Allowances are fully fungible and can be traded and surrendered to meet compliance obligations, with no limits. • Removals limited only by eligibility, i.e. what removals solutions are permitted and under what conditions. • No restrictions on removal purchases[192].

5.2. Removal policy models: description and theoretical evaluation

'No link: Disconnected market'

[190] Here, mitigation is through removals (which are outside the scope of an AgETS, which consider only emissions). This differs from farmers or processors mitigating by reducing their emissions, which we would expect due to the price incentive for emissions covered by the scope of the AgETS.
[191] Regulators could choose to integrate only some LULUCF sectors, e.g., if regulators were focussed on the climate impact of the agricultural food value chain, they could integrate just soil carbon and agroforestry removals into the AgETS+Removals, with other LULUCF removals regulated elsewhere. See Chapter 3 for discussion of removals scope.
[192] Note: It is theoretically feasible to imagine an integrated ETS with some restrictions on removal purchases (e.g. % of compliance obligation that could be met with removals credits, types of removals solutions permitted, restrictions on the type of buyer permitted). However, this would pose numerous design challenges (including e.g. differentiated credit prices, complexity and administrative costs). It is not clear that this would be an effective way to address potential issues. Accordingly, we do not include a separate policy option for 'Interconnected: with restrictions'

Disconnected markets



Link: No link to AgETS

Removals buyer: Government[193]

Removals provider: LULUCF actors who meet removals eligibility requirements. They are voluntary participants outside the scope of the AgETS (though AgETS compliance entities could also be removers providers, e.g. farmers could carry out removals).

AgETS policy option link[194]: All five AgETS policy options possible

Removal payment: Result-based payment (i.e. cash payment related to removals achieved, e.g. through CRCF) or other public funding approaches (e.g. grants or subsidies, such as CAP)

Existing examples: Australian Emissions Reduction Fund (see Section A.3), ETS2 and social climate fund (see Section A.4), Common Agriculture Policy, EU Innovation Fund

Overview: The Disconnected market model is characterised by no link between the AgETS and the provision of removals. The government is the sole purchaser of removals and uses AgETS revenue to fund removals purchases. However, the AgETS would be separate, with the AgETS cap and allowance supply unaffected by the supply of removals. The amount of funding available for removals would depend on the stringency of the cap and the degree that allowances are auctioned or sold at a set price (rather than freely allocated). Care must be taken to ensure effective and long term hypothecation of AgETS revenue, e.g., following the model set by the EU ETS hypothecation to the Innovation Fund and Modernisation Fund.[195] However, the number of removals purchased would not affect AgETS allowance supply.

[193]"Government" refers to any public agency or institution acting on the government's behalf. We envision this occurring at the EU scale but could feasibly occur at Member State or other scales.
[194] The AgETS study considers three overarching AgETS policy models: a "farm-level ETS", where individual farmers monitor their own agricultural emissions and must purchase sufficient allowances to cover them; a "upstream ETS", where producers upstream in the agricultural value chain of farms (e.g. fertiliser importers/producers, feed importers) must monitor the agricultural emissions associated with their products and purchase sufficient allowances to cover them; and a "downstream ETS", where producers downstream in the agricultural value chain of farms (e.g. meat and dairy processors) must monitor the agricultural emissions associated with the products they process and purchase sufficient allowances to cover them.
[195] Velten et al (2016) reviewed the use of ETS auction revenue and recommend that strict earmarking of revenue is required to ensure that the revenue is used to fund climate action. They also recommend high quality monitoring and reporting to enable external quality review.

The government would establish, through eligibility rules, the type of removals providers and approved removals actions. As the supply of removals would not be translated into AgETS allowances, there would be greater flexibility about the type of removals actions that could be funded: removals would not necessarily need to be quantified, meaning that action-based payments would be possible as well as results-based payments. The quality of removals would depend on removals funding rules, e.g., if removals were funded through the CRCF, they would need to meet the QU.A.L.ITY criteria established by the CRCF methodologies. However, given that these removals would not be directly used for compliance in the AgETS, the risk to environmental integrity posed by low-quality removals would be lower than the models discussed below.[196] For example, there would be no risk posed of non-permanent removals units being used by compliance entities under the AgETS. The government would have full flexibility in their funding of removals.

The government has full control over the type (quality) and amount (quantity) of removals funded. Accordingly, they could treat different removals options differently, including setting different prices for different types of removals (e.g. higher payments for those that also deliver biodiversity benefits, see Section 0). Projects could be funded based upon reverse auctions, where projects bid a price and amount of removals, and the government accepts those bids up to a set per tonne CO_2-e price, total budget, or quantity of mitigation (see e.g. Australian Emissions Reduction Fund). Separation of removals from the AgETS gives the government full control over how much mitigation is achieved through removals, and how much through emissions reductions.

Box 18 Practical considerations: Implementing the disconnected market policy option through the Common Agricultural Policy

One option for implementing the "disconnected markets" policy option would be to channel the money raised through the AgETS into the EU Common Agricultural Policy (CAP) infrastructure to co-finance LULUCF removals. This could be done using the eco-schemes (Pillar 1), which are defined by the individual Member States in their CAP Strategic Plans and are voluntary for farmers. Currently, at least 25% of the budget of the direct payments is allocated to eco-schemes, providing a financial incentive for climate- and environment-friendly farming practices; this could be augmented (or replaced) by revenue raised through the AgETS. Member States could integrate approved carbon farming methodologies under the voluntary EU-wide framework to certify carbon removals into their eco-schemes. The French CAP Strategic Plan agri-environment climate measure "Transition of practices" (see Section A.7) could be an early example of how this could work. It offers a "certification pathway" based on a point system where farmers can choose between three payment levels (standard, superior, specific) in return for implementing increasingly ambitious transition practices, with bonuses available if three additional criteria apply (Plan Stratégique National de la PAC 2023-2027). If this model was to be implemented, care would have to taken to ensure that the revenue from the AgETS is spent effectively through the CAP; the European Court of Auditors (2021) in their special report on the CAP criticized the little impact of CAP funds attributed to climate action during the 2014-2020 funding period.

Table 33 Theoretical strengths/weaknesses assessment (relative to other policy models): 'No link: Disconnected market'

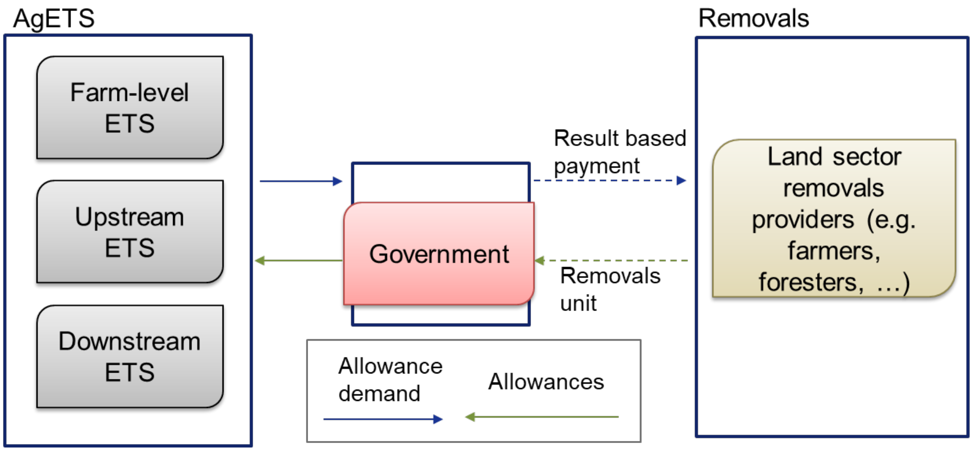
	'No link: Disconnected market'
Effectiveness	**Increased land-based removals**: Removals incentives would depend on government ambition (and revenue raised through AgETS). Government would have full control over level of removals, limited only by revenue raised in the AgETS. Speed of implementation would be fast due to the simpler mechanism (i.e. no integration into AgETS and centralisation of removal funding).

[196] If low-quality removals (e.g. non-additional, non-permanent, or overestimated removals) are used in place of emissions reductions, the total amount of mitigation achieved decreases. If removals are not permitted to be traded for emissions reductions, then the achieved level of emissions reductions will not be affected by low quality removals. Low quality removals would still be a problem, as they would represent ineffective removals. However, they would not affect the amount of emissions reductions achieved.

	High quality removals: Permanence would depend on how removals are funded by government (i.e. government can selectively fund more long-lasting removals). Biodiversity impacts would depend on removals funding rules (i.e. government can selectively fund removals that deliver greater biodiversity benefits). No risk of non-additional removals credits affecting AgETS, as removals separate from AgETS. Whether removals themselves are additional depends on removals funding rules. Note: if removals are certified through CRCF, quality would accord with CRCF QU.A.L.ITY criteria as implemented through the methodologies under development.
Efficiency	**Static efficiency:** The model would incentivise all removals by eligible removers that can be generated equal to or below the price offered by the government. The scope of removals covered would depend on design decisions.
	Dynamic efficiency: Regulators would have full control over the supply of removals, enabling them to incentivise activities beyond those with currently low marginal costs.
	Economy-wide efficiency: The 'No link: Disconnected market' model would not automatically equivalise mitigation costs across LULUCF polluters and removals, as the government would negotiate separately (and at different times) with removers and with polluters, and there would be no common currency (i.e. removals would not be translated into emissions allowances), though the government could consider marginal abatement costs of different sectors and target accordingly; the extent to which these mitigation costs equal those in other sectors of the economy would depend on design decisions (e.g. the cap).
	Administrative costs: The market would be relatively simple, due to the government's centralisation of removals purchases and the separation of removals from the AgETS; however, the government would be required to administer a removals funding scheme; this could feasibly build on existing experience with e.g. Innovation Fund, CAP.
	Participant transaction costs: Participant transaction costs could be kept relatively low, as participants would only participate voluntarily; the government could design simple payment methods with fixed payments (or more complex and with higher participant transaction costs, e.g. auctions). Given lower risk to AgETS due to no link, MRV could be less stringent, lowering costs, especially if action-based payments were used.
Coherence	**AgETS match:** Implementable alongside all AgETS policy options. Due to the full separation, AgETS and removals policies would not need to be closely matched (except to avoid overlap).
Political/legal feasibility	**Absence of legal/political barriers:** No significant legal barrier as EU has competency for climate policy. Feasibility depends on specific design of removals policy option. As removals funding poses incentives (rather than costs for polluters arising in AgETS), would expect low political resistance from affected sectors. However, deciding how the government spends this central fund would be highly contested, especially if removals are provided by non-agriculture sectors (e.g. forestry).

Indirect link

Interconnected: through government



Link: Indirect – via the government

Removals buyer: Government

Removals provider: LULUCF actors who meet removals eligibility requirements. They are voluntary participants outside the scope of the AgETS (though AgETS compliance entities could also be removers providers, e.g. farmers could carry out removals).

AgETS policy option link: All five AgETS policy options possible

Removal payment: Result-based payment (i.e. cash payment related to removals achieved, e.g. through CRCF)

Existing examples: Australian Emissions Reduction Fund (initial proposal linked to Australian ETS) (see Section A.3)

Overview: In this model the government acts as an intermediary between the polluters under the AgETS and removals providers. The government is the sole purchaser of removal credits. It then converts the removal credits into emission allowances, which it makes available to AgETS polluters (either in the way of free allocation or by auctioning them). Funding for removals would come from the revenue gained by selling allowances into the AgETS (i.e. through AgETS allowance demand). Quality and quantity concerns could be directly managed by the government buyer, who would establish through eligibility rules the type of removal providers, approved removal actions and the volume of purchases. The CRCF could be used to establish the quality of removals. The most straightforward form of participation would be voluntary, though feasibly administrators could make participation obligatory for some LULUCF actors. Payments would be result-based, i.e. eligible participants would implement approved removal actions, which would then be subject to certification (i.e. monitoring and verification of the removals achieved by removal activities, e.g. in line with the CRCF); the government would pay the remover in accordance with their achieved removals (e.g. per t CO_2-e). As sole purchaser, the government can centralise search and bargaining for removal purchases. By achieving economies of scale, overall transaction costs could be lower than for the direct link models discussed below.

The government would have full control over the type and amount of removals funded, and how / how many of these were converted into AgETS allowances: they could treat different removals options differently (i.e. paying more for certain types of removals) and would not need to assume equivalency between removals and emissions reductions (i.e. could convert removals into allowances at rates other than 1:1). Accordingly, governments would have control over how mitigation is carried out (e.g.

emissions reductions vs removals and which types of removals). Given the large role of a government as an intermediary, respondents in the stakeholder survey considered this policy model the least administratively feasible. Nonetheless, this concept of a government as an intermediary has been explored in the context of the EU ETS in the form of an EU Carbon Bank (see **Box 19**).

Under this model, there would be a link between the supply of LULUCF removals and the AgETS: the removals could be made available to the AgETS in a number of ways, most straightforwardly by auctioning allowances backed by removals into AgETS, though other alternatives would be possible (e.g. by linking free allocations to removals supply). The interconnection would make the AgETS responsive to the supply of removals, e.g. the level of agricultural emissions reductions and AgETS market prices would depend on removals supply, and conversely, the revenue available for funding removals would depend on AgETS demand (and cap).

Box 19 Practical considerations: An "EU Carbon Bank"

Rickels et al (2022) proposed a Carbon Central Bank as one element to make the EU ETS fit for net zero. The proposed solution serves two functions: it preserves ETS price stability as allowance supply approaches zero towards 2040, and ensures the functioning of the ETS even as the emissions covered by the cap become net negative. Second, the authors view it as a superior solution to manage and stabilise EU ETS prices than the Market Stability Reserve (MSR) in its current form. The Carbon Central Bank would procure carbon removal credits up front, and build up a stock of such credits in a dedicated reserve. From this reserve, it would then release credits into the EU ETS when the carbon prices exceeds a certain trigger – thereby expanding the supply of emission allowances on the market (and easing the carbon price), but without increasing the (net) emissions allowable under the ETS cap. The authors argue that such a model would incentivise removals and encourage learning-by-doing related to permanent removals (e.g. BECCS and DACCS), without reducing incentives for emissions reductions in the EU ETS, and would also future-proof the EU ETS for net-negative emissions trading.

While the Rickels proposal represents a more gradual change of the current ETS architecture in the EU (and in particular the MSR), a related proposal by Edenhofer et al. (2023) goes one step further to advocate for a European Carbon Central Bank (ECCB) with a mandate to develop the market for removals and facilitate its alignment and eventual integration with the European Emissions Trading System(s). Like the Rickels paper, the ECCB would be tasked to procure carbon removals through a (reverse) auction process. In doing so, it would apply discount factors to account for non-permanence and incomplete additionality of certain CDR types. Rather than a uniform auction (in which all CDR options would compete based on least cost), separate auctions could be envisaged for different bundles / types of CDR, depending on the degree of permanence achieved, but also the maturity of different removal technologies. This would allow to support the development of those CDR options that are currently more expensive but expected to become cheaper, or to account for (non-climate) externalities of different CDR options, be they positive or negative. In this way, the ECCB could help address some of the moral hazard and time consistency problems for non-permanent removal options and ensure that the carbon liability incurred by the providers of non-permanent removals is properly managed and accounted for. By aggregating removals of different origins and vintages, it would also help to pool the risks of different options.

Both options have the advantage that they provide more options to allow the market for removals to develop, and the removal options to mature (both technological options and business models). Through upfront purchases and by allowing the build-up of a stockpile / reserve of removals, it also creates greater certainty for the providers of removal credits, particularly if the purchasing proceeds according to a specified schedule and pre-announced volumes.[197] By establishing an intermediary, they also provide more options to pool risks and ensure the liabilities related to non-permanent storage are accounted for.

Table 34 Theoretical strengths/weaknesses assessment (relative to other policy models): Interconnected: through government

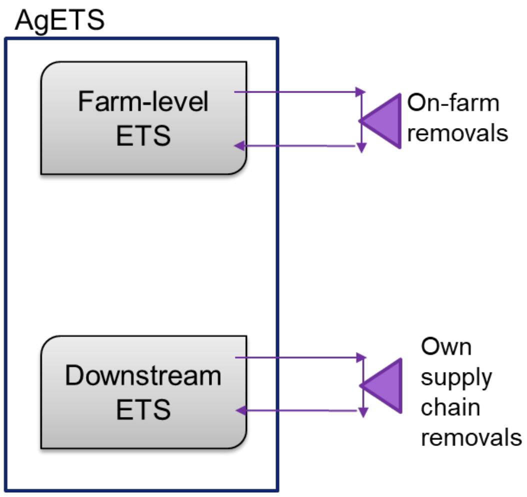
	Interconnected: through government

[197] Critics maintain, however, that the CCB proposal would merely replace the market uncertainty with the uncertainty about how the CCB would act, and that the resulting root cause – regulatory uncertainty – could not be eliminated through a new, politically established institution. As for the market uncertainty, a liquid forward market would be sufficient to provide the necessary foresight (Ferdinand 2023).

Effectiveness	**Increased land-based removals:** Removals incentives would depend on government ambition (and revenue raised through AgETS). Regulators would have full control over level of removals, limited only by revenue raised in the AgETS. Speed of implementation would be relatively fast (no additional compliance entities in AgETS, due to simplicity of centralising removals purchases); though integration into AgETS may take some time.
	High quality removals: Permanence would depend on how removals are funded by government (i.e. government can selectively fund more long-lasting removals). Biodiversity impacts would depend on removals funding rules (i.e. government can selectively fund removals that deliver greater biodiversity benefits). Risk of non-additionality depend on whether removals providers voluntarily or obligatorily participate. Voluntary involvement of LULUCF sector participants creates systemic bias towards non-additionality (adverse selection) and leakage risks Note: if removals are certified through CRCF, quality would accord with CRCF QU.A.L.ITY criteria as implemented through the under-development CRCF methodologies.
Efficiency	**Static efficiency:** The model would incentivise lowest cost removals per unit of CO_2 by eligible removers that can be generated equal to or below the price offered by the government. The scope of removals covered would depend on design decisions.
	Dynamic efficiency: Regulators would have full control over the supply of removals, enabling them to incentivise activities beyond those with currently low marginal costs.
	Economy-wide efficiency: The Interconnected through government model would not automatically equivalise mitigation costs across AFOLU polluters and removals, as the government would negotiate separately (and at different times) with removers and with polluters (though the regulator would be expected to take into account marginal costs when setting caps and funding removals). This would only achieve economy-wide efficiency if the government set a single removals price and it was equal to the AgETS allowance price); the extent to which these mitigation costs equal those in other sectors of the economy would depend on design decisions (e.g. the cap).
	Administrative costs: The market would be moderately complex: the government's centralisation of removals purchases and AgETS participation would simplify the mechanism relative to the 'Interconnected: External credits model'. However, the number of removers would still be relatively large and require some administration (though they would not be AgETS participants).
	Participant transaction costs: Participant transaction costs could be kept relatively low, as participants would not have to participate in the ETS (avoiding negotiation and variable prices). MRV costs associated with certification of removals to enable result-based payments would still be significant.
Coherence	**AgETS match:** Implementable alongside all AgETS policy options. Having the government as the intermediary (with no direct link between polluters and removers, or removals and AgETS allowances) decreases need for close match between AgETS policy option and removals policy options.
Political/legal feasibility	**Absence of legal/political barriers:** No significant legal barrier as EU has competency for climate policy. Feasibility depends on specific design of removals policy option. As removals funding poses incentives (rather than costs for polluters arising in AgETS), would expect low political resistance from affected sectors. However, deciding how the government spends this central fund would be highly contested, especially if removals are provided by non-agriculture sectors (e.g. forestry).

Direct link

Interconnected: Deductions



Link:	Direct
Removals "buyer":	AgETS polluter (farmer/downstream processor) [198], who reduce their own AgETS compliance obligation by personally implementing removals
Removals provider:	AgETS polluter (farmer/processor): same entity as the "buyer"
AgETS policy option link:	Farm-level AgETS and downstream AgETS possible
Removal payment:	Deduction in AgETS compliance obligation
Existing examples:	Farm ETS: NZ: He Waka Eke Noa farm "deductions" (see Section A.8); Downstream ETS: Science-based Targets Initiative Forestry Land and Agriculture (FLAG) (see Section A.5) [199]

Overview: The deductions model would be a removals extension to either a farm-level or downstream AgETS.[200] It would feature no additional participants (relative to an AgETS) and no trading of removals. Rather, AgETS polluters (i.e. farms, downstream processors) are incentivised to carry out removals themselves, in exchange for a reduction in their AgETS compliance obligations. In the simplest form of a deductions model, regulators would not allow surplus removals to be traded (i.e., in the situation where an AgETS participant's AgETS emissions were less than their removals). This would generate fewer incentives for LULUCF removals. However, if trading was allowed, removals would be fungible with emissions reductions, which poses risks due to the non-equivalence of LULUCF removals and agricultural emissions. The deductions model would only create incentives for actors already covered by the AgETS. It would not incentivise LULUCF removals by any other actors.

The simplest version of the deductions model would be linked to a farm-level AgETS: AgETS polluters (farmers who are compliance entities) could implement removals on their own farms, which could be certified, with an equivalent deduction off their own AgETS compliance obligation. Removals (and the resulting deductions) would be voluntary and additional to the emissions quantification and obligation (meaning AgETS polluters would not be liable for net LULUCF fluxes, unless they voluntarily

[198] While it may be technically feasible to also implement a deduction-style model with the AgETS upstream model, we do not consider it as an option due to practical challenges. It is unclear how the upstream compliance entity (e.g. fertiliser producer/importer, feed importer) would incentivise removals within the EU, as they do not buy from EU-based actors who have land or would obviously be removals providers. Additionally, their products (fertiliser and feed) are more closely associated with emissions (and emissions reductions) than removals.
[199] FLAG is not a direct example for a compliance trading system but does overlap and provides some guidance for how a downstream AgETS could also quantify LULUCF removals.
[200] See Chapter 2 for description of the policy options proposed in AgETS Study.

implemented removals and had them certified as deductions).[201] A similar deductions model has been proposed in New Zealand: farmers will be able to reduce a levy on their agricultural emissions by implementing removals actions (see Section A.8).

A variant of the deductions model could also be developed to link to a downstream AgETS, which would be similar to an External credits model: Downstream AgETS polluters (meat/dairy processors) could incentivise farmers from within their supply chain to implement removals activities, which could be certified and then an equivalent deduction applied to their own processor AgETS compliance obligation (see Box 7 for expanded discussion). This deductions model would only be applicable where these deduction activities fall outside the scope of the AgETS (e.g. the AgETS covers agricultural emissions, the deduction activities cover LULUCF removals).[202] **Box 20** explores in more detail how such a model could be linked to a downstream AgETS.

This model links the AgETS and LULUCF removals: the deductions would have the effect of loosening the cap on the AgETS, lowering ETS allowance prices and decreasing emissions reductions (which would be replaced by removals approved as deductions). LULUCF removals would depend on the AgETS market (and the relative prices of LULUCF removals and emissions reductions for AgETS participants). As discussed in Section 0, regulators could restrict the impact on agricultural emissions reductions by making the AgETS cap tighter in the face of expected LULUCF removal deductions, or by limiting the extent to which polluters would be able to surrender removals to meet ETS compliance obligation, (e.g. through quantitative restrictions that impose upper limits or maximum % limits on the surrendering of removals credits towards compliance). This would give regulators some control over the share of emissions reductions vs. removals. Regulators would be able to manage what type of removal activities are incentivised through eligibility criteria, e.g. through those established by CRCF. However, relative to No link and Indirect link policy models, they would have less ability to influence which types and what quantity of LULUCF removals are implemented.

Box 20 Practical considerations: Deduction model linked to a downstream AgETS

This box outlines practical considerations for deploying a deduction model alongside a downstream AgETS. As described in more detail in Chapter 2 (and the AgETS Study), the downstream AgETS policy option involves downstream actors in the agriculture value chain (e.g. meat and dairy processors) to purchase sufficient AgETS allowances to cover the agricultural emissions associated with the products they process.[203]

The deduction model in a downstream AgETS would allow the downstream polluters (e.g. meat/milk processors) to reduce their compliance obligation by having their agricultural suppliers (e.g. farmers) implement eligible removal activities. For example, a downstream AgETS on meat/dairy processors would incentivise carbon removal activities on livestock farms. The deduction model would therefore create a financial incentive for processors to work together with their agricultural suppliers to invest in removal activities or directly pay them to implement removal activities, creating a new revenue stream for farmers. It also adds an additional financial

[201] The actual calculation of removals could be carried out at the same time as AgETS MRV (if participants opt in for deduction activities) or could be a separate process.
[202] This is slightly different to “insetting”, which occurs when a downstream compliance entity (e.g. meat processor) reduces its own compliance obligations by paying upstream entities (e.g. farmers) to reduce emissions and that mitigation is within the scope of their ETS (and thus reflected in a reduced compliance obligation for the downstream entity). Instead, the model here would have downstream polluters rewarded (in the form of deductions from their compliance obligations) for removals carried out on their suppliers’ (i.e. farmers’) lands, where those removals are outside the scope of the AgETS compliance obligation quantifications. Feasibly, it could be effective to create incentives for removals through a processor’s supply chain in this manner (rather than through an external credits model, where any operator could offer removals but would not be linked to the processors’ supply chain).
[203] This box does not cover the practical considerations of linking a deductions removals policy model with the other AgETS policy option (farm-level ETS or upstream ETS); while many of the practical considerations overlap with those discussed here, these would also pose some unique practical challenges and opportunities.

consideration for processors in selecting their suppliers, with farmers that have the potential to implement eligible removal activities or already conducting them obtaining a competitive advantage.[204]

To have the carbon removal activities count towards reducing the obligation of downstream polluters, the achieved carbon removals will have to be certified. This will require farmers to monitor, report and verify the carbon removals for the processor they supply. As it would be the processor who has the compliance obligation, the processor would be responsible for the overall MRV of the emissions and removals in its supply chain, including reporting to the competent authorities.

The degree to which the MRV under the deductions model leads to an additional administrative burden on farmers depends on whether the removal suppliers (e.g. farmers) already had to report information under the downstream AgETS to the processors they supply, for which two methods have been considered in the AgETS report:

- AgETS downstream mandatory (i.e. simple) MRV : the compliance obligation of processors is determined based on the quantity of meat or dairy, multiplied by default emission factors, requiring no data from farmers. If the deductions model was to be implemented, processors would require farmers to set up a new MRV process for their carbon removals, i.e. this would imply additional farmer administrative burden.
- AgETS downstream voluntary (i.e. complex) MRV approach: processors that want their compliance obligation to be determined based on specifics of their farmers are required to collect detailed data from their farmers (e.g. animal, farm, and farm management data). If the deductions model was to be implemented, there would be little additional administrative burden for those farmers that already have to collect data for downstream processers, as they already have an MRV process in place.

The deductions model shows many similarities with the 'Interconnected: external credits' model (see following section) as in both cases carbon removals are taking place outside the boundary of the downstream AgETS. Accordingly, the deductions model must set the same stringent requirements as the external credits model to ensure equivalence of the removals with emissions reductions (as discussed in Section 0). Double claiming of removals under the deductions model and another initiative must be avoided (WWF, 2022). However, there are also some distinct differences between the deductions and external credits models:

- Liability for MRV: under the deductions model, processors would be liable for ensuring that the carbon removals have been certified and are eligible to be used to reduce their compliance obligation, including the associated administrative costs. The processors could use the CRCF as the basis for this MRV, once it is finalised, to ensure that the method was transparent and consistent. It would be in the interests of the processors to ensure farmers implement a robust MRV process for the removal activities and feasibly to pay for it (to avoid penalties for non-compliance with the ETS). Under the External credits model, the responsibility for the MRV lies with the removal suppliers and the associated administrative costs would have to be recuperated through the credits they sell.
- Financial risks (and rewards): in the deductions model, the financial risks and rewards of investing in removal activities lies, in principle, with the processor. Since processors would directly financially benefit from the removal activity through a reduction of their ETS compliance obligation, they would be directly incentivised to invest in removal activities or pay their suppliers to do so. The risk of whether the removal activity would achieve the desired carbon removals, would also lie with the processor. With the external credit model, the financial incentive comes from the potential price farmers might be able to sell the external credits they generate through the removal activities. This puts the financial risk with farmers, but also their reward could be higher than under the deduction model if the price of external credits is higher than the processor removals payments. The specific risks and rewards will depend on the external credit or deduction contracts between processors and farmers. For example, a processor may already form a contract with a farmer under the external credits model to purchase the credits against a fixed price before these are generated, lowering the financial risk for the farmer.
- Scope of eligible removal activities: in the deductions model, only carbon removals from the suppliers of the processors would be eligible (i.e. the farmers they purchase meat/milk from). This would exclude carbon removal activities by other farmers (who do not supply the specific processor purchasing removals) and also any removal activities from non-livestock farmers (e.g. forest owners). Accordingly, the deductions model will theoretically be less efficient than the external credits model, as fewer removals suppliers will be incentivised to act.

[204] If only carbon removal activities taking place in the EU would be eligible under the deductions model, it could provide an incentive for processors to switch from non-EU suppliers to EU suppliers. However, in the case of meat and dairy processors, such impact is expected to be small as there is limited import of live animals and raw milk from outside the EU. See for example European Parliament (2018).

There is some precedence for voluntary examples of this deductions model: various large multinationals, including food and beverage companies, have their own voluntary programmes to pay farmers and other landowners in their supply chain to implement carbon removal projects. Companies generally do this to “inset” or “compensate” their carbon footprint.
However, NewClimate Institute (2023) found that for multinationals they analysed, there was no evidence that the companies claiming to inset their emissions have gone through rigorous processes of measuring and independently validating the legitimacy of their carbon removal claims. Under the deductions model, processors will therefore have to work with their suppliers to set up new MRV systems and processes to ensure the carbon removals are eligible for reducing their compliance obligations. The Science-based Targets Initiative’s Forestry, Land and Agriculture (SbTI FLAG) target setting framework provides a potential model for establishing and monitoring attainment of processor mitigation targets, including removals (see Section A.5 for a detailed description of this practical example).

Some EU-based meat processors have set SbTI targets and incentivise their farmers for reducing emissions and implementing removals, including, e.g. Danish Crown. Danish Crown identified that a key challenge was the cost of developing the 300-datapoint life-cycle analysis net emissions model they use to track farm climate performance and the overall performance of their company. The development of the Danish Crown Climate Track model took two years to establish and came at a cost that they suggest may only be coverable by larger companies. Danish Crown also indicated that their model depends on good existing data availability, such as that provided by the Denmark farmer-owned accounting service; they have not yet been able to implement the same model in e.g. Germany due to less data availability. Danish Crown have focussed on insetting (rather than offsetting) to keep payments within their sector and to promote in-sector innovation.

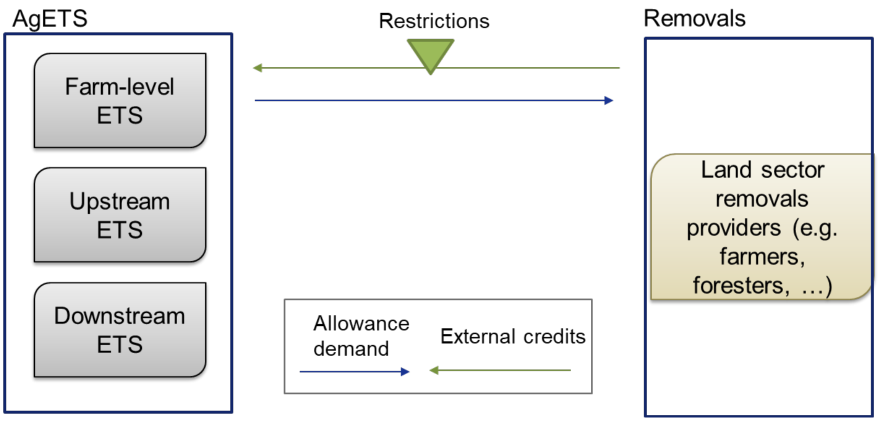
Table 35 Theoretical strengths/weaknesses assessment (relative to other policy models): Deductions

	Deductions
Effectiveness	**Increased land-based removals:** Only AgETS polluters would face incentives (no other AFOLU actors). As forestry actors were not included in AgETS, this would exclude a significant source of removals.[205] Removals incentives would depend on the stringency of the integrated ETS cap and the relative costs of emissions reductions or other sources of ETS allowances. Only those AgETS polluters who implement deductions would be incentivised to store carbon. Speed of implementation could be fast, due to no additional participants relative to the AgETS and relatively low complexity.
	High quality removals: Permanence would depend on specific design of deductions: liability may be enforceable through the AgETS, as removers would be compliance entities. Biodiversity impacts would depend on specific certification rules. Some risk of non-additionality, as polluters would voluntarily decide to carry out removals. Risk would be lower than external credits market due to fewer actors being eligible to provide removals (i.e. only AgETS polluters). Note: if removals are funded through CRCF, quality would accord with CRCF QU.A.L.ITY criteria as implemented through the under development methodologies.
Efficiency	**Static efficiency:** The deductions model would not ensure that all lowest cost removals would be incentivised, as the only actors who could carry out removals would be AgETS participants (lower cost removals by other actors would not be incentivised). The scope of removals would be relatively small as only AgETS participants could provide removals.
	Dynamic efficiency: Regulators would have some control over the mix of emissions reductions and removals that occur through deduction certification rules (e.g. those set by CRCF) and quantitative limits. In this model, regulators would not have the ability to incentivise activities beyond those with currently low marginal costs, limiting their ability to support development of mitigation options or related innovations over time. Regulators would not be able to influence removals being offered by actors beyond AgETS participants.
	Economy-wide efficiency:

205 Agroforestry would be incentivised but this would still exclude a significant set of removals actors (e.g. forestry sector).

	The Deductions model would not equivalise mitigation costs across AFOLU polluters and removers, as many potential removers would be excluded. Polluters would be incentivised to implement removals on their own farm (or within their supply chain) up until the point that their marginal cost of removals equalled the allowance price; the resulting emissions unit demand should lead to an allowance price that achieves static efficiency (i.e. lowest cost combination of removals/mitigation) within AgETS polluters. The extent to which the polluters' abatement costs equal those in other sectors of the economy would depend on design decisions (e.g. the cap).
	Administrative costs: The market would be relatively simple compared to the other policy models, with no additional compliance entities and relatedly moderate ongoing costs.
	Participant transaction costs: Participant transaction costs would be low relative to other removal policy models, due to eligibility being voluntary and being limited to a small number (only AgETS polluters), all of whom would already be AgETS participants. Transaction costs would be relatively low, as those participants would face few additional costs relative to existing AgETS participation (apart from additional MRV costs of removals).
Coherence	**AgETS match:** Straightforward to implement alongside farm-level AgETS, as MRV systems for farm-level AgETS could be adapted to also cover LULUCF removals. Possible but more complex to implement alongside downstream AgETS, though this would depend on the MRV required under AgETS.
Political/legal feasibility	**Absence of legal/political barriers:** No significant legal barrier as EU has competency for climate policy. Feasibility depends on specific design of removals policy option. As removals funding poses incentives (rather than costs for polluters arising in the AgETS), political resistance may not be so significant. Removals funding would stay within the scope of the AgETS (i.e. go towards AgETS polluters), which would be politically attractive.

Interconnected: External credits



Link: Direct

Removals buyer: AgETS polluter (farmer/processor/upstream actor)

Removals provider: LULUCF actors who meet external credit certification eligibility requirements. They are voluntary participants, and may or may not be compliance entities of the AgETS.

AgETS policy option link: All five AgETS policy options possible

Removal payment: Credits (permitted to meet AgETS compliance obligations, potentially with some restrictions)

Existing examples: Alberta Technology Innovation Emissions Reduction (TIER) system (see Section A.6), California Air Resources Board Compliance Offset Program (see Section A.2), among others

Overview: In an external credits model, there is a direct link between removers and AgETS polluters. Removers implement (certified) LULUCF removals and in return receive a corresponding number of credits, which they can then sell directly to AgETS polluters, who can use external credits to fulfil their AgETS compliance obligations. Removers voluntarily opt-in to the AgETS+Removals market (they are not obligatorily included). Regulators would establish an external credit certification system that acts as a gatekeeper for external credits (e.g., that could be based on the CRCF), which would set eligibility and removals certification procedures, and rules to ensure the quality of credits (e.g. the CRCF QU.A.L.ITY criteria implemented through the CRCF methodologies that are under development).

Under the external credit model, any actors who can implement certified LULUCF removals are eligible for credits. This means the policy will incentivise removals by more actors, i.e. not just the AgETS compliance entities who are eligible under the deductions model. Therefore, like the No link and Indirect link removal policy models (and unlike the Deductions model), this removal policy model would enable inclusion of LULUCF removals beyond those implemented on the agricultural land covered by the AgETS.[206]

The direct link to the AgETS means that the AgETS mitigation will be affected by LULUCF removals, and vice versa. External LULUCF removal credits would loosen the AgETS cap, lower allowance prices and decrease emissions reductions (which would be replaced by removals) compared to a situation without a direct link to LULUCF removals. Conversely, this interconnection to the AgETS would also make removals supply dependent on the AgETS market, especially the AgETS cap, demand, and qualitative/quantitative rules on external credit use. The regulator would have some control over the degree of link. As discussed in 0, this could be managed through qualitative restrictions (limiting the types of activities or actors eligible to generate removals credits e.g. through setting eligibility criteria for the certification procedure, e.g. in CRCF methodologies), and through quantitative restrictions (limits on the quantity of removals credits that can be surrendered by AgETS polluters towards their compliance obligations); the effects on AgETS cap can also be directly managed by adjusting the AgETS cap for the expected external credits. These restrictions and the rules established by the certification mechanism would enable regulators to have some control over how mitigation is carried out (e.g. emissions reductions vs removals), and what type of removal actions.

As external credit providers, removers would face different requirements than those of compliance entities under the ETS. These would be established by a certification mechanism, e.g. the CRCF. While removers could be required to follow the same MRV requirements as required of compliance entities under the ETS, this is uncommon. MRV for external credits is often adjusted to the specific credit generating activity and regulators mainly focus on reducing MRV costs to decrease barriers to removers voluntarily implementing external credit-generating activities. An example is provided by the California Air Resources Board Compliance Offset Program (see case study in Section A.2): there, methodologies detail different MRV requirements tailored to each removal activity, which differ from the MRV requirements for compliance entities.

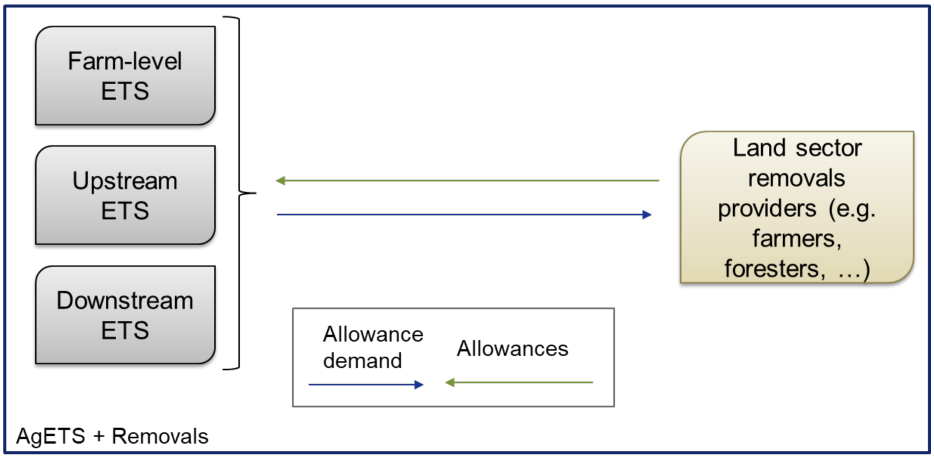
Table 36 Theoretical strengths/weaknesses assessment (relative to other policy models): Interconnected: External credits

	Interconnected: External credits
Effectiveness	**Increased land-based removals:** Removals incentives would depend on the stringency of the integrated AgETS+Removals cap and the relative costs of emissions reductions or other sources of ETS allowances (e.g.

[206] E.g. forestry and biochar, see discussion in Chapter 3.

	government auctions) – regulators would not be able to ensure high levels of removals (if, e.g., the market price was lower than the cost of removals). Removals incentives may decrease if restrictions were imposed (e.g. limits on who can participate and what activities can be certified). Only those eligible removers who voluntarily participate would be incentivised to store carbon; non-participants would face no liability for reversals. Speed of implementation would be faster than an interconnected market, due to fewer compliance entities, but slower than some options, due to the relatively high complexity.
	High quality removals: Permanence would depend on specific design of external credits and certification. Biodiversity impacts would depend on specific certification rules. Risk of non-additionality relatively high: voluntary involvement of LULUCF sector participants creates systemic bias towards non-additionality (adverse selection) and also poses leakage risks Note: if removals are funded through CRCF, quality would accord with CRCF QU.A.L.ITY criteria as implemented through the methodologies that are under development.
Efficiency	**Static efficiency**: The 'Interconnected: External credits' model would equivalise mitigation costs across eligible AFOLU polluters and removers unless restrictions applied. Price incentives would apply to all eligible removals activities, incentivising all removals activities at lower cost than the market ETS price (any restrictions would decrease efficiency). The scope of removals covered would depend on design decisions.
	Dynamic efficiency: Regulators would have some control over the market through restrictions and certification rules, which would allow them to manage the balance of mitigation achieved by emissions reductions vs removals. These blunt tools would give only limited ability to incentivise activities beyond those with currently low marginal costs.
	Economy-wide efficiency: The 'Interconnected: External credits' model would equivalise mitigation costs across eligible AFOLU polluters and removers unless restrictions applied, or few removers voluntarily participate; whether these match abatement costs in other sectors of the economy would depend on design decisions (e.g. the cap).
	Administrative costs: Relative to other removal policy models, the market would be moderately complex; only voluntary removers would be involved in the system (rather than all eligible AFOLU removers becoming compliance entities in an integrated ETS).
	Participant transaction costs: Only voluntary removers who choose to participate would face transaction costs; non-participants would face no costs. The relative complexity of the market would generate relatively high transaction costs, as participants would have to find buyers for removals credits, manage variable prices, and manage restrictions.
Coherence	**AgETS match**: Implementable alongside all AgETS policy options. The match would depend on specific design of each AgETS policy option and AgETS+Removals options.
Legal/political feasibility	**Absence of legal/political barriers:** No significant legal barrier as EU has competency for climate policy. Feasibility depends on specific design of removals policy option. As removals funding poses incentives (rather than costs faced by AgETS polluters), would expect low political resistance from affected sectors. If removals are provided by non-agriculture sectors (e.g., forestry), there could be political resistance to costs being borne by agriculture to reward other sectors.

Integrated ETS



Link: Direct
Removals buyer: AgETS polluter (farmer/processor/upstream actor)
Removals provider: LULUCF actors who are obligatorily compliance entities within ETS, i.e. scope of ETS includes the removers.
AgETS policy option link: All five AgETS policy options possible
Removal payment: Allowance (fully fungible, equivalent to AgETS emissions unit)
Existing examples: New Zealand Emissions trading system – Forestry sector (see Section A.1)

Overview: In a fully integrated ETS that covers GHG emissions from agriculture as well as land-based emissions and removals, participants would be able to generate, sell and trade removal credits without a fixed limit, as long as they meet all relevant requirements (regarding e.g. monitoring, certification of emission reductions, liability etc.). An integrated ETS features a direct, unrestricted link between the AgETS compliance entities and the removers, who are also compliance entities in the integrated ETS.

Like AgETS polluters, LULUCF removers would be obligatory participants within the scope of the integrated ETS; regulators can include only particular types of removers (e.g. forested land, agricultural land) and may also use thresholds (e.g. to exclude small land users). As fully integrated compliance entities, removers would be required to meet ETS reporting obligations: they would receive fully fungible allowances for generating removals but would be required to surrender allowances if they had net emissions from their land (e.g. from cutting down trees); this would generate incentives to maintain current carbon stores (as for those participating foresters in the NZ ETS, see Section A.1). This inclusion of LULUCF removers as obligatory participants would increase the size and administrative complexity of the AgETS, as well as requiring extensions to the AgETS MRV to account for monitoring of LULUCF removals and emissions. Therefore, this policy model scored one of the lowest in terms of administrative feasibility in the stakeholder survey.

The Integrated ETS design is effectively the same as a AFOLU inventory, scaled down to the entity-level, with a cap set on net-emissions and removals. Like any inventory, certainty depends on the quality of the data and its quantification. Like in a national inventory, additionality is not an issue, as the inventory (AFOLU ETS) captures all emissions and removals from the covered sectors each year, and contribution to climate targets is managed through the cap.[207] Rather than rewarding removers for additional actions, the Integrated ETS approach rewards those delivering net removals each year.[208]

Within an integrated ETS, removers would be rewarded with fully fungible allowances (i.e. fully equivalent to the allowances required to be surrendered by AgETS polluters). This implies equivalence of removals and emissions reductions covered by the scope of the ETS and equal prices for emissions reductions and removals; this would make it challenging to promote more costly carbon removals or to recognise removals that generate additional value (e.g. those with significant biodiversity co-benefits).[209] Governments would be unable to restrict the relative amounts of mitigation through removals and emissions reductions.[210]

Table 37 Theoretical strengths/weaknesses assessment (relative to other policy models): Integrated ETS

	Integrated ETS
Effectiveness	**Increased land-based removals:** Removals incentives would depend on the stringency of the integrated AgETS+Removals cap and the relative costs of emissions reductions or other sources of ETS allowances (e.g. government auctions) – regulators would not be able to ensure high levels of removals (if, e.g., the market price was lower than the cost of removals). All eligible removers would also face incentives to store carbon, as they would be liable for any carbon emissions (i.e. through reversals). Speed of implementation would be slower than some options, due to the relative complexity of an integrated ETS.
	High quality removals: Permanence would be inherently supported through market liability for reversals, as all LULUCF actors covered by the AgETS+Removals would face costs if they released stored carbon. Biodiversity impacts would depend on specific rules. Additionality would not be an issue, as all eligible LULUCF sector participants would be automatically included. This would avoid the risk of adverse selection and reduce leakage risks (within the EU). Note: if removals are funded through CRCF, quality would accord with CRCF QU.A.L.ITY criteria as implemented through the under development methodologies.
Efficiency	**Static efficiency:** The integrated ETS would incentivise lowest cost removals (from all LULUCF removers who are eligible participants) that can be generated at a lower cost than the market AgETS+Removals price, which would reflect all mitigation options within scope (emissions reductions and removals). The scope of removals covered would depend on design decisions.
	Dynamic efficiency: Regulators would have relatively little control over the market, e.g. the balance of mitigation achieved through removals vs emissions reductions, or the ability to influence which removals were being incentivised (e.g. no differentiated prices). Other measures (e.g. removals quantification rules or CCfDs) could potentially be employed but generally little ability to incentivise activities beyond those that currently have low marginal costs (no consideration or ability to reflect expected long-term carbon prices).
	Economy-wide efficiency: The integrated ETS would equivalise mitigation costs across eligible LULUCF polluters and removers (i.e. those that are compliance entities). Whether these match abatement costs in other sectors of the economy would depend on design decisions (e.g. the cap).

[207] Furthermore, as all eligible removers are obliged to participate (unlike e.g. the External credits model, where removers voluntarily opt in), there is no risk of non-additionality due to adverse selection.
[208] If net removals are to be traded to other sectors outside of the AFOLU ETS, then sectoral additionality may be an issue. To ensure environmental integrity, it would be necessary for any AFOLU ETS certificates sold to other sectors were matched by additional emissions reductions/removals that go beyond what would have happened in the AFOLU sector without that incentive.
[209] The government could implement removal quantification rules to step away from equivalency, e.g., they could discount the quantified removals in accordance with their quantification uncertainty.
[210] In the New Zealand ETS, forestry offers much cheap mitigation, resulting in forestry removals delivering 73% of all mitigation achieved by the NZ ETS in 2020, with only 27% mitigation through emissions reductions in other sectors (Carver et al 2022).

	Administrative costs: The market would be complex, with many compliance entities (due to obligatory inclusion of eligible AFOLU removers), and relatively high ongoing costs.
	Participant transaction costs: All eligible AFOLU removers would face relatively high up-front transaction costs, as all would be compliance entities, and MRV costs for sequestration are relatively high. The relative complexity of the market would also generate high transaction costs, e.g. learning the system, managing variable prices etc.).
Coherence	**AgETS match:** Implementable alongside all AgETS policy options. The match would depend on specific design of each AgETS policy option and AgETS+Removals options. If the scale of compliance entities differ between AgETS and AgETS+Removals (e.g. upstream AgETS and farm-level removals), care must be taken to avoid double-counting. If the scale of compliance entity is the same, then system boundaries should be aligned to simplify administration and avoid perverse incentives.
EU-added value	**EU-wide approach**: Integrated ETS would create opportunities for trade, increasing efficiency of achieving overall mitigation (i.e. AgETS emissions reductions and AgETS+Removals 1b removals) across the whole of the EU at lower costs and higher market liquidity.
Legal/political feasibility	**Absence of legal/political barriers:** No significant legal barrier as EU has competency for climate policy. Feasibility depends on specific design of removals policy option. As removals funding poses incentives (rather than costs for polluters arising in ETS), would expect low political resistance from affected sectors. If removals are provided by non-agriculture sectors (e.g., forestry), there could be political resistance to costs being borne by agriculture to reward other sectors.

5.3. Comparison of removal policy models

Our theoretical evaluation of removals policy models provides some guidance on their strengths and potential pitfalls. Table 38 presents a visual summary of the theoretical evaluation of the removal policy models, allowing direct comparison between them. Section 1.2 describes the objectives for the policy and the criteria used to assess policy models in more details.

Table 38 Removals policy model: theoretical comparison of relative strengths and weaknesses

		No link	Indirect link	Direct link		
		'No link: Disconnected market'	Interconnected: through government	Deductions	Interconnected: External credits	Integrated ETS
Effectiveness	Increased land-based removals					
	High quality removals					
Efficiency	Static efficiency					
	Dynamic efficiency					
	Economy-wide efficiency					
	Administrative costs					
	Participant transaction costs					
Coherence	AgETS match					
Political/legal feasibility	Absence of legal/political barriers					

The abstract evaluation of each of these models is only suggestive: whether these theoretically expected outcomes will occur will also depend on the wider design of the removal policy option, in particular the AgETS being linked to (see Chapter 2) and the scope of carbon removals selected (see Chapter 3), and the specific rules and requirements of the removal policy option (discussed in Chapter 4). For this reason, this table should be read with care. It presents the relative strengths and weaknesses of each removal policy model in comparison to the other policy models, assuming that all other elements are held the same.

It does not show how influential the selection of the removal policy model will be on the attainment of the objective, relative to other elements (i.e. the AgETS policy, the supply of removals, or the design decisions). Accordingly, it is more informative to read this diagram horizontally than vertically. For example, reading horizontally one can see that, all other things being held the same, the Integrated ETS appears most likely to deliver high quality removals (as integration of removers into the ETS makes them liable for reversals, increasing likelihood of permanence). However, it is important to note that the choice of removal policy model will not be decisive for this objective, which will depend more on the scope of removals that will be permitted and their MRV. Conversely, the choice of removal policy model will have a significant effect on whether static efficiency is achieved (i.e., whether the lowest cost removals will be incentivised); here, we can see that the 'Integrated ETS' and 'Interconnected: through government' models appear most likely to achieve the criterion.

To select between different policy models, the decision maker must consider which criteria are most important. The table does not show the relative importance of each criterion. As discussed in Section 1.2, this decision is a political one. For example, when comparing the different removals policy models, the 'No link: Disconnected' policy model appears relatively strong compared to the direct link models on the effectiveness criteria, but weaker on the economy-wide efficiency and political acceptability criteria; which model would be preferred depends on whether the decision maker prioritises efficiency or effectiveness. An alternative example is shown by the 'Direct link: Deductions' model: if the most important objective is to increase political acceptability of the AgETS+Removals policy at relatively low administrative and farmer transaction cost, then this is a strong option, even though it scores lower on effectiveness and efficiency criteria than the other policy models.

Policy makers should also consider utilising different policy models for different types of removals. As explored in Chapter 3, the removal policy options differ widely in terms of MRV confidence, as well as other attributes. Those removal options with high MRV uncertainty (such as soil carbon sequestration) are less appropriate for the 'Direct link: Integrated ETS' policy model. Administrators of Integrated ETS policies have few tools at hand to manage differentiated quality allowances, but it will remain difficult to manage trade of non-equivalent soil removals for AgETS emissions reductions.[211] Instead, other policy models should be considered for soil carbon removals: the ''No link: Disconnected market' policy model may be most appropriate for uncertainly quantified removals, as this model avoids the risk of low quality removals impacting the AgETS market. It also allows for removals to be funded without requiring results-based payments: this may allow for more efficient funding of low-MRV-certainty removals such as soil carbon, where strict MRV requirements pose a significant transaction cost and reduce implementation. Removals that have more certain MRV, such as forestry options, would

[211] This can be partially managed through design decisions, as discussed in Section **Error! Reference source not found.**.

be better suited to integration in Direct link models (as illustrated by the NZ ETS's inclusion of forestry, see Section A.1).

Linking to AgETS options

The preferred removals policy model may also depend on the selected AgETS option that it will link to, although all models can be combined with almost all AgETS options studied. Table 38 shows all removal policy models are, in principle, compatible with all ETS options investigated in the AgETS study, i.e., an on-farm, upstream and downstream AgETS options. The 'No link: Disconnected' policy model and 'Interconnected: through government' would be the most straightforward implement alongside the AgETS options, while other policy models have additional considerations:

- Under the 'No link: Disconnected' policy model, removal activities do not affect the AgETS allowance supply, so it would be equally compatible with all AgETS options.
- Under the 'Indirect link: Interconnected through government' policy model, the government buyer has full control over the type and amount of removals that are funded and converted into AgETS allowances. This enables the government buyer to actively manage the impact that removal units have on the AgETS cap, which can be tailored to any AgETS options.
- The 'Direct link: Deductions' policy model is the only removals policy model that is not compatible with all AgETS options due to practical challenges of combining it with an upstream AgETS (see Section 0). It would be relatively straightforward to implement alongside an on-farm AgETS, as MRV systems for an on-farm AgETS could be adapted to also cover LULUCF removals. With a downstream AgETS, it may introduce additional complexities depending on the AgETS MRV requirements. In addition, qualitative and/or quantitative restrictions may need to be set on the use of removals as deductions and the AgETS cap will have to take the potential use of deductions into account.
- The 'Direct link: External credits' model is compatible with all AgETS options. Similar as the Deductions policy model, the use of removals as external credits may need to be controlled through qualitative/quantitative rules and the AgETS cap will have to take the potential use of credits into consideration.
- The 'Direct link: Integrated ETS' policy models is also compatible with all AgETS options. Since this policy option features a direct, unrestricted link between eligible removal units and AgETS allowances, there is no need to set qualitative and/or quantitative restrictions on removal units. Instead, it is important that the AgETS cap is set based on net emissions and removals.

While almost all combination between the studied AgETS options and removals policy models are possible, there were two combinations with a downstream ETS that received strong stakeholder support. From the stakeholder survey conducted for this study, respondents considered the downstream AgETS in combination with the 'No link: Disconnected' market or the 'Direct link: Deductions' policy model as more preferred as shown in Table 39:

- Respondents were most in favour of the downstream AgETS in combination with the ''No link: Disconnected' policy model were mainly stakeholders from NGOs and environmental organisations that expressed their strong opposition against the use of LULUCF carbon removals to meet compliance obligations under an AgETS.
- Respondents that were most in favour of the downstream AgETS combined with the 'Direct link: Deductions' policy model had agriculture or manufacturing of fertilisers or feed as their main activity.

The ‘No link: Disconnected market’ and ‘Direct link: Deductions’ policy model were also the ones that scored highest in terms of administrative feasibility. Conversely, any combinations with the ‘Indirect link: Interconnected through government’ or ‘Direct link: External credits’ were least preferred by stakeholders, particularly when combined with an on-farm ETS or upstream ETS. In general, the stakeholders opposed an on-farm ETS in almost all combinations with the removals policy model except the ‘No link: Disconnected market’ option, where the average stakeholder opinion was neutral.

Table 39 Comparison of stakeholder preferences for combinations between AgETS options and policy models for linking a reward system for carbon removals (n=61)

	AgETS options		
Policy models for linking LULUCF carbon removals	On-farm ETS	Upstream ETS	Downstream ETS
No link: Disconnected market	+/-	+/-	++
Indirect link: Interconnected through government	--	-	+
Direct link: Deductions	--	+/-	++
Direct link: External credits	--	-	+
Direct link: Integrated ETS	-	+/-	+

Note: ++ = strongly preferred, +/- = neither prefer or not preferred, -- = strongly not preferred. See the Stakeholder survey summary report part of this study for more details.

This split in view by stakeholder group on the preferred removals policy model was also observed in the stakeholder workshop held for this study. Although there was a general consensus that a downstream AgETS is considered more practical compared to an on-farm or upstream AgETS, there was no consensus on the role of LULUCF carbon removals in an AgETS. Stakeholders from NGOs argued that the scale up of removal activities should be treated as separate and complementary to emission reductions, expressing their strong opposition to a system where emission reductions and removals are interchangeable due to risks of impermanence and emission deterrence. Stakeholders from the agriculture value chain and foresters indicated that any form of financial resources to achieve carbon removals would be a positive development, even if it may not be possible to find perfect solutions in avoiding these risks. Ultimately, this comes down to a trade-off between seeking pragmatic solutions to incentivise land-based carbon removals towards climate neutrality in 2050 while addressing the potential risks related to carbon removal policies.

Policy makers can and should also consider the sequencing of policy models. More complex models such as the Integrated ETS may be unrealistically complex policies to establish with the current levels of experience and data. Instead, more administratively simple policies (as indicated by efficiency criteria “administrative costs”) could be established first to enable learning-by-doing and faster implementation. Furthermore, sequencing may help in developing knowledge on experience on approaches to manage risks of emissions reduction deterrence and non-equivalence risks such as non-permanence. Policy makers could start with less-integrated removal policy models and only shift to models with a stronger integration of removals into an AgETS when (and if) MRV approaches improve and non-equivalence risks can be managed.

Interactions between removal policy model and design elements

Our theoretical evaluation of removal policy models in Chapter 5 considers the models in isolation. However, their strengths and weaknesses will be affected by the specifics of how they are designed (i.e. their interactions with the design elements we discuss in Chapter 4) and the types of removals included in the AgETS+Removals policy (i.e. the scope of removals, discussed in Chapter 3). In this section, we assess removals policy models related to two key design elements: non-equivalence of

LULUCF removals and AgETS emissions(Section 0) and double-counting and LULUCF coherence (Sections 0 and 0)

Non-equivalence of LULUCF removals

The risk posed by integrating non-equivalent LULUCF removals into an AgETS differs depend on the removals policy model. As discussed in Section 0, when integrating removals into an AgETS, the non-permanence risk can only be managed, it cannot be completely dispensed with. While this risk can be somewhat managed through the approaches outlined in that section, regulators must weigh up whether the benefits of including removals (e.g. lower compliance costs associated with slower transition periods) outweigh the risks. It is important to note that this only applies to removal policy models where removals are integrated into the AgETS ('Direct link' and 'Indirect link' models). Alternatively, regulators can use removal policy model 'No link: Disconnected market', which keeps removals separate from the AgETS. This policy model avoids any implication of equivalence or trading off of non-permanent removals for emissions reductions. Instead, the removals (and risk of reversal) is firewalled off from the AgETS, avoiding the issues of non-permanence within the ETS (though this risk must instead be borne and managed by the government or other intermediary in charge of the 'No link: Disconnected market'). Also, there is no risk of deterring AgETS mitigation with non-permanent removals.

Double counting

The risk of double-counting will manifest differently across the different removals policy models (discussed in 0), as follow:

- 'Direct link: Integrated ETS': Provided that alignment in terms of the scale of compliance entities and system boundaries is ensured, the risk of double-counting would be relatively low.
- 'Direct link: External credits': Double-claiming requires particular attention in the case of the external credits policy model and a deductions model linked to a downstream AgETS. The external credits option entails the participation of actors and activities outside of the scope of the ETS, posing leakage risks and significant monitoring challenges to managing the risk of double-counting.
- 'Direct link: Deductions': A deductions model involving insetting would require that AgETS+Removals participants demonstrate that carbon removal interventions along their value chains have not been used in other voluntary or governmental schemes or counted towards scope 3 emissions reductions of another actor, inside or outside the AgETS+Removals. On the other hand, in a deductions model linked to a farm-level AgETS, where polluters implement removals on their own farms, double-counting would not present a similarly significant challenge.
- No link/interconnected through government (see Sections 0 and 0): Carbon removals models with no direct link between removals providers and AgETS participants assume a greater role for the government as an intermediary which, as the sole purchaser of removals, has control over the quality aspects of carbon credits. If the intermediary agency is instituted at EU level, both the 'no link' and 'interconnected: through government' options pose lower risks of double-counting, as the EU actor can enforce a uniform MRV approach and a central registry. In addition, the disconnected model opens the possibility of funding removals which may not need to be certified or rewarded through results-based payments. As this model would not involve trading off agricultural emissions reductions for external credits, the risk of double-counting would not be material. Depending on the practical design, this option may present opportunities for a more universal shift towards "contribution claims" or "climate

responsibility" approaches, which have been proposed by several stakeholders to address the double-counting risks inherent in the use of removals to compensate for emissions reductions.

6. Conclusion of Part 2

This report has investigated policy models that use price-based mechanisms linked to an agricultural emissions trading system to incentivise removals in the LULUCF sector. This report has provided an overview of four key elements for AgETS+Removals policy design:

- The **LULUCF removals options** in the EU, and how they can be **monitored, reported and verified**
- Key **design decisions and options** relevant for a market-based mechanism that combines AgETS with incentives for removals
- An overview of potential **removals policy models** that link removals to an AgETS, and their strengths and weaknesses

The analysis is based on theoretical and empirical literature, expert interviews, a review of existing experience with comparable policies from around the world, as well as survey and workshop inputs.

LULUCF removals options

Carbon removals from the LULUCF sector will be essential to attain the EU's climate objectives - but cannot replace rapid emissions reductions in all sectors. Overall, EU LULUCF removals offer significant potential for mitigating climate change at prices comparable to some of the more expensive abatement options. If implemented carefully and in ways that align with local contexts, they can be considered nature-based solutions, simultaneously enhancing biodiversity and delivering other societal benefits as well as climate mitigation. Indeed, one key advantage of carbon removal actions is their ability to deliver on multiple societal objectives, including those that can be difficult to quantify (such as biodiversity or climate adaptation). Realising this potential must therefore be central to policy design.

EU LULUCF carbon removals offer significant potential for mitigating climate change, though further research is needed to quantify the impact of carbon removal activities on climate change mitigation. Evidence on the supply of LULUCF removals at different carbon prices suggests that up to 2030, there will be some forest management, agriculture, and afforestation removals available at prices below €25 per tonne. The mitigation potential of LULUCF removals options remains uncertain due to differences between the overall technical potential and the economic potential, which reflects how much mitigation would be implemented at a specific carbon price. The latter can be significantly lower due to economic barriers such as learning requirements and transaction costs. The actual supply of LULUCF removals that can be used in an AgETS will depend significantly on the conditions and requirements for their certification and any other rules set under an AgETS+Removals policy; here, the CRCF methodologies under development could potentially play a standard setting role.

The nature of LULUCF removals poses challenges to their incorporation into an agricultural emissions trading system; policy design, including the CRCF, may be able to address some of these challenges. A key challenge is the limited robustness and the high cost of monitoring, reporting and verification (MRV) for removals. Currently, the MRV of soil carbon removals and agroforestry pose particular challenges for certification. Due to their context-specificness and research and experience gaps, they generally lack standardised MRV approaches and/or require costly sampling to limit uncertainties. Improved forest management approaches, by contrast, pose significant additionality concerns. While afforestation/reforestation is relatively well-studied and demonstrated, there are concerns about leakage and sustainability impacts. All these challenges could translate into substantive risks for the AgETS: removals with overestimated or non-additional effects would undermine the environmental integrity of the AgETS altogether, i.e. result in more GHGs in the atmosphere than if these non-equivalent removals were not allowed into the AgETS. The European Commission's proposed Framework for Carbon Removal Certification aims to address these challenges and to develop standardised certification procedures for removals, including LULUCF removals. A cautious approach is recommended before LULUCF removals are linked to an AgETS: firstly, increased research and piloting of LULUCF removal MRV approaches (e.g., the methodologies developed under the CRCF), to ensure context-specific, accurate, and lower-cost MRV methods with greater certainty; secondly, a conservative approach to integrating LULUCF removals into an AgETS, with the aim of learning by doing and minimising structural risks until understanding and experience increases.

LULUCF removals face significant challenges of impermanence and a risk of reversal, posing a fundamental difference to agricultural emissions reductions. With the exception of biochar, all LULUCF removal options pose a high risk of being short-lived, with the potential of being re-emitted into the atmosphere in the future. In contrast, agricultural emissions reductions are permanent: a ton of emissions avoided today can never be "re-released" to the atmosphere. This risk of impermanence can be somewhat managed through removal policy design (as the CRCF aims to do), but never fully avoided. Existing removal policies illustrate different possible approaches to manage the risk of impermanence, including limiting eligibility to "more permanent" types or actors, defining removal credits as temporary (as is proposed by the CRCF), enforcing seller or buyer liability for reversals, or discounting. However, none will be failsafe - especially at the 300-1000+ year timescale of carbon dioxide in the atmosphere. These approaches to managing impermanence risk effectively increase the cost of removals – either for the buyer, supplier, or regulator. Accordingly, regulators must consider the relative benefits and costs of linking each type of removals into an AgETS, and whether result-based approaches to LULUCF removals, and their integration into an AgETS+Removals, will be the most effective and efficient way to increase LULUCF removals.

Key design decisions under an AgETS+Removals policy

Integrating removals into an AgETS can reduce incentives for agricultural emissions reductions ("emissions reduction deterrence"). If LULUCF removals have lower costs than agricultural emissions reductions, the inclusion of removals effectively increases the AgETS cap, as emissions can be offset by increased carbon removals in the LULUCF sector. However, given that there is an urgent need to reduce emissions across all sectors, it would be problematic if removals were to deter from needed emission reductions. Such emissions reduction deterrence is larger in directly linked removal policy models than in policy models where the removals are not linked, or linked only indirectly. In addition, certain design features may limit or reduce the risk of deterrence (e.g. through qualitative and quantitative limits, adjusting the AgETS cap to account for the increased supply of LULUCF credits, etc). However, there is also a dynamic effect: the (expected) inclusion of removals in any AgETS may constitute a moral hazard, where the promise of removals obfuscates clarity on the needed emissions reduction effort, delays needed investments, or distracts political attention. Especially in the short term, inclusion of removals should therefore be designed in such a way that it reduces the risk of emission reduction deterrence (e.g., through a staged introduction of removals with qualitative or quantitative limits).

From a dynamic perspective, the goal is to gradually scale up removals over time. In the medium to long-term (e.g. in the 2040s, and certainly post-2050), carbon removals will play an increasingly important role to offset those residual emissions that are hard or impossible to avoid (for technological/economic, or social/political reasons). However, for removals to be able to play this role, they need to scale up over time. Scaling up removals technologies helps bringing down their cost, gathering experience and standardising protocols (e.g. related to MRV), developing a market environment and suppliers of removal projects, as well as competition for suitable technologies and business models. Some stakeholders in this study's workshop and survey argued that the scale up of removal activities should be treated as separate and complementary to emission reductions, expressing their strong opposition to a system where emission reductions and removals are interchangeable due to risks of impermanence and emission deterrence. Other stakeholders indicated that any way of scaling up carbon removals would be a positive development, even if it may not be possible to find perfect solutions in avoiding these risks. The challenge is therefore to find the sweet spot, deploying policies that incentivise removals but do not do so too fast (which would increase the risk of emission deterrence and impermanence) nor too slow (preventing technologies and business models from reaching market maturity). Again, this calls for a gradual, stepwise approach to integrating removals into any AgETS, closely monitoring the impacts and adjusting where needed.

Removals policy models

The different removal policy models explored in this study pose different strengths and weaknesses as tools to effectively, efficiently, and equitably achieve increased LULUCF removals and agriculture/land sector mitigation. Which removal policy model is selected determines the policies' ability to meet its objectives. Selecting between different removal policy models often implies trading off between different objectives (e.g. effectiveness / environmental integrity vs. efficiency / low costs of removals). Navigating these trade-offs requires, first and foremost, clarity about the objectives and possibly their changing relevance over time: while effectiveness / environmental integrity would seem paramount in any timeframe, it can also be argued that achieving greater efficiency now can help to enable greater ambition later, if the (political or economic) cost will decline over time. Likewise, as argued above, avoiding emission reduction deterrence is crucial in the short run, but ambiguous in the medium to long-term.

Different types of removals could and should be governed by different policy models, with sequencing of policy models also part of the considerations. For instance, less certain removal types could be incentivised by simpler, less risky (but also less efficient) policy models such as 'No link: Disconnected markets' or 'Direct link: Deductions' combined with conservative design settings, while options such as afforestation may be more appropriate for more integrated approaches. Here, it would also be sensible to apply a sequencing approach: start with less-integrated removal policy models to reduce risk of emissions reduction deterrence and integration of non-equivalent removals into an AgETS while knowledge and experience develop, and only shift to a more integrated AgETS+Removals when (and if) MRV approaches improve, and emissions reduction deterrence and impermanence risks can be managed.

Although almost all combinations of the studied removals policy models and AgETS options are possible, stakeholder acceptance differs widely for combinations. In principle, all AgETS options studied (on-farm, upstream and downstream AgETS) are compatible with all removal policy models. The only exception is the 'Direct link: Deductions' policy model where the combination with upstream AgETS would be difficult due to the practical challenges. However, the downstream AgETS in combination with the 'No link: Disconnected' policy model or the 'Direct link: Deductions' policy model received the strongest support among stakeholders. Any combinations with the 'Indirect link: Interconnected' through government or 'Direct link: External credits' model were least preferred by stakeholders, particularly when combined with an on-farm ETS or upstream ETS. In general, the stakeholders opposed an on-farm ETS in almost all combinations.

Overall, to best transition the agriculture and land sector and our food system to sustainability, it will be crucial to consider AgETS+Removal policy design as part of a wider systemic change. The climate impacts of land, agriculture, and food are driven by multiple intersecting policy and market drivers. Any AgETS+Removals policy will only play a part in transforming this system to reduce emissions, increase carbon removals, and deliver on other sustainability and societal objectives. Crucially, any AgETS+Removals policy must be accompanied by increased climate and sustainability ambition in the Common Agricultural Policy and accompanying policies such as Farm to Fork and the Effort Sharing Regulation. Scientific research, policy experimentation, and stakeholder collaboration will be essential to develop and test sustainable farming approaches. Policy incentives for farmers alone will not be enough – farmers must be supported to develop the skills necessary to implement the necessary changes, and the agricultural supply chain must support the transition. COWI, Ecologic Institute & IEEP (2021) outline elements of an enabling environment for farmers, including free advice, supportive ministries/agencies, flexible and simple approaches, and systems with rewards for early effort, as well as accountability. Finally, any AgETS+Removals must be a complementary piece of the wider sprint towards net zero, driven by rapid decarbonisation of all sectors of the European economy, and international cooperation and support for the global effort.

Open questions and further research

This exploratory study serves as background for the assessment of a AgETS+Removals policy, although many questions still have to be answered. The study identifies a number of open questions and areas for further research, including:

Fit of the final CRCF methodologies: Due to the numerous uncertainties surrounding LULUCF removals, especially the challenges related to monitoring, reporting, and verification, there remain open issues surrounding their incorporation into an AgETS+Removals policy. The potential for overestimated, non-additional, and generally uncertain LULUCF removals would undermine the environmental integrity of an AgETS+Removals policy. The final form of the CRCF methodologies, which are still under development, aims to manage and contain these risks. The proposed QU.A.L.ITY criteria are a good starting point for minimum standards to certify carbon removals, however the specifics of how MRV issues will be addressed for each removal option will need to be carefully considered by the Commission and the Expert Group on Carbon Removals.

Marginal abatement cost curves of LULUCF removals: The supply of carbon removals is strongly related to the cost of removals: it is only profitable for LULUCF removals to be implemented when the payment is at least as much as the marginal abatement cost. The available figures used in this study included definitions that do not entirely align with our understandings of removal options, lack data for agroforestry and biochar, and are limited to a relatively short time frame (2030). In order to gain a better understanding of the potential supply of carbon removals in an AgETS+Removals policy and how this may interact with reductions of agricultural emissions, it will be important to develop further research on these marginal abatement cost curves at the EU level.

Potential role of and interaction with the CAP: It will be critical to thoroughly evaluate how the Common Agricultural Policy can interact with and support the ambition of an AgETS+Removals policy. Concerns have already been raised over the effectiveness of CAP efforts at promoting climate-friendly soil measures to reduce net emissions, as well as the CAP's protection of carbon stored in grasslands, implementation of afforestation, and agroforestry. As such, future work should explore how to enhance the CAP approaches in this regard to ensure that it is able to deliver effective LULUCF removals, especially in line with other relevant policies like the EU Soil Strategy, Farm to Fork Strategy, and the EU Forestry Strategy, the Nature Restoration Law, and the proposed Soil Health Law.

Impacts of biochar: Respondents to the stakeholder survey expressed concerns about the impacts of biochar, particularly with regards to potential impacts on land-use change, soil health, and biodiversity. Further research on the effects of biochar will be necessary if this removal option is incorporated into an AgETS+Removals policy.

Further development of MRV approaches: Given the significant uncertainties and assumptions inherent in existing MRV approaches for LULUCF removals, it will be important to ensure that investment and research in this area continue to develop. This would include, for example, deepened understanding of factors affecting SOC quantity and stability as well as sampling methodologies. In addition, it will be important for soil carbon monitoring approaches to consider all relevant GHG emissions associated with soil management to ensure that non-CO_2 emissions from farming practices do not replace carbon removals. Particularly, the relationship between N_2O emissions and increased SOC storage may lead to an overestimation of mitigation potential and should also be further researched.

Development of policy models into concrete AgETS+Removals policy options: a next step from this report would be to further develop the policy models into concrete policy options. This will enable them to be assessed against economic, environmental and social impacts that were not considered in this study. In the development of the policy options, a key consideration is that different policy models best suited for different types of removals depending, for example, on how MRV concerns are addressed in different approaches. As a result, some AgETS+Removals policy options could be a combination of different policy models. Development of policy models should also consider the sequencing of different models based, considering the appropriate level of complexity for the situation.

Environmental impact of AgETS+Removals policy options: An important design decision with regards to developing an AgETS+Removals policy is to ensure that carbon removals support sustainability objectives. These may relate to biodiversity, climate adaptation, water resources, pollution, etc. It will be important to expand research on the possible co-benefits of carbon removal approaches in order to ensure that carbon removals are prioritised that also generate co-benefits that support the achievement of sustainability objectives.

(Socio-)economic impact of AgETS+Removals policy options: In the stakeholder survey, respondents were asked about the impact of the different removal policy models on (socio-)economic aspects such as global competitiveness, trade balance, food prices and income of farmers. About a third to half of the respondents did not answer the question or filled in "no opinion". Of the respondents that did fill in the questions, the opinions on positive or negative impacts were very diverse. To most questions, the opinion was leaning towards negative impacts, including on income of farmers, even though the removal policy models are intended to support the income of farmers. This could reflect a lack of understanding or uncertainty of the (socio-)economic impact of the policy models, and calls for further research on these once the models have been more clearly defined into concrete policy options.

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Annex - Practical examples

To support our review of the theoretical literature on carbon removals policy models, in this section we look to existing examples of the carbon removal policy models as practical case studies. Each case study introduces an example of a removals policy option (or related policy). In each, the focus on the removals aspect of the policy, and on how it links to an ETS (if appropriate) – i.e. how allowance demand or funding raised through polluter pays is used to generate removals incentives. Each case study also describes other important contextual and design information, as well as providing references and links to more information.

Section A.9 documents how case studies were selected, and the template used to gather consistent information. Given that there are limited examples of an agriculture-focussed emissions trading system (i.e. AgETS) or of the linking removals to an ETS, the selected case studies diverge to differing degrees from the specific policy model we are interested in. However, each case study offers lessons on how such a policy could be developed, whether it is the link between removals and an ETS, incentivising action in the LULUCF sector, relevant EU governance example, or other insight. All case studies present consistent information except in a few cases where the significantly different case study policies are reflected by slight variations to the template to increase clarity. These practical examples will provide useful input for developing concrete removals policy options in the next stage of the study.

A.1 New Zealand ETS - Forestry

Name	New Zealand Emissions trading system - Forestry
Overview	• New Zealand's ETS has been operational since 2008. • It covers emissions and removals from all sectors of the New Zealand economy. Participants must report on their emissions and removals; those with net emissions must surrender sufficient New Zealand Units (NZUs) to cover them, while those who are net removers receive credits. Removers voluntarily choose to become fully integrated ETS participants in order to receive NZUs for their removals; they then would face liability for deforestation. • Forestry has been covered by the ETS since the origin of the policy. Forestry participants are included in two ways: mandatory inclusion of all land that was forested pre-1990; voluntary inclusion of unforested land/land forested post 1990. • In the year ending June 2022, there were 2378 forestry participants, who generated 5.6Mt CO_2-e of removals (NZ EPA, 2022).
Scope: emissions	• All gases: CO_2, CH_4, N_2O, SF6, HFCs, and PFCs • ETS covers all sectors (% of total reported emissions): Liquid fossil fuels (24%), Stationary energy (23%), Industrial processes (3%), Waste (1%), Agriculture (48%), Forestry - deforestation of pre-1990 forests (<1%). • Total of 2887 participants in the ETS; 2606 voluntarily opted in; 281 mandatory. • Agriculture has reporting obligations but no surrender obligation, though this will change by 2025. The government and agricultural sector have partnered to develop a pricing system for agricultural emissions, which is still being finalised.

Scope: removals	• Removals solutions: afforestation and "other removal activities" (no soil carbon, agroforestry, or improved forest management).
	  ◦ Forestry removals: Owners of land that was unforested pre-1990 can voluntarily opt-in to receive NZUs in return for removing carbon through afforestation (2021/22: NZUs equivalent to 5.6MtCO_2-e) (NZ EPA 2022).
	  ◦ Other removals credits: NZUs also awarded for producing substances with embedded GHGs e.g. methanol (2021/22 year: NZUs equivalent to 1.86 MtCO_2-e); or for exporting hydro-/perfluorocarbons[212], i.e. outside of New Zealand ETS scope (2021/22 year: NZUs equivalent to 0.83 MtCO_2-e) (*Ibid)*.
	  ◦ Removals credits account for 53% of total NZU surrenders in 2021/22 (*Ibid.)*

Removals policy model	Direct link: Integrated ETS
Link to polluter pays policy option	• Link: Direct link from polluter to removers in the form of removals allowance demand: Removers are fully integrated into the ETS. The units they earn for removals are NZUs, identical to those allocated by the government and those that polluters must surrender to meet removals obligations. Removers trade units in the open ETS market.

[212] These are largely offset by compliance obligations tied to import of hydro-/perfluorocarbons.

Reward type	• Reward type: Removers are rewarded with New Zealand Units – equivalent to one metric tonne of carbon dioxide equivalent emissions or removals – that can be sold at the market price. The price of an NZU in 2022 ranged between approximately €41-51 (Commtrade, 2023), though historically it has fluctuated, with prices in 2013 dropping below €2 (due to allowance demand being met by very cheap imported Clean Development Credits, which have since been excluded from the NZ ETS (Leining & Kerr 2016). The ETS has been revised to reduce price fluctuations, with annually increasing minimum auction prices and a trigger price for release of reserve units (ICAP 2023).

Environmental integrity elements: removals	• Removal Monitoring, Reporting, and Verification: Participants self-report removals, enforced and verified through random and targeted audits. Removals estimated using one of two methods:
	  • Small landowners (<100ha) self-report removals based upon forest size and a simple "look-up table" provides default carbon sequestration per ha estimates, based upon forest type (five tree species groups), age, and region.
	  • Larger landowners (>100ha) must carry out a "field management" assessment every five years (by the landowner or a consultant), which calculates removals based upon a random sample of plots within the forest, measuring slope, tree radius and diameter, tree height, species, forest management).
	• Removal permanence requirements: Foresters who are participants in the ETS are liable for any reversals of carbon storage, enforced through ongoing MRV requirements; if they deforest, they must purchase an equivalent amount of NZUs to cover their emissions. If reversal is unintentional (e.g. wildfire), they must only surrender emissions if they fail to replant.
	• Removal additionality requirements: All land unforested in 1990 is eligible to receive removals credits for all sequestration from 2008; i.e. all are assumed to be additional. No other additionality tests or requirements.
	• The New Zealand ETS has been criticised for generating only limited emissions reductions, principally due to low prices resulting from unlimited access to low cost Kyoto Protocol credits until 2012 and policy uncertainty (Leining, Kerr, & Bruce-Brand 2019). Even so, forest mitigation was 73% of ETS mitigation in 2020 (Carver et al. 2022). There are no controls to reduce forest mitigation deterring emissions reductions, with no quantitative or qualitative limits on forest-generated New Zealand Units (*Ibid.)*. As prices have increased since 2020 due to policy changes, there have been increases in afforestation, which is suggestive that forestry mitigation will continue to play role in New Zealand mitigation and supply of New Zealand Units, with a corresponding potential of deterring other mitigation at the margin.
	• The inclusion of forestry in the New Zealand Emissions trading system has been criticised for incentivising exotic forestry at the expense of native forests (which have higher biodiversity and social value, especially for indigenous communities) and for outcompeting agricultural land, leading to reduced food production, employment and export earnings (MPI & MfE 2022).
	For more information, see New Zealand Ministry of Primary Industries (2023)

Administrative burden	• Administrative costs: Overall, Leining and Kerr (2016) estimate that administration costs of the whole ETS between 2008 (beginning of policy) and 2016 were 38.9million NZD (23million EUR), with annual costs of 6.4million NZD (3.8million EUR). • Participant transaction costs: Larger landowners must carry out field management assessments every five years. In addition, participants face fees for registering land (500-4100NZD), annual emissions return fees (165NZD), and some other costs (NZ MPI 2022).
Governance	• Participating actors/point of obligation: individual foresters • Regulator/administrator: NZ ministries for the Environment and Primary Industry administer and regulate the market; New Zealand Environmental Protection Agency manage the ETS registry and all reporting.
Link and references	• Carver T, Dawson P, O'Brien S, Kotula H, Kerr S and Leining C (2022) Including forestry in an emissions trading system: Lessons from New Zealand. Front. For. Glob. Change 5:956196. doi: 10.3389/ffgc.2022.956196 • Commtrade (2023) Spot NZUs (webpage). https://www.commtrade.co.nz. Accessed 25.012.2023 • ICAP (2023) https://icapcarbonaction.com/en/ets/new-zealand-emissions-trading-scheme • Leining, Catherine and Suzi Kerr (2016) Lessons Learned from the New Zealand Emissions trading system. Motu Working Paper 16-06. https://rise.esmap.org/data/files/library/new-zealand/3%20Cross%20Cutting/CC21.1%20Lessons%20Learnt%20from%20NZETS_Motu_16_06.pdf • Leining, Catherine; Kerr, Suzi; Bruce-Brand, Bronwyn (2019). The New Zealand Emissions trading system: critical review and future outlook for three design innovations. *Climate Policy*. doi:10.1080/14693062.2019.1699773 • MPI & MfE (2022) Summary of submissions: Managing exotic afforestation incentives in the New Zealand Emissions trading system. Ministry for Primary Industries. https://www.mpi.govt.nz/dmsdocument/53635-Summary-of-submissions • NZ EPA (2022) ETS participant emissions OCTOBER 2022. https://www.epa.govt.nz/assets/Uploads/Documents/Emissions-Trading-Scheme/Reports/Emissions-returns/Participant-Emissions-Report.pdf • New Zealand Ministry of Primary Industries (MPI) (2023) About Forestry in the New Zealand ETS Resources (webpage). https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/about-forestry-in-the-emissions-trading-scheme/

A.2 California Air Resources Board Compliance Offset Program

Name	California Air Resources Board Compliance Offset Program
Overview	• California's Compliance Offsets Program has been operational since 2006, as part of the state's cap-and-trade scheme. • The Cap-and-Trade scheme sets a declining limit on emissions that cover approximately 85% of the state's emissions. The number of allowances equals the cap, or the total amount of permissible emissions. One allowance equals one metric ton of carbon dioxide equivalent emissions (using the 100-year global warming potential). • The California Air Resource Board issues ARB Offset Credits to qualified projects with certified reduction or sequestration of greenhouse gases (GHG), based on six Compliance Offset Protocols, approved by the Board, each defining an eligible removal or emission reduction method. • Compliance offsets are tradable credits representing emissions reduction or removals from sources not subject to a compliance obligation in the Cap-and-Trade Program. Compliance participants can surrender offset credits to meet a share of their compliance obligations under the cap and trade.

Scope: emissions	• Gases scope: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrogen trifluoride (NF3), and other fluorinated greenhouse gases.
	• The Cap-and-Trade covers:
	  ○ Electricity generation (including imports);
	  ○ Large stationary sources (including refineries, oil and gas production facilities, food processing plants, cement production facilities, and glass manufacturing facilities) that emit more than 25,000 tCO_2-e annually;
	  ○ Since 2015, distributors of transportation fuels, natural gas, and other fuels are also covered. Fuels exclusively for aviation or marine use are not covered.
	• Approximately 600 entities have reporting obligations, and approximately 400 of those have compliance obligations.

Scope: removals	• Removals solutions are restricted to the six methodologies defined as part of the Compliance Offset Protocols. This list includes afforestation, improved forest management, along with emissions reduction approaches:
	  ○ Rice cultivation projects: this protocol provides a method to quantify and report GHG emission reductions associated with changes in rice cultivation practices that would otherwise be released to the atmosphere as a result of conventional rice cultivation practices.
	  ○ US forest projects: this protocol provides a method to quantify GHG emission reductions and GHG removal enhancements associated with the sequestration of carbon achieved by increasing and/or conserving forest carbon stocks.
	  ○ Urban forest projects: this protocol provides methods to quantify and report GHG removal enhancements associated with a planned set of tree planting and maintenance activities to permanently increase carbon storage in trees.
	  ○ Livestock projects: this protocol provides a method to quantify GHG emission reductions associated with the installation of a biogas control system (BCS) for manure management on dairy cattle and swine farms that would otherwise be released into the atmosphere as a result of livestock operations from those farms
	  ○ Mine methane capture projects: this protocol provides methods to quantify GHG emission reductions with the capture and destruction of methane that would otherwise be released into the atmosphere as a result of mining operations.
	  ○ Ozone depleting substances projects: the protocol provides methods to quantify GHG emission reductions associated with the destruction of high global warming potential ozone depleting substances.

Removals policy model	Interconnected: External credits.
Link to polluter pays policy option	• Compliance offsets are tradable credits representing emissions reduction or removals from sources not subject to a compliance obligation in the Cap-and-Trade Program. Under the Cap-and-Trade, entities can employ the compliance offset credits to satisfy a share of their overall compliance obligation, called the quantitative usage limit, which varies per compliance period, ranging between 4 and 8% of the entities' overall compliance obligation.
Reward type	• Removals providers receive offset credits, which can be sold to compliance participants. Price levels for the cap-and-trade have been stable, increasing from a minimum of \$10/ton (current prices) to \$20 until mid-2021, with a maximum value of \$30.85/tonCO_2 reached in 2022.
Environmental integrity elements: removals	• The Offset Project Operator or Authorized Project Designee is responsible for project listing, monitoring, reporting, and verification. Additionally, all offset projects must submit to independent verification by ARB-accredited verification bodies at least once every six years. Since its inception, 663 forestry projects have been issued ARB credits. No information is available on Urban forest projects. • Removal permanence requirements: GHG offset projects involving biological carbon sequestration must address the potential reversibility of sequestered carbon, which is the loss of stored carbon after ARB or registry offset credits have been issued. Consistent with guidance from the Intergovernmental Panel on Climate Change, permanence is defined as 100 years (more information). • Removal additionality requirements:

	◦ The activities that result in GHG reductions and GHG removal enhancements are not required by law, regulation, or any legally binding mandate applicable in the offset project's jurisdiction, and would not otherwise occur in a conservative business-as-usual scenario; ◦ The GHG reductions and GHG removal enhancements resulting from the offset project exceed the project baseline calculated by the applicable version of the Compliance Offset Protocol under which the offset project has been listed (more information). ◦ The forest carbon offset methods have been criticised for systematically over crediting, that is, awarding certificates that are not matched by real, additional climate benefits (Badgley et al 2021). The forest offset method uses standardised baselines to determine eligibility and credit calculation, which effectively rewards any forest that goes beyond regional averages, rewarding project developer selectively developing projects using forests that are ecologically distinct in ways that mean they better regional averages (without additional action). Badgley et al (2022) estimate that 29% of forest offset credits are not matched by real climate benefits.
Administrative burden	• Administrative costs: data collection and analysis are pointed at as administratively burdensome for both the agency and the participants. Low administrative burden has been identify as a key priority.
Governance	• Participating actors/point of obligation: project managers of offset projects, whose eligibility is established by the protocols. • Regulator/administrator: California Air Resources Board, composed of 16 members that appointed jointly by the State's Governor and the Senate.
Link and references	• Badgley, G., Freeman, J., Hamman, J. J., Haya, B., Trugman, A. T., Anderegg, W. R. L., & Cullenward, D. (2022). Systematic over-crediting in California's forest carbon offsets program. Global Change Biology, 28, 1433–1445. https://doi.org/10.1111/gcb.15943 • California Air Resources Board, Compliance Offset Program, retrieved on February 21st, 2023 from: https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program • California Air Resources Board, Compliance Offset Protocol Livestock Projects, retrieved on February 21st, 2023, from: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2014/capandtrade14/ctlivestockprotocol.pdf • California Air Resources Board, Compliance Offset Protocol Rice Cultivation Projects, retrieved on February 21st, 2023 from: https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/protocols/rice/riceprotocol2015.pdf • California Air Resources Board, Compliance Offset Protocol Urban Forest Projects, retrieved on February 21st, 2023 from: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/copurbanforestfin.pdf • California Air Resources Board, Compliance Offset Protocol US Forests Projects, retrieved on February 21st, 2023 from: https://ww2.arb.ca.gov/sites/default/files/cap-and trade/protocols/usforest/forestprotocol2015.pdf • Witcover, J. et al. (2015) Achieving California's Greenhouse Gas Goals: A Focus on Transportation. Policy Institute for Energy, Environment and the Economy of the University of California, Davis, https://www.next10.org/sites/default/files/2019-07/achieving-california-ghg-goals.pdf#page=76

A.3 Australian Emissions Reduction Fund

Name	Australian Emissions Reduction Fund
Overview	• An Australian emission-trading scheme (ETS) was set up following the EU example in 2011, as part of the Clean Energy Act. The ETS was initially intended to cover 767 facilities, accounting for 80% of Australia's GHG emissions. The scheme covered the energy sector, major industrial activities, mining, domestic shipping, domestic aviation, rail transport and non-transport use of fuels, waste (accepted by landfills after 1 July 2012), and fugitive emissions. It did not include agriculture, forestry and land use, for which a separate system, linked to the ETS, was designed: the Carbon Farming Initiative (CFI) Act allowed for emission offset/removals projects that, if accepted, would lead to the issuance of Australian Carbon Credit Units (ACCUs) for the emissions abated or sequestered. Entities under the ETS could purchase ACCUs to meet their obligations. However, the Clean Energy Act was repealed in 2013, in the wake of a change of government. • The new government developed the Direct Action Plan, taking effect in 2015. The main tool within the plan is the Emission Reduction Fund (ERF), a financing instrument providing incentives to reduce emissions through investments to drive technological innovation. Under the ERF, the government purchases emission reductions offered by businesses, local governments, or others, mainly through reverse auctions. • The ERF replaced the CFI, extending the CFI model to also cover energy, industry, and transport. Instead of a market-based system, the government buys up ACCUs generated through emission-reduction projects. All pre-existing CFI projects automatically transitioned to the amended ERF. CFI methodologies remained largely unchanged. ACCUs can also be sold in the private market as voluntary offsets.
Scope: emissions	• As the ETS was repealed, there is no polluter pays ETS to fund removals (or emissions reductions). These are funded directly by the government through the ERF, which covers abatement projects that reduce or avoid emissions of methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2).
Scope: removals	• The ERF provides Methodology Determinations with rules for crediting emission reduction or carbon sequestration. To use the particular method and take part in the ERF, proponents need to apply to the Clean Energy Regulator. The Regulator develops the methods and manages project registration,

	compliance and crediting emissions reductions/removals for projects under the ERF. The following methodologies are relevant to the AFOLU sector (*removals in italics)*: ○ Avoided clearing of native regrowth; ○ Avoided deforestation; ○ Beef cattle herd management method; ○ *Estimating sequestration of carbon in soil using default values method;* ○ *Fertiliser use efficiency in irrigated cotton method;* ○ *Human-induced regeneration of a permanent even-aged native forest method;* ○ *Measurement based method for new farm forestry plantations method;* ○ *Measurement of soil carbon sequestration in agricultural systems method;* ○ *Native forest from managed regrowth;* ○ *Plantation Forestry method;* ○ Reducing GHG emissions in beef cattle through feeding nitrate containing supplements method; ○ Reducing GHG emissions in milking cows through feeding dietary additives method.
Removals policy model	Disconnected markets (note: initial proposal was for an 'Interconnected: External credits' system, but this did not eventuate due to the repealing of the ETS).
Link to polluter pays policy option	• There is no link with a polluter-pays option. Under the ERF, proponents enter into a contractual arrangement to sell ACCUs to the Australian authority (the Clean Energy Regulator, or CER), following a successful ERF auction (i.e. a carbon abatement contract).
Reward type	• There are two different types of carbon abatement contracts: ○ Optional Delivery contract provides the right to sell carbon abatement to the CER at an agreed price within a set time. This allows contract holders to manage their price and supply risks with a view to encourage more carbon abatement projects as a result. ○ Fixed Delivery contract sets the obligation to provide a set number of ACCUs at a set price for the duration of the contract. In case the agreed quantity cannot be delivered by one project, proponents can source the difference from other projects or from the secondary market.
Environmental integrity elements: removals	• Removal MRV description: Projects are only eligible when covered by an approved methodology. Depending on the methodology, all kinds of conditions must be met to ensure that emission reductions/removals are real and additional. The proponent of an eligible project must first seek a carbon abatement contract (Verschuren, 2017). After the proponent has secured the funds, the project as well as the reporting obligation commence. Reporting of projects is structured in periods of varying length (six months to five years for sequestration projects, and six months to two years for emission avoidance projects). The regulator can request audits from proponents with varying regularity. • Removal additionality requirements: as part of the Offset Integrity Standards, "abatement is permanent and additional to business as usual" (more information). • Removal permanence requirements: sequestration projects can have a 100 or 25 year permanence period depending on the methodology requested by the project applicant. A 5% discount applies on quantified removals, which is put aside as a permanence buffer; 25-year permanence period receives an additional 20% reduction in carbon credits to reflect that such projects selecting the 25-year permanence period are less likely to be long-lasting than 100-year projects (more information).
Administrative burden	• The MRV processes are usually run by consultants because of their complexity, which impacts costs for farmers (more information).
Governance	• Participating actors: any proponent entity wishing to partake in the ERF. • The Regulator (CER) issues ACCUs for GHG abatement undertaken as part of the ERF. The issuance of ACCUs is governed by the CFI Act 2011, the Carbon Credits (Carbon Farming Initiative) Regulations 2011 (CFI Regulations 2011) and the Carbon Credits (Carbon farming Initiative) Rule 2015) CFI Rule 2015. • The Emission Reduction Assurance Committee (ERAC) is an independent statutory committee that assesses and advises the Regulator on the compliance of methodology determinations (methods) against the Offsets Integrity Standards set out in the Act to ensure the continued integrity of the Emissions Reduction Fund.
Link and references	• Environmental Defense Fund (May 2015) The World's Carbon Markets: A Case Study Guide to the new Australian Emissions Reduction Fund, https://www.edf.org/sites/default/files/australia-case-study-may2015.pdf • Verschuuren, J. (2017). Towards a regulatory design for reducing emissions from agriculture: lessons from Australia's carbon farming initiative. *Climate Law*, *7*(1), 1-51. • Verschuuren, J. (2018). Towards an EU regulatory framework for climate-smart agriculture: the example of soil carbon sequestration. *Transnational Environmental Law*, *7*(2), 301-322.

A.4 ETS2 and Social Climate Fund

Name	ETS2 and Social Climate Fund
Overview	*Note: the ETS2 and Social Climate Fund do not incentivise removals. It is nevertheless useful as a model of how ETS revenue can be used to fund other social objectives.* • As part of the revision of the ETS under the policy reform package Fit-for-55, the system will be extended through the creation of a separate ETS covering emissions from road transport, buildings and additional sectors. In order to relieve some of the potentially regressive effects of carbon pricing on these sectors, a Social Climate Fund (SCF) will be established.

	• Active from 2026 until 2032, the SCF is proposed as a funding instrument to address vulnerable households, micro-enterprises and transport users. The eligible actions for funding include measures intended to increase energy efficiency of buildings, decarbonisation of heating and cooling (e.g. integration and storage in buildings of energy from renewable sources), and granting improved access to zero- and low-emission mobility and transport. • Each Member State submits to the European Commission a Social Climate Plan, comprising a set of proposed measures to reduce the vulnerability of households and businesses to increased fuel prices, while advancing the decarbonisation of these sectors.
Scope: emissions	• ETS2 will cover carbon dioxide (CO_2) emissions from fuels released for consumption in the buildings, road transport and additional sectors.
Scope: removals	• Removal activities are not covered or incentivized by the SCF.
Removals policy model	'No link: Disconnected' markets (revenue from ETS2 will be used to fund SCF activities but there is no effect on ETS2 supply of allowances).
Link to polluter pays policy option	• The proposal establishes that the SCF should be financed by the revenue generated from the auctioning of allowances under ETS2. • In principle, a maximum amount of EUR 65 billion should be made available for the implementation of the Fund for the period 2026-2032. • Measures providing temporary direct income support to absorb the increase in road transport and fuel prices shall not represent more than 37.5% of the estimated total cost of the Plan. • Moreover, Member States shall contribute at least to 25 percent of the total estimated costs of their Plans.
Environmental integrity elements: removals	• The proposed piece of legislation states that the measures included in the national Social Climate Plans should cause no significant harm to environmental objectives within the meaning of Article 17 of Regulation (EU) 2020/852 (Sustainable Finance Taxonomy), including significantly harming: ○ Climate change mitigation; ○ Climate change adaptation; ○ Sustainable use and protection of water and marine resources ○ The circular economy; ○ Pollution prevention and control; ○ The protection and restoration of biodiversity.
Administrative burden	• Currently, no information is available on the administrative and transaction costs associated with the measure, as it is not in place yet.
Governance	• Each Member State shall submit to the European Commission a Social Climate Plan. The Plan shall include national, and where relevant, regional and local measures and investments to address the impact of carbon pricing on vulnerable households, micro-enterprises and transport users. • Stakeholder inclusion: Member States shall submit to the Commission a Social Climate Plan following consultations with local and regional level authorities, representative economic and social partners, relevant civil society organisations, youth organisations and other stakeholders. • Member States are requested to provide milestones, targets and an indicative comprehensive timetable for the implementation of the measures and investments. • Note: Scarce information is available on the detail of Social Climate Plans, as they have only just been announced.
Link and references	• European Commission (December 18th, 2022) European Green Deal: EU agrees to strengthen and expand emissions trading, and creates a Social Climate Fund to help people in the transition; retrieved on the February 21st, 2023: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7796

A.5 Science-based Targets Initiative - Forest, Land and Agriculture (FLAG) target setting framework

Name	Science-based Targets Initiative (SBTi) – Forest, Land and Agriculture (FLAG) target setting framework
Overview	• The Science Based Targets initiative (SBTi) aims to enable companies to demonstrate leadership on climate action by developing and publicly committing to science-based GHG reduction targets. The standard is voluntary and global in its reach, with 4,000 companies setting targets or committing to do so via the SBTi as of end of 2022. • In September 2022, the SBTi released the Forest, Land and Agriculture (FLAG) target-setting framework, following the launch of its Net-Zero standard the previous year. The FLAG standard includes land-based emissions reductions and removals and applies to businesses in the land use sector or companies in other sectors with land use-intensive activities in their value chain. • The framework incorporates two approaches for determining the FLAG target: ○ a sector approach (absolute contraction), for companies with diversified emissions or those that are further from production. The FLAG sector pathway is based on a global mitigation target for the land sector of 13.9 $GtCO_2$-e/yr in 2050, including both emission reductions and removals, with a rate of mitigation of 3.03%/yr. Companies using the sector pathway have the flexibility to choose the most relevant mitigation options to meet their target. ○ a commodity approach (physical intensity convergence), for companies with focused commodity emissions. The approach is currently available for 11 commodities: beef, chicken,

	dairy, leather, maize, palm oil, pork, rice, soy, wheat, and timber & wood fibre. For each commodity, an intensity reduction rate is provided, and companies' actual targets depend on starting emissions intensity, projected growth in production and location of production/sourcing (pathways are available at a 26-region resolution). • From April 2023, integrating a FLAG target will be mandatory for companies making their first submission to SBTi.
Scope: emissions	• Gases covered on emissions side: CO_2 (Land-use change, on-farm machinery, biomass transport, fertiliser production), CH_4 (manure management, enteric fermentation, flooded soil, agricultural waste burning), N_2O (manure management, fertiliser application, leaching, run-off, crop residue, agricultural waste burning, fertiliser production) • Polluter pays sectors covered by policy: 1) AFOLU sectors: Forest and paper products (forestry, timber, pulp and paper); food production (agricultural production); food production (animal source); food and beverage processing; food and staples retailing; and tobacco; 2) Businesses in any other sectors with FLAG-related emissions that total more than 20% of gross overall emissions across scopes[213]. (Note: In-supply chain removals may be accounted toward a FLAG target, but not an energy/industry SBTi target). n the case of SMEs (non-subsidiaries with <500 employees), scope 3 targets are not required or validated by SBTi. • Number of participants: All companies that have already submitted their targets to SBTi and meet the above criteria will be required to set a FLAG target by 2023 or 2024 (depending on the date of the first submission), with the accompanying carbon removal sub-targets. Any business setting an SBTi Net Zero target must incorporate the FLAG approach.
Scope: removals	• Removals solutions: Forest restoration on working lands (e.g., silvopasture), improved forest management (e.g., optimizing rotation lengths and biomass stocks), agroforestry, enhancing soil organic carbon (e.g., implementing integrated crop-livestock systems), biochar amendments. • No hierarchy of actions / specific removals incentivised; „SBTi does not prescribe which specific mitigation actions a company should undertake, as long as GHG accounting is done in accordance with the GHG Protocol standards"
Removals policy model	Deductions
Link to polluter pays policy option	• The SBTi FLAG standard is an example of a model where upstream actors (e.g. processors, fertiliser manufacturers) can reduce their own compliance obligations by carrying out removals themselves or within their value chain, where GHG emissions stem from upstream or downstream sources and activities.
Reward type	• Reward type: The reward aspect of the implementation of carbon removals is not made explicit in the framework. Different scenarios are possible, e.g. where the reporting company either purchases and retires a removal credit from within its value chain or works with a supplier to increase removals in the value chain without a credit being generated.
Environmental integrity elements: removals	• Removal MRV description: Given the focus on target setting, SBTi does not generally mandate how mitigation actions should be implemented and monitored, as long as best practices are followed and GHG accounting is done in accordance with the GHG Protocol standards. Participants self-report and take responsibility for assurance. • The SBTi specifies that, to prevent the double claiming of carbon farming interventions, the company must be able to demonstrate that the farmers and their surrounding area haven't participated in (voluntary) carbon credit schemes, governmental carbon reduction schemes or any other supply chain decarbonizing schemes, with farmers counted in another company's scope 3. • Removal permanence requirements: In accordance with the GHG Protocol Land Sector and Removals Guidance, companies can only include CO_2 removals with ongoing storage and monitoring in net GHG targets. Further details on the specifications of ongoing storage will be elaborated based on the GHG Protocol. • Removal additionality requirements: Additionality is a quality criterion for credited GHG reductions and removals under the GHG Protocol; the SBTi framework does not introduce more specific requirements or safeguards.
Administrative burden	• Administrative costs: The SBTi provides target validation service on a fee basis, with target validation cost for non-SMEs ranging from \$9,500 to \$14,500 Validation service fees account for around 35% of SBTi's income needs, with further 20% of the total covered by project-specific funding dedicated to new guidance development and standard updates. Core funding accounts for the remaining 45% of income. • Participant transaction costs: Setting a SBTi FLAG target requires significant resources. Companies must develop or review their scope 1, 2 and 3 GHG inventories to ensure alignment with the GHG Protocol and the SBTi GHG emissions inventory, as well as partially covering SBTi administrative costs through the payment of target validation fees. Additional costs are likely to be associated with meeting reporting requirements and third party assurance.
Governance	• Points of obligation: Companies

[213] SBTI divide emissions into three scopes: scope 1 are direct emissions, scope 2 indirect emissions from energy, and scope 3 refer to all other indirect emissions (including, e.g. emissions from suppliers such as farms).

	• Regulator/administrator: SBTi validates the accuracy and relevance of the target submission, with mandatory target re-calculation and re-submission at least every 5 years. This includes assessing the carbon removal target projections against SBTi Criteria and Recommendations. However, SBTi does not currently verify annual disclosures on progress against targets or check the validity of carbon removal actions undertaken. Companies are individually responsible for reporting and assurance.
Link and references	• Science Based Targets Initiative (2021). Science based targets criteria and recommendations. Version 5.0. https://sciencebasedtargets.org/resources/files/SBTi-criteria.pdf • Science Based Targets Initiative (2022). Forest, land and agriculture science-based target-setting guidance. https://sciencebasedtargets.org/resources/files/SBTiFLAGGuidance.pdf • Science Based Targets initiative (2020). Science Based Target-setting Manual, Version 4.1. https://sciencebasedtargets.org/resources/files/SBTiCorporate-Manual.pdf • WRI & WBCSD (2022). Land Sector and Removals Guidance. Part 1: Accounting and Reporting Requirements and Guidance. Supplement to the GHG Protocol Corporate Standard and Scope 3 Standard. Draft for pilot testing and review. https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf

A.6 Alberta's Technology Innovation Emissions Reduction (TIER) system

Name	Alberta's Technology Innovation Emissions Reduction (TIER) system
Overview	*Note: the Alberta ETS does not currently have offset protocols that incentivise removals, with all protocols focussed on emissions reductions.*[214, 215] *It is nevertheless useful as a well-documented example of an offset system that targets the agriculture sector (for emissions reduction offsets).* • Alberta's current ETS is called Technology Innovation and Emissions Reduction (TIER), and is effective since 2020, though previous versions of the ETS system have been in place since 2003. It is one of the oldest carbon markets in the world. • Facilities are required to pay for the tonnes of emissions that go above their baseline through three different options: buying offsets from certified emission reduction projects in Alberta; by buying emissions performance credits (EPCs) from other facilities having produced lower emissions than their benchmark; or by paying a fixed fee into a technology fund of CAD \$50/tCO_2-e [€33], in 2022). • Facility-specific benchmark: a facility is required to reduce emissions intensity by 10% relative to the facility's historical production-weighted average emissions intensity. • 240 emissions reduction offset projects were developed for the ETS (as of 2018), generating 53.5 MtCO_2-e emission offsets between 2007 and 2020 in the ETS (about a quarter of the total compliance). The total emissions offsets generated by the agroindustry in 2020 amounted to 0.3 MtCO_2-e and 6.2 MtCO_2-e for the fertilizer industry (2020).
Scope: emissions	• Gases: Agricultural Nitrous Oxide Emission (N_2O), CO_2, CH_4, HFC, PFC, SF_6 • The ETS covers the following sectors: oil, gas and coal production facilities, refineries, hydroelectricity facilities, metal and mineral industry, food processing, agroindustry, fertiliser industry, forest products facilities, chemical industry. Only facilities emitting more than >100,000 tCO_2-e/year in 2016 or subsequent years can take part in the TIER system.

[214] The template differs slightly from the other case studies to reflect that no removals are incentivised, only emissions reductions (italics indicate changes to template).
[215] The Alberta emission offset programme previously had a protocol that rewarded removals: the Quantification protocol for conservation cropping, which was discontinued in 2021.

Scope: *emissions reductions*[216]	• Alberta's ETS offset system has protocols for 18 emissions reduction activities, including five agriculture-related activities: agricultural nitrous oxide emission reductions, biofuel production and usage, biogas production and combustion, reducing greenhouse gas emissions from fed cattle, selection for low residual feed intake markers in beef cattle. • Example protocol: the Agricultural nitrous oxide emission reductions protocol • Scope is limited to on-farm reductions of emissions from nitrogen sources and fuel use associated with the management of synthetic fertilizer, manure fertilizer and crop residues. • Projects generate carbon offsets by switching to a so-called set of "Beneficial Nitrogen Management Practices" (BMPs) for annual cropping systems. These management practices are integrated into a plan called the 4R (Right Source at the Right Rate, the Right Time and the Right Place) Nitrogen Stewardship Plan. This plan aims at optimising crop response per unit of added nitrogen, minimising the risk of nitrate to accumulate in the soil and potentially denitrify or be emitted as N_2O, or be lost through leaching or runoff. Examples include cover cropping, conservation tillage, buffer strips. • Emission reduction projects run on an eight-year crediting period, with the ability to have a five-year crediting period extension. • Number of participants: in 2018, 54 approved project applications, including 5 in the agroindustry.
Emissions reductions policy model	Interconnected: External credits
Link to polluter pays policy option	• Reward type: • Offset restrictions: ETS facilities can meet a maximum of 60% of their total compliance obligation per year using emissions performance credits and emissions offsets. The TIER ETS introduced in 2020 allows more credits to be used than previously (maximum limit of flexibility credits went from 30% to 60%).
Environmental integrity elements: *Emissions reductions*	• Before the protocol is approved, it has to go through a technical review to ensure environment integrity of the project and check consistency of the life cycle analysis approach applied to the reduction or sequestration activity. • Example protocol: the Agricultural nitrous oxide emission reductions protocol: • There are 3 levels within the 4R Stewardship Plan (see above). For the basic level, nitrogen must be applied following recommendations of the plan. For the intermediate level, nitrogen is applied according to qualitative estimates of field variability (landscape position, soil variability). For the advanced level, nitrogen is applied according to quantified field variability (e.g., digitized soil maps, grid sampling, satellite imagery, real time crop sensors). • Carbon offset quantification is calculated on a mass basis using nitrogen inputs and crop mass per crop type across the farm enterprise at field or farm level. • Removal permanence requirements: The likelihood of reversal needs to be assessed during protocol development, based on historical data and future projections. A percentage based multiplier can be applied to emissions reductions based on the likelihood of reversal: 'risk-based assurance factor' or 'discount factor'. • Removal additionality requirements: during the technical review stage, the protocol developer must be able to demonstrate that the reduction or sequestration activities result in an emission reduction or sequestration of greenhouse gases that is additional to business as usual. More info here.

[216] Note: Removals are not incentivised through the offset option; only emissions reductions are recognised.

Administrative burden	• Administrative costs: Facilities emitting >100,000 tCO_2-e/year are required to submit annual compliance reports. Facilities emitting >100,000,000 tCO_2-e/year are also required to submit an annual forecasting report. Annual compliance reports are required to be verified by a qualified third-party assurance provider. • Offset provider transaction costs: Projects must be able to provide sufficient records to justify the emission reductions being claimed. Documentation on field practices and data farm records have to be made available to a third party verifier and government auditor upon request. Agricultural professionals assist farmers in designing and implementing the 4R Plan. These professionals must be trained and accredited to apply the protocol
Governance	• Participating actors/point of obligation: project developer for the offset project • Regulator/administrator: Alberta government
Link and references	• Alberta Government (2015) Quantification Protocol for Agricultural Nitrous Oxide Emission Reductions, Specified gas emitters Regulation. https://open.alberta.ca/dataset/a2985519-ee0b-4b70-92a6-bdd46f7dfffc/resource/4e3f1503-5dca-40c4-9a63-2a8a7bfb7f27/download/7145865-protocolnitrousoxidereductions-sep2015.pdf • Alberta Government (2023) Alberta's Cap and Trade Program. https://lpdd.org/resources/albertas-cap-and-trade-program/ • Alberta Government (2018). Technical Guidance for Offset Protocol Development and Revision, Alberta Government, July 2018 https://perma.cc/4K66-9LJZ • Carvalho et al (2021). Offset approaches in existing compliance mechanisms – Adding value and upholding environmental integrity? German Environment Agency. https://www.carbon-mechanisms.de/fileadmin/media/dokumente/Publikationen/Bericht/cc_58-2021_offset_approaches_in_existing_compliance_mechanisms.pdf • Alberta Climate Change Office (2018). 2018 CCIR Compliance and Offset Workshop. https://www.alberta.ca/assets/documents/aeos-2018-ccir-compliance-offset-workshop-presentation.pdf • Alberta Government (2020) TIER regulation fact sheet. https://www.alberta.ca/assets/documents/ep-fact-sheet-tier-regulation.pdf

A.7 French CAP strategic plan agri-environment climate measure (AECM) "Transition of practices" reduction of carbon footprint (70.27)

Name	French CAP strategic plan agri-environment climate measure (AECM) supporting the "Transition of practices" specifically the reduction of the carbon footprint (70.27)
Overview	• Agri-Environment-Climate Measures 70.27 is an environmental and climate flat rate payment that supports farms' ecological transition using a results-based payment. Farmers receive a personalised assessment to assess the results achieved at the end of the period compared to an initial diagnosis. Agricultural GHG emissions reduction is one of the three pathways that farmers can choose to receive the flat-rate payment, along with pesticides reduction and feed autonomy. • Farms are required to achieve a minimum 15% improvement in the carbon footprint of the farm over a contract period of 5-7 years. Methods for reaching the emissions reduction are not specified in the CAP strategic plan. • AECM 70.27 is a new measure, part of France's CAP funding allocation for the period 2023-2027. The total budget for this measure amounts to approximately 135 million euros over 5 years. This approach is innovative within the CAP: instead of paying farmers for implementing practices on a certain area of land, the partly results-based payment depends on farmers demonstrating that they have improved or achieved better climate results.

	Note: While this measure focuses (inter alia) on emissions reduction, and is not linked to an Emissions trading system, it illustrates a novel results-based approach within CAP that could be a model for funding removals through CAP using public revenue. Some key information about its implementation are not yet known.
Scope: emissions	• Gases: CO_2, CH_4, N_2O • Sectors: Agriculture • Number of participants: All CAP participants within France. CAP Indicator R16 on climate-related investments in farms provides a rough estimate of the number of farms that will benefit from the payment for emissions reduction between 2023 and 2029, amounting to an estimated 3266 farms. Note: this also include farmers receiving payment for the pesticides reduction or feed autonomy pathway.
Scope: removals	• Removals solutions: None; this measure does not target removals
Removals policy model	Disconnected markets
Link to polluter pays policy option	• This measure illustrates how government revenue can be used to deliver agricultural mitigation; revenue raised from a polluter pays ETS could provide this revenue.
Reward type	• Reward type: Farmer receives a flat rate payment if the 15% result indicator is met at the end of the contract. The flat-rate remuneration is calculated from the average characteristics of French farms (average UAA in particular). The amount is set at €18,000 per farm over a period of 5 years, i.e. €3,600 per year. This can potentially be adjusted according to the size of the holding through flat-rate aid.
Environmental integrity elements: removals	• MRV description: Farmers must submit to two GHG emissions assessments: at the beginning and end of the commitment period. In addition, they must develop an action plan, and record their practices and commit to two half days of follow-up. • Removal additionality requirements: The eligibility of beneficiaries will be judged in the light of other commitments already implemented on their farm in order to avoid duplication of funding for the same actions. e.g. farms already contracted to implement an agri-environment climate measure on a large area of the farm (90% of arable land and/or grassland).
Administrative burden	• Participant transaction costs: As the measure is implemented through CAP frameworks, most likely that for beneficiaries, additional administrative costs would be quite low as they probably already are CAP beneficiaries. Farmer will face additional and potentially substantial monitoring, reporting and verification costs. Since the payment is based on the achievement of the reduction target, farmers having failed to achieve this target will receive no payment despite administrative costs. • Administrator costs: Measure implemented through existing CAP frameworks with systems in place to monitor beneficiaries, potentially lowering additional costs. Administration will face additional and potentially substantial verification costs.
Governance	• Participating actors/points of obligation: Individual farmers • Regulator/administrator: Government
Link and references	• Ministry of Agriculture, Agrifood, and Forestry of France (2022). French CAP strategic plan. https://agriculture.gouv.fr/pac-2023-2027-le-plan-strategique-national • Midler and Pagnon (2023). Environment and climate assessment of France's CAP Strategic Plan. https://ieep.eu/publications/environment-and-climate-assessment-of-frances-cap-strategic-plan/

A.8 New Zealand He Waka Eke Noa Deductions proposal

Name	He Waka Eke Noa – Deductions proposal
Overview	• He Waka Eke Noa is a collaboration between the NZ government, the primary sector, and the Māori[2] agribusiness to address agricultural GHGs. They have come up with a proposal to introduce an on-farm levy on agricultural and LULUCF emissions in New Zealand by 2025 while deducting emission reductions and carbon removals. The proposal covers all GHG emissions (CH_4, N_2O, CO_2) and removals from the agriculture sector and a subset of the LULUCF sector. • Milestones until 2025 are: 25% of farms knowing their emissions and removals numbers by 31 December 2021, and 100% by 31 December 2022, 25% of farms having a written plan by 1 January 2022, and 100% by 1 January 2025. • The initiative came from the private sector in 2019 in response to the Governments plan for the primary sector to join the ETS. *Note: This case study summarises the recommendations by the He Waka Eke Noa partners. Their proposal is still under discussion and has not yet been agreed to or implemented by the government so this proposal may not become law exactly as described. It nevertheless offers a useful overview of how a deductions policy could be designed.*
Scope: emissions	• All GHG: CH_4, N_2O, CO_2 • Covers emissions and removals from the agriculture and some of the LULUCF sector: exempt are emissions from wetlands and removals from arable and grassland (i.e. soil carbon). The levy covers farms with an annual average of over: 550 stock units (sheep, cattle, deer and goats); OR 50 dairy cattle; OR 700 swine (farrow to finish); OR 50,000 poultry; OR 40 tonnes of nitrogen through synthetic nitrogen fertilizer application. This definition covers all farms that emit over approx. 200 tonnes CO_2-e per year, which are around 23,000 farms and around 96% of all agricultural GHG emissions. • As of 31 August 2022, the partnership has achieved 18,288 number of farms (which are 75% of total farms) holding a documented annual total of on-farm greenhouse gas emissions, and 8,501 number of farms (which are 35% of total farms) having a written plan to measure and manage their greenhouse gas emissions[3].
Scope: removals	• Removals solutions: 1) Permanent vegetation - including planted or regenerated indigenous vegetation that would not be harvested and is generally self-sustaining through self-seeding. Land must remain in permanent vegetation and not be cleared. 2) Cyclical vegetation - defined as vegetation that is planted and may be felled and re-established. This includes: Perennial crops, Scattered forests, Shelterbelts and Woodlots. • Only indigenous vegetation will be rewarded (based on the April 2021 NZ ETS eligibility criteria) would not be eligible for the system). • Permanent indigenous vegetation established before 1 January 2008: will be rewarded with an annual rate based on additional sequestration from management action. • Indigenous vegetation or riparian vegetation established on or after 1 January 2008 will be rewarded with an annual sequestration rate based on yearly accumulation of carbon. • Cyclical vegetation established on or after 1 January 2008 will be rewarded by recognising the long-term average carbon stock. • Larger forestry planting is already rewarded through the New Zealand ETS.
Removals policy model	Interconnected: Deductions
Link to polluter pays policy option	• Link: Polluter is remover through deductions of emission reductions and removals. Farms calculate their short- and long-lived gas emissions, then calculate on-farm sequestration (and approved emission reduction actions) and discounted this from their compliance obligation.
Reward type	• Reward type: Reward is a deduction from compliance obligation; Farms are provided with a payment or credit if removals are greater than emissions, . The price for sequestration is different from the levy rates for emissions. Recommendation is that the initial price for sequestration be linked to the NZ ETS carbon price but be discounted (around 75–90% of the NZ ETS carbon price i.e., a discount of around 10-25%). Note, it appears that this would be a different (much higher) price than the levy price faced by farmers for emitting (which is proposed to be set at approximately 5% of the ETS price). • The price of an NZU in 2022 ranged between approximately €41-51 (Commtrade, 2023), this would imply a removals payment of €30.75- €45.9.

Environmental integrity elements: removals	• Removal MRV: Sequestration will be reported annually. Sequestration can be calculated for a five-year period, then annualised to align with reporting timeframes in an emissions report. Sequestration rates will need to be determined by experts. • Removal additionality requirements: Additionality is defined as sequestration that is 'new' or additional to what would have happened under business-as-usual practices. Two ways are considered to meet additionality: 1) setting a baseline year, so any sequestration in vegetation established on or after the baseline year is considered additional or 2) By setting a baseline of 'business-as-usual management', so that any sequestration associated with active management is considered additional. • Removal permanence requirements: For permanent vegetation, farms will face financial liabilities if the vegetation areas registered are cleared. For cyclical vegetation, farms will face financial liabilities if vegetation is cleared and not replaced within five years, or there is a land-use change, and no replanting occurs. If vegetation is damaged or destroyed by an adverse event, the farm will not face any penalty, but will no longer receive recognition for the sequestration in that area until vegetation reaches the same state it was before the adverse event.
Administrative burden	• Total establishment cost: ▪ Farm level levy: \$114m-\$144m. This includes the development of the system alongside the first two years of operation. (This includes the polluter pays side, as well as the removals deduction) • Annual average operating cost (2025-2027): ▪ Administrative costs: \$32m-\$36m ▪ Farmers transaction costs: \$19m (additional time spent by farmers collating data and reporting • Annual average operating cost (2027-2030): ▪ Administrative costs: \$43m-\$47m ▪ Farmers transaction costs: \$27m-\$37m
Governance	• He Waka Eke Noa is a collaboration between the NZ government, the primary sector, and Māori agribusiness. • The Government is in the process of considering the proposal and recommendations. They are not signatories to the recommendation. • The partners have appointed a steering group to provide oversight and ensure delivery of milestones. There are 8 steering group members which represent: Independent chair, Ministry of Environment, Ministry for Primary Industries, Federation of Māori Authorities Te Aukaha, DairyNZ, Agrifood processors, Beef + Lamb New Zealand and Horticulture New Zealand. • The preferred partnership approach will involve four entities with key roles and responsibilities: An implementation agency including science and implementation panel, a system oversight board including an independent Māori board and Ministers. • The point of obligation is a levy on emissions at farm-level for all farms that are GST (Goods and Services Tax) registered. Exempted are small-scale farmers that do not meet the minimum requirements set out in the section "scope: emissions". • A progress report is issued every six months.
Additional lessons	• The initiative came from the private sector in 2019 in response to the Governments plan for the primary sector to join the ETS. • The initiative highlights that the price on emissions should stay as low as possible. • A collaboration between the government, the primary sector and Māori farmers to reduce agricultural GHG emissions can be considered as novel.
Link and references	• Commtrade (2023) Spot NZUs (webpage). https://www.commtrade.co.nz. Accessed 25.012.2023 • He Waka Eke Noa (2022) Recommendations for pricing agricultural emissions. Report to ministers. Available at: https://hewakaekenoa.nz/wp-content/uploads/2022/06/FINAL-He-Waka-Eke-Noa-Recommendations-Report.pdf • He Waka Eke Noa (2022) Six-month progress report. April 2022 – September 2022. Available at: https://hewakaekenoa.nz/wp-content/uploads/2022/09/He-Waka-Eke-Noa_Six-Month-Progress-Report_September-2022.pdf • Website available at: https://hewakaekenoa.nz/

A.9 Practical example selection

	Market design	Buyer of removals	Seller of removal	Examples	Selected Y/N	Justification for selection
Direct link: polluter - remover	• Integrated ETS	• AFOLU Polluter: Farmer/ processor/ fertiliser	• Any (eligible) LULUCF remover	• NZ ETS forestry	• Y	• Large, well-established removals policy, well-documented
				• NZ ETS Permanent Forest Sink Initiative	• N	• Smaller than NZ ETS forestry; discontinued
	• Interconnected: External credits	• AFOLU Polluter: Farmer/ • Processor • /fertiliser	• Voluntary eligible LULUCF remover, outside of ETS scope	• Alberta Offset program	• Y	• Well-documented offset market; uses ETS revenue to fund farmer mitigation (incl. nitrous oxide emissions, not removals)
				• Quebec Carbon Market offset programme	• N	• Includes agriculture, similar to Alberta, less well-documented
				• California Air Resources Board Compliance Offset Program (forestry)	• Y	• Large international example of offset policy
				• Regional Greenhouse Gas Initiative (USA)	• N	• Very few offset projects/credits
				• China Certified Emissions Reductions (CCERs) - link to China and Regional China ETSs	• N	• Poorly documented; difficult to find evidence, reporting
				• Saitama ETS forestry absorption credits	• N	• Small scale
				• Pan-Canadian Approach to Pricing Carbon Pollution	• N	• Includes proposal for offsets, less well-documented that Alberta.
				• Pennsylvania nutrient credit trading program	• N	• Not emissions focussed

Indirect link: Polluter - government - remover	Interconnected: through government	Government as intermediary (on behalf of/using polluter payments)	Any (eligible) LULUCF remover	Oldfield et al. (2021): Jurisdictional approach to soil carbon removals?	N	Theoretical rather than practical case study; not EU-specific
				Australian Emissions Reduction Fund (focus on initial design linked to Australian ETS)	Y	Large public policy. Covers both indirect link and ‘No link: Disconnected’ market, as currently exists without ETS link but initially proposed to link to Australian ETS
‘No link: Disconnected’ market	Disconnected markets	Government	Any (eligible) LULUCF remover	CAP - French Strategic Plan result-based payment example	Y	Interesting example of new results-based payment for climate mitigation
				ETS2 and social climate fund	Y	EU context. Interesting to understand how social climate fund is linked to ETS2
				USA Inflation Reduction Act - agriculture elements	N	Funding does not arise from ETS or implementation of polluter pays.
No link: Polluter is remover	Deductions	Farm ETS: polluter gets deductions on own emissions liability (no buyer/seller)		Farm ETS: NZ: He Waka Eke Noa farm “deductions”	Y	Well-developed public sector example, good match for AgETS+Removals scope
		Processor/ fertiliser ETS: processor	Farmers within supply chain	SbTI FLAG	Y	Well-developed, private sector
				California Low Carbon Fuel Standard	N	Interesting as alternative to AgETS policy options; less relevant for AgETS+Removals

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