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Analysis of the European Commission proposal for revising the EU LULUCF Regulation

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1 Introduction

1.1 Background and aim of the paper

Under the European Green Deal, the European Union (EU) has committed to achieve net-zero greenhouse gas (GHG) emissions by 2050 and set a more ambitious climate target of net-55% emissions reductions by 2030 compared to 1990 levels. Both of these ambitions rely fundamentally on the role of natural sinks from the Land Use, Land-Use Change and Forestry (LULUCF) sector to compensate residual emissions. But they also come at a time in which the EU's natural sinks are in decline. Over the last decades, the EU's net-removals have fallen from a peak of -329 Mt CO_2eq in 2009 to -243 Mt CO_2eq in 2019 (European Union 2021), mainly due to an increase in forest harvesting rates, including for bioenergy. Achieving the EU's climate goals will thus require reversing this negative trend and securing a strong contribution from the land-use sector towards the EU's climate-objectives.

For this to be achieved, climate change mitigation in the land-use sector needs to reduce risks to environmental integrity. Environmental integrity is achieved by ensuring that aggregated global GHG emissions do not increase as a result of a mitigation activity or implementation of instruments. Among the most discussed risks to environmental integrity are **additionality** of mitigation measures, **non-permanence** (reversals) of emission reductions or removals, uncertainty in **monitoring** and risk of incomplete reporting, but also the challenge of ensuring other environmental and social **safeguards**.

The paper addresses national and EU policymakers, experts and NGO-representatives looking for an interpretation of the European Commission's (EC) proposal for a revised LULUCF Regulation and other suggestions for revisions currently published. The aim of this paper is fourfold: First, it aims to present an overview of the EC proposal for the revision of rules for treating the LULUCF sector under the EU's climate policy. Second, it discusses central assumptions that are underlying the Impact Assessment and other policy documents that form the basis of the proposal. Two case studies of national level perspectives on these assumptions are meant to complement the analysis. Third, we draw on the analysis to identify remaining risks for the environmental integrity of the EU's policy architecture from and during further integration of the land-use sector into the EU's climate policy. Finally, we review the proposed amendments of the LULUCF Regulation in the draft report of the rapporteur in the European Parliament ENVI Committee and draw initial conclusions.

1.2 A paradigm-shifting proposal

On July 14, 2021, the European Commission published in the Communication COM(2021) 554 final[1] its proposal for a revision of the EU LULUCF Regulation EU (2018/841). The proposal can be considered a gradually performed **paradigm shift** regarding the treatment of the LULUCF sector in the EU's climate target architecture. The paradigm shift is five-fold:

The first paradigm shift is related to the **rules for accounting of LULUCF**. Since the first recognition of land-use activities under the Kyoto Protocol climate policy regime, emissions and removals from the sector were treated differently from other sectors. This LULUCF accounting approach consisted of different reference values for different land use categories, including also caps to emissions and removals that could be accounted for (Böttcher et al. 2019). The revised Regulation overcomes any

[1] https://ec.europa.eu/info/sites/default/files/revision-regulation-ghg-land-use-forestry_with-annex_en.pdf

special treatment of LULUCF emissions and removals and, after 2025, introduces an accounting system relying only on **reported emissions and removals**.

Second, as a consequence of paradigm shift one, the revised Regulation for the first time formulates **absolute EU and national binding targets** for the period 2026 to 2030. For the EU it is based on projections of emissions and removals for LULUCF under policy scenarios and supposed to reflect cost efficiency of mitigation measures in the sector. The national targets are instead based on historic reported emissions and removals and therefore sensitive to accuracy of GHG reporting data, in particular in Member States whose existing monitoring approaches need to be significantly improved to ensure accurate annual tracking of progress.

Third, the proposal foresees establishing a **land-use pillar** that includes both LULUCF emissions and removals and non-CO_2 emission from the agriculture sector (also referred to as the AFOLU sector, Agriculture, Forests and Other Land Use). This step was discussed in earlier proposals of the LULUCF climate policy in the EU but rejected due to assumed uncertainty in LULUCF GHG monitoring. The Commission sees now arguments for this integration to simplify accounting, increase flexibility for Member States, and treat related fields of mitigation in a common framework.

Fourth, the proposal lays the ground for even more **fungibility of fossil and biogenic carbon**. In the mid-term future, there will no longer be a “firewall” between emissions and removals from the land-use sector with emissions from other sectors. The existing LULUCF Regulation allowed for limited flexibilities between LULUCF and the Effort Sharing sectors (including Agriculture, Transport, Buildings and Waste, as well as non-ETS Industry). The revised Regulation sets the stage for a more and more integrated architecture with full fungibility for Member States between sectors and mitigation strategies post 2030 and towards the implementation of the Paris Agreement with challenges related to such fungibility that can potentially harm environmental integrity.

Finally, the **integration of LULUCF in the overall 2030 EU climate target** and the EU Climate Law[2], significantly increases the visibility of the sector by making LULUCF a relevant component for achieving the GHG emission reduction target of -55%. This visibility comes also with an increased risk of non-compliance both for EU and individual Member States as some categories of inventory data on LULUCF show significant levels of uncertainty.

The proposal also aims at **enhancing quality of monitoring and reporting** of emissions and removals from LULUCF motivated by the much more prominent role of the sector in the EU’s integrated net emissions reduction target based on GHG inventories. Moreover, the Commission strives for more coherence with other EU policies that also rely on land monitoring – such as the Common Agricultural Policy, Habitat Directive, etc. This is to be achieved by Member States through the use of geographically explicit data layers with relevance to these policies and listed in Annex III of the proposed Regulation.

Here, we analyse the proposal and associated documents by first providing an overview of suggested changes to the regulation. In a second step central assumptions in analyses and scenarios underlying the proposal are reviewed and discussed, with an emphasis on those related to costs. For a better illustration, in two case studies we contrast central assumptions of the proposal with national perspectives on mitigation potentials and projections of the LULUCF sector in Germany and Finland. Next, we identify some remaining risks to the environmental integrity of the LULUCF Regulation based on our discussion of the five paradigm shifts. Finally, we review the draft report of

[2] The EU’s 2030 climate target of -55% greenhouse gas emission relative to 1990 levels is a ‘net’ target that includes LULUCF in the base year and target. This is a shift

the rapporteur for the file in the European Parliament's ENVI committee to assess how his amendments modify or reverse the European Commission's proposals.

2 Overview of proposed LULUCF revision

In the following we present an overview of suggested changes to the regulation and briefly analyse general implications.

2.1 Rules for accounting and flexibilities

For the first period of 2021-2025 covered by the proposal, the original land accounting categories of the LULUCF Regulation 2018/841 remain in place (e.g. afforested land)[3]. This means the EU-wide and national "no-debit" target will be limited only to the first period (see Figure 2-1, panel B). Achieving the target corresponds to a net sink of about -225 Mt CO_2 for the EU.

After 2025 the accounting rules for LULUCF will be simplified and further trimmed to the reporting categories that Member States already provide with their reporting obligations under UNFCCC[4]. These include reporting categories as set out in the Common Reporting Format in which industrialised countries globally document their GHG inventories. This means that accounting rules will become more transparent and reconcilable as especially projected baselines (Forest Reference Level) and different historic reference periods (Grasslands, Croplands, Wetlands) will disappear.

The current LULUCF Regulation also includes different types of flexibilities to help Member States deal with uncertainty, natural disturbances and reduce the risk of non-compliance that will still be applicable for the first period. These flexibilities remain but are modified and in part restricted in the European Commission's reform proposal. For example, **general flexibilities** to exchange units between Member States and for individual Member States between Effort Sharing Regulation (ESR) and LULUCF remain, while notably banking over subsequent periods is no longer allowed (Art. 12). A **managed forest land flexibility** continues to allow for a compensation for Member States that face debits from accounting of a forest sink against the Forest Reference Level but is now limited to the 2021 to 2025 accounting period (Art. 13). Moreover, **natural disturbances** can still be excluded from accounting for the first period, if they exceed a certain historic margin of disturbance emissions documented by the Member States.

At the same time, the Commission also proposes a new **land use flexibility mechanism** (Art. 13b) for the years 2026 to 2030 aimed at transferring some of the flexibility options from the first period. The scope of flexibility is extended to all land use categories. The flexibility can be used by Member States that do not meet their target, provided that overall, the sector forms a net sink in the country and the EU as a whole achieves its target. Moreover, the flexibility is capped at 178 Mt CO_2eq. for all Member States with national maximum amounts provided in Annex VII. The proposal allows Member States to compensate deviations from the target that can be attributed to natural disturbances, such as pests, fire, storms, etc. Criteria for how to provide evidence for such events are included in Annex VI of the original Regulation.

[3] As foreseen by the previous Regulation, wetlands can voluntarily be included in the accounting. The option is selected by two Member States, including Germany.

[4] This implies changes for some aggregate land use categories used for accounting (e.g. land converted to forest land).

Conclusion: The Commission proposal keeps and modifies many of the flexibilities from the existing LULUCF Regulation, while in part significantly tightening them and notably excluding the banking of units to use for compliance beyond 2030. The revised approach also moves ***accounting closer to reporting****, reduces efforts for constructing and reviewing reference levels and increases transparency. Establishing a mandatory accounting of the most important land use categories closes loopholes of the KP that allowed an imbalanced accounting of sinks. Moreover, the accounting against projected reference values for forests "masked" a decline of carbon sinks in EU Member States. The full and consistent accounting of land-based carbon increases value of carbon storage for landowners, farmer and foresters. It also makes EU accounting more consistent with international rules of UNFCCC reporting.*

2.2 Absolute EU and national binding targets

The major change after 2025 is that an EU-wide target is set to -310 Mt CO_2 by 2030. It constitutes an **absolute target based only on reported data** and without applying accounting against references (see above). This implies an increase of 85 Mt CO_2eq compared to the no-debit target that was assumed to correspond to a target of -225 Mt CO_2eq. It includes binding national targets for Member States in a table in Annex IIa that are based on the GHG inventory for the years 2016, 2017 and 2018 and the share of total EU land area. From 2026 to the 2030 target there will be a linear trajectory, with a starting point in 2022, to be followed by countries. This is a complete change of target setting with implications for Member States that for the first time will have to comply with **absolute targets in the LULUCF sector**.

Conclusion: Already under the 2018 LULUCF Regulation annual compliance targets existed for EU Member States ("no-debit"). The paradigm shift in the new proposal lies in that the targets form absolute values of net removals (for some Member States net emissions) and that these targets have been derived from historic inventory data.

2.3 Land-use pillar

For the period post-2030, the Commission proposes establishing a **land use pillar**. In practice this would entail that the scope of the new framework for the land sector will combine LULUCF emissions and removals with non-CO_2 emissions from the agriculture sector from 2031 onwards. Furthermore, for the combined sector the Commission foresees a **GHG neutrality target by 2035**. In other words, GHG net-emissions of both sectors need be reduced to zero by that date. In 2025 EC will propose EU-wide measures for post-2030 period, based on Member States reports. No further flexibilities beyond 2030 have been specified so far. It thus remains unclear whether after 2030 there will still be flexibilities with other ESR sectors. The proposal envisages a "robust carbon removal certification system" with sectors beyond agriculture that "have exhausted their emissions reduction possibilities" or more than 90% emission reductions achieved that could participate in a carbon market mechanism.

Conclusion: The European Commission's 2050 Long-term Strategy and comparable analyses of pathways to climate-neutrality rely substantially on LULUCF removals to generate negative emissions and compensate for residual emissions in other sectors. A joint land use sector implies ***full flexibility between LULUCF and Agriculture*** *after 2030. The integration of agriculture is likely to represent only a first step towards a more comprehensive integration of the land sector with other sectors in the period after 2035.*

2.4 Fungibility of fossil and biogenic carbon

With the formation of a land-use sector including agricultural emissions, the proposal also prepares for full fungibility of fossil and biogenic carbon through carbon markets and makes reference to the Paris Agreement that sets out the target of achieving "*a **balance between anthropogenic emissions by sources and removals by sinks** of GHG in the second half of this century*". Since land-use emissions and removals were first brought into the architecture of international climate policy, there has existed a "firewall" between volatile, non-permanent, and to a large degree not directly human-induced and relatively **uncertain biogenic emissions** on the one hand, and removals from the land-use sector and continuous, purely anthropogenic and rather easily measured fossil emissions on the other hand. This firewall was created due to fears that countries could prefer land-based mitigation measures over required fossil emission reductions and thus exchange carbon stored in permanent fossil reservoirs with carbon in vulnerable biomass and soil pools.

Conclusion: Dealing with non-permanence risks in accounting involving carbon markets requires accurate and complete reporting but also adequate rules (Böttcher et al. 2021a). To provide robust and environmentally integrous credits for the market, the framework needs to discriminate between units of carbon from land use and those from fossil fuels and provide a trading exchange rate that accounts for the risk of non-permanence. The proposal for the revision of the LULUCF Regulation provides a first basis for improving accuracy and completeness of LULUCF monitoring. The legislative proposal to set rules for carbon markets is scheduled for end of 2022. Only then a judgement on robustness can be made.

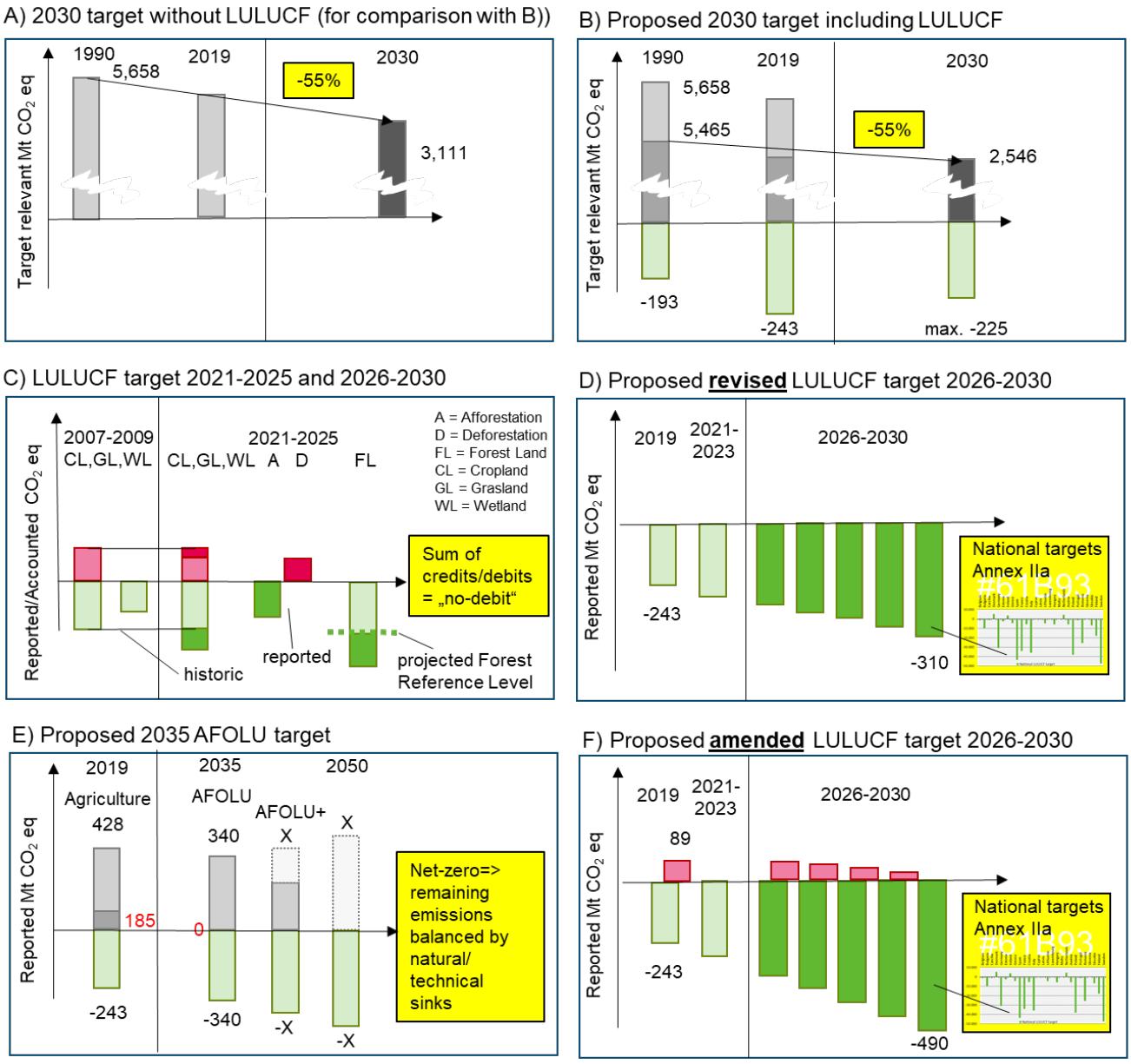
2.5 Integration of LULUCF in the overall 2030 EU climate target

Considering the **full scope of emissions and removals in the EU 2030 emissions reduction target**, as adopted by the EU, implies basically already full flexibility (up to 225 Mt CO_2) between all sectors included in the target. At the same time, it introduces a single year perspective. While interannual variability and uncertainty of data was dealt with under LULUCF Regulation so far by averaging GHG estimates over subsequent inventory years, the overall EU mitigation target of -55% includes inventory estimates for LULUCF in the single years 1990 and 2030. **Single years can be affected more easily by natural disturbances** with implications for the ambition level and the risk of non-compliance at the EU level. The LULUCF sector is subject to frequent recalculations of data that can have major implications for reported historic emissions and removals, even for the net balance reported, especially following changes in methods that are expected from Member States.

Figure 2-1 presents a simplified description of the evolving treatment of the land-use sector in the EU's climate target architecture according to the Commission's proposal. The different panels demonstrate how much the proposal constitutes a paradigm shift in accounting of GHG emissions and removals in the LULUCF sector with regards to the net-accounting of the climate target (Panel A versus B), moving from a highly constrained and complex accounting with a "no-debit" target to simple GHG accounting as reported with absolute EU and Member States targets (Panel C versus D) towards a fully integrated target (Panel E).

Conclusion: The approach for integrating LULUCF in the overall 2030 EU climate target can be considered an implementation of accounting of sinks as considered by the Paris Agreement. It increases the visibility of the LULUCF sector and emphasizes the importance of mitigation measures beyond the fossil-fuel sectors. However, the way of integration based on single year estimates and the historically observed effects of recalculations in countries with large areas under LULUCF reporting (see Annex II providing as an example data from Germany, Matthes 2021) can significantly affect an integrated EU target and create compliance issues.

Figure 2-1: Where is LULUCF? The evolving treatment of the land-use sector in the EU's climate target architecture according to the Commission's proposal.



Source: Own compilation. Explanations: A) 2030 target assuming the theoretical case that the 55% target is excluding LULUCF, B) European Commission's proposal of EU economy-wide target, C) LULUCF Regulation 2021-2025 and 2026-2030, D) European Commission's proposal for revised LULUCF Regulation 2026-2030, E) European Commission's proposal for an AFOLU target 2035, F) Proposed amended LULUCF target 2026-2030 in the draft report of the rapporteur in the European Parliament ENVI Committee.

2.6 Enhanced quality of monitoring and reporting

Uncertainties related to monitoring and reporting of emissions and removals in the LULUCF sector has long been a reason for excluding the sector from GHG mitigation targets. With the full integration of its emissions and removals in base and target year the sector becomes relevant for compliance with the reduction target and also more prominent regarding potential measures for mitigation. The Commission therefore calls for an "upgrade" of GHG monitoring and reporting using advanced technologies, especially provided by **remote sensing** methods, to produce **geographically explicit estimates** of emissions and removals. The integration of such technologies holds also potential for

increasing coherence of land-based mitigation with other EU policies that also rely on land monitoring while reducing overall costs and increasing synergies in the long-run. Technological capacities have increased massively in the recent past, including services provided by the Copernicus Programm and its Sentinel satellites. Indeed, the integration of remote sensing data offers transparent, consistent and complete assessments of the state of ecosystems with high temporal and spatial resolution. However, upgrading LULUCF monitoring also requires increased capacities in Member States, adaptation of individual reporting methods and harmonized approaches resulting in upfront efforts.

Conclusion: Methods used by Member States for LULUCF reporting often lag decades behind technological development. However, the business models foreseen by the Commission will need to rely on carbon credits with high integrity that can only be generated by a complete monitoring system with high accuracy, temporal resolution and consistent approaches across all Member States. A quantum leap in GHG reporting in the LULUCF sector is thus required to fully ensure the environmental integrity of land-based mitigation, especially if carbon market mechanisms are to be introduced. This monitoring system may also require the development and use of reference datasets and modelling capacities by the EU bodies to supervise markets, going beyond what is included in the LULUCF proposal.

3 Underlying assumptions on mitigation potential and costs

Accompanying the proposal for a revision of the LULUCF Regulation (COM(2021) 554 final) within the Fit-for-55 Package, the European Commission (EC) provides an impact assessment (SWD(2021) 609 final) that is expected to form the basis for "*delivering the [2030] target collectively by the EU in the most cost-effective manner possible, preserving the EU's competitiveness and taking account of Member States' different starting points, specific national circumstances and emission reduction potential*".

The potential for increasing removals and its costs are different for different options and in different Member States. This is due to differences in biophysical, climatic or economic conditions. Besides geographical location also soil type, land use type and management history are important influencing factors. The costs typically include **investment costs** of implementing measures. Mitigation options are also associated with **opportunity costs** for land managers. This can, for example, be costs of foregone income and a decrease in land prices linked directly to afforestation activities or reduced crop yields on rewetted areas.

The impact assessment builds on data, modelling tools and assumptions that have an impact on the results of the assessment. In the following we briefly identify main assumptions in the impact assessment regarding mitigation potentials and associated costs and compare these to bottom-up estimates and information from the scientific literature.

3.1 Underlying scenarios

The EU target for 2030 is set to -310 Mt CO_2eq. There are different scenarios forming the basis of decision for this target (Table 3-1). The Reference scenario 2020 from the Commission's impact assessment projects an EU LULUCF sink of -258 Mt CO_2eq in 2030 without an application of a carbon price on the LULUCF sector. The MIX policy scenario achieves a similar level of net LULUCF removals. Neither scenario reaches GHG neutrality in 2050.

The value of -310 Mt CO_2eq is derived from the 1.5 TECH scenario, one of the three scenarios from the European Commission's 2050 Long-term Strategy from 2018 expected to lead to GHG neutrality in 2050 (see Table 9 of EC (2018)). It assumes a carbon price of 30 EUR/t CO_2eq and rather limited additional incentives to improve the land use sink. Instead, it focuses on technical solutions to achieve net-zero GHG emissions. It increases CCS aiming to lower more the remaining emissions. Similarly, it applies more use of e-gases and fuels based on air captured or biogenic CO_2 to reduce remaining emissions. It applies negative emission technologies via biomass coupled with CCS and the storage of biogenic CO_2 in material.

Two separate scenarios from the 2050 Long-term Strategy – 1.5LIFE and 1.5LIFE-LB – assume that significantly higher carbon price levels of 70-80 EUR/t CO_2eq lead to increased investment into afforestation and forest sink enhancement, allowing the sink to increase further to -465 Mt CO_2eq and -480 Mt CO_2eq[5], respectively, by 2050.

The 1.5 TECH scenario considers that additional LULUCF removals compared to the EU Reference scenario could be achieved in the next decade via a range of relatively inexpensive near-term mitigation actions. In particular, the scenario assumes that the LULUCF sink could be enhanced further through economic incentives targeting reduction of deforestation, increase of afforestation, better forest management, and better agriculture practices storing soil carbon.

Conclusion: There are a number of existing EC scenarios that achieve a higher net sink for the LULUCF sector than the proposed -310 Mt CO_2eq, though the biggest increases are seen in the longer term. Scenarios that assume a drive towards a more circular economy, changes in lifestyle and consumer choices, including less carbon intensive diets and thus allowing for increased afforestation suggest that the EU could increase the net removals of CO_2 to 350 Mt CO_2eq by 2030. However, the relatively high deployment of bioenergy in the 1.5 TECH scenario underlying the proposed target can be considered as limiting factor for a more ambitious sink target.

[5] 1.5 LIFE-LB assumes that great removals can be achieved at a lower carbon price of 70 EUR/t CO_2eq since biomass demand is reduced.

Table 3-1: Overview of scenarios relevant for the proposed revision of the EU LULUCF Regulation

Scenario name	Achieving GHG neutrality?	CO_2 price [EUR/t CO_2eq]	Net LULUCF sink 2030 (2050) [Mt CO_2eq]	Assumptions and measures implemented in LULUCF sector	Source
Reference 2020	no	-	-258 (-271)	Forms the most recent projection of "Business as usual" in the EU based on most recent data	(1)
MIX (Policy scenario)	no	-	-256	Considers changes in the biomass demand from the energy sector compared to Reference 2020 following 1.5TECH. Assumes increased production of lignocellulosic crops and wood removals from the forest.	(1)
1.5TECH	yes	30	-310 (-317)	Relies on an increase of all technology options, the deployment of biomass related to significant amounts of carbon capture and storage (BECCS). The LULUCF net sink is enhanced through afforestation and short rotation coppice.	(2)
1.5LIFE	yes	80	-350 (-464)	Assumes a drive towards a more circular economy, changes in lifestyle and consumer choices, including less carbon intensive diets. Compared to 1.5TECH, it assumes an enhancement of the net sink, e.g. through increased afforestation.	(2)
1.5LIFE-LB	yes	70	-350 (-472)	Considered a "sensitivity analysis of 1.5LIFE with a strong focus on technology options other than biomass leading to an increased net sink.	(2)
LULUCF-MIX			-295	Scenario variant of MIX realising additional sink potential in managed forests and afforestation.	(3)
LULUCF+	-	-	-340 (-425)	Scenario including additional actions to increase the net LULUCF sink to meet the EU 2035 land sector and 2050 overall neutrality targets. It includes optimisation of forest management, afforestation and improving soil management including through rewetting and restoration.	(3)
No-debit (baseline)	-	-	-225	Represents the current policy framework. It does not represent a separate scenario but an accounting perspective.	(1)
Forest Reference Level (FRL)	-	-	-257	Emissions and removals from managed forests are assumed at the level of FRLs. Other categories are assumed to follow the development of the MIX scenario.	(1)

(1) Proposal for a revision of the LULUCF Regulation (COM(2021) 554 final)

(2) European Commission (EC) (2018)

(3) Impact Assessment to the Climate Target Plan (European Commission (EC) 2020)

Source: Own compilation

3.2 Demand for biomass

The 1.5 TECH scenario assumes an increasing demand for bioenergy. Demand for bioenergy is an input to the LULUCF modelling as it is determined by energy sector models. These are informed by assumptions on biomass potentials also used for LULUCF modelling. However, the potential to increase carbon removals in LULUCF at a given price for CO_2 is therefore not directly balanced with potentials for reducing emissions from fossil fuel use. This results in a strong role for energy crops, while other options in LULUCF, e.g. fallowing land are less pronounced. However, the substantial use of woody energy crops instead of stem wood limits the negative impact on the forest sink and therefore helps to maintain the overall LULUCF sink. Compared to natural regeneration through fallowing of cropland, there can be negative implications for biodiversity depending on how crop plantations are established (see Box 3-1).

Box 3-1: "Joker" option short rotation coppice (SRC)

Fast growing energy crops include lignocellulosic grass and short rotation coppices characterized by faster growing rates and therefore higher productivity potential than forest biomass production. These energy crops can maintain, to some extent, economically viable yields on marginal lands and better preserve the soil content in organic carbon compared to arable land. In the EU policy scenarios short rotation crops have an important role. Most of the demand is supplied via lignocellulosic grass such as switchgrass and miscanthus while short rotation coppices, poplar and willow, provide 20 to 25% of the demand in energy crops. But so far there are no mandatory ecological guidelines to make SRC compatible with biodiversity concerns, which is of high importance if SRC is going to expand in the European landscapes.

Compared to annual monoculture crops, SRC provides woody habitat structures and longer undisturbed soil, which favours the presence of e.g. fungus, insect and bird species. But SRC are less biodiverse compared to mixed deciduous forests. Hence, in a forest dominated landscape, SRC most likely are negatively influencing biodiversity while they potentially enhance it in agricultural homogeneous structured landscapes (Vanbeveren und Ceulemans 2019). Measures which positively influence biodiversity in SRC are e.g. cultivation of different tree species, sectional harvesting (Zitzmann und Rode 2021) and stimulating biological control rather than applying fertilisers and pesticides (Vanbeveren und Ceulemans 2019).

The strong penetration of energy crops in 1.5TECH coupled with the implementation of agricultural practices aiming at improving the soil carbon sequestration turns cropland in EU in this scenario from net carbon source to net carbon sink by 2050, with the LULUCF sink in the EU increasing to -350 Mt CO_2.

Non-energy related wood demand is also considered an input to the underlying land use models. Therefore, mitigation effects in forests are largely achieved by "structural and geographic relocation of harvesting schedules" while still satisfying this wood demand. This assumption constitutes a certain "ceiling" of the mitigation potential in forests and excludes options that would be deployed at higher levels of carbon prices. However, the European Commission expects that these higher carbon prices could trigger increasing competition between carbon storage and wood production and lead to alternative business models for forest owners in the EU.

Conclusion: Despite the fact that the demand for biomass is projected to lead to an increase in carbon storage in cropland through the establishment of short rotation plantations, the assumptions in the European Commission's modelling artificially constrain the potential for carbon storage in EU

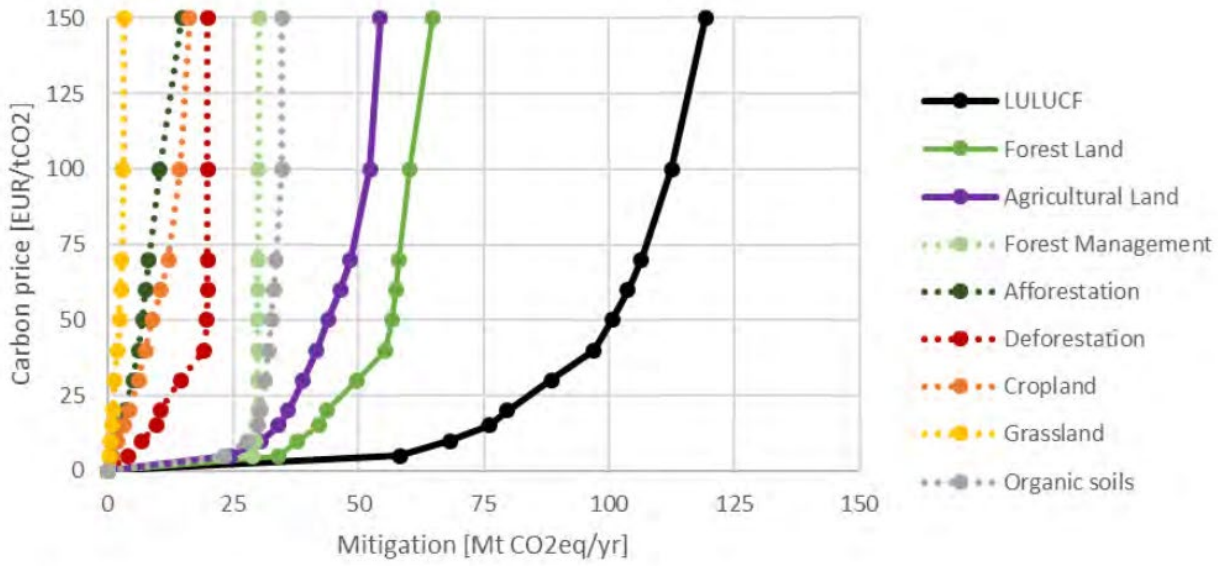
forests and also the expansion of forests as carbon sinks. Furthermore, negative impacts from short rotation coppices for bioenergy production on biodiversity cannot be ruled out.

3.3 Marginal abatement cost curves

Based on the MIX scenario, Marginal Abatement Cost (MAC) curves have been estimated by the models GLOBIOM and G4M. MAC curves depend on the number and quantity of technologies for mitigation action and the opportunity costs for those actions. The curves simulate emission reduction potentials at a given carbon price (equal to the marginal cost for the abatement of a ton of CO_2eq) for a specific scenario and year.

The level of removals required to achieve -310 Mt CO_2eq in 2030 is around 54 Mt CO_2eq higher than the level that the policy scenario assumes to be feasible at zero additional cost per ton of CO_2eq (256 Mt CO_2eq). The impact assessment assumes that the gap can be filled at relatively low costs per ton of CO_2 (between 5 EUR/t CO_2eq and 10 EUR/t CO_2eq).

Figure 3-1: 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



Source: EC 2021

For the impact assessment, marginal abatement cost curves were estimated for the MIX scenario in 2030 and modelled in the models GLOBIOM and G4M for the main LULUCF categories and in the model CAPRI for organic soils on agricultural land (Figure 3-1). The European Commission estimates that until 2030 a carbon price of 5 EUR/t CO_2eq could deliver additional mitigation of about 60 Mt CO_2eq; 10 EUR/t CO_2eq could deliver another 10 Mt CO_2eq (Figure 3-1).

It is remarkable that a number of the European Commission's MAC curves increase exponentially to extremely high carbon prices already at rather low potentials (e.g. Grassland or Afforestation). At a carbon price of 150 EUR/tCO_2eq management of organic soils reaches a maximum mitigation potential of 35 Mt CO_2 per year. This is despite the fact that current emissions are 71 Mt CO_2eq. (30 MtCO_2eq for Cropland and 41 MtCO_2eq for Grassland).

Conclusion: Assumptions on costs curves in the European Commission's impact assessment determine what is considered "cost-efficient". The cost curves constrain the maximum abatement potential at levels that are considerably lower than potentials found in other studies. The effects associated with these limitations in the European Commission analysis are counteracting: the first bears the risk of overestimating the abatement potential at a given price point, the latter the risk of underestimating the realistic potential that can be technically achieved.

3.4 Costs and implementation time for specific measures

Costs of **afforestation** are assumed to be high leaving little potential even at high carbon prices. This is despite the fact that dietary changes could provide double benefit as the land freed from food production, with consequently less emissions, could become available for new forests that could also be established through natural regeneration. However, the mitigation potential of afforestation at the beginning of the implementation period is small compared to the potential after 30 or 50 years. This is because trees take time to reach their sequestration potential. Afforestation activities can also be associated with land clearing and site preparation that cause initial carbon emissions that need to be compensated (e.g. applies for afforestation of grassland).

Investment costs for afforestation include opportunity costs and technological costs. Often there are incentive schemes, including under the CAP, which could prevent farmers from converting marginal land into forests because they fear losing premiums under the first pillar. Converting land into forests is also a permanent land management decision with particularly high initial costs which only pay off for future generations. Technological costs for afforestation related to instalment (soil preparation, seedlings) and maintenance for at least 20 years (soil cleaning, pre-commercial thinning) are considered. Depending on Member State specific costs and specific instalments and maintenance needs (e.g., one or two soil cleanings and pre-commercial thinnings), total costs per hectare for at least the first 20 years of operation range between EUR 1,177 and EUR 3,285. This is still lower than average payments of 4,000 EUR/ha under the CAP.

Measures changing the **management of forests**, such as an extension of rotation length, lowered thinning and reduced harvest intensity, are estimated to have the highest mitigation impact for forests (about 30 Mt CO_2eq) and at carbon prices as low as 10 EUR/t CO_2eq – largely reflecting opportunity costs, e.g. foregone income due to a longer rotation length. However, without further regulation the potential for increasing the carbon sink in forest biomass with these practices is also limited, even at very high carbon prices, by the opportunity cost of selling the wood. This is because an increase of the carbon price reduces the wood that can be extracted and is thus in direct competition with relatively high wood prices for the use of the same wood. However, expert views differ significantly with regards the effect of mitigation options in forests on the availability of wood. Nabuurs et al. (2017) expect that the forest sink could be expanded by 193 Mt CO_2 in 2050 through "climate smart forestry" options (improving forest management 129 Mt CO_2, establishing forest reserves 64 Mt CO_2) leading even to an increase in wood supply. By contrast, Welle et al. (2020) expect a considerable reduction of wood harvest is required to achieve an increase in the forest sink by 211 Mt CO_2 in 2030, in particular by abandoning fuel wood use and reducing the use of hardwood for short-lived wood products.

Avoided deforestation is also estimated to hold significant mitigation potentials at moderate carbon prices (10 Mt CO_2eq for 15 to 20 EUR/t CO_2eq) and reaches 20 Mt CO_2eq at 150 EUR/t CO_2eq.

Fallowing of **organic soils**, currently used for agriculture or as grasslands, holds the same mitigation potential as measures for improved forest management (about 30 Mt CO_2eq for cropland and 41 Mt CO_2eq for grassland). However, the mitigation potential reaches a limit of about 35 Mt CO_2eq already

at low carbon prices (below 25 EUR/t CO_2eq) when all land has been set aside (assuming 1.5 Mha of cropland and 3 Mha of grassland on organic soils, corresponding to 1.18% and 3.33% of the respective total land use category area). The literature suggests a much larger mitigation potential associated with the rewetting of organic soils, which some studies estimate to range between 48 – 54 Mt CO_2eq per year (Roe et al. 2021; Pérez Domínguez et al. 2020; UBA 2019). At the same time, the impact assessment considers only costs for compensation for foregone income (opportunity costs). It does not consider costs for restoration and rewetting of the land that is actually needed to increase water tables and stop mineralization of the organic matter.

Other measures on **agricultural land** are estimated in the impact assessment to have a comparatively low potential for climate mitigation (below 20 Mt CO_2eq). By contrast, the range of estimates at EU level for increased carbon sequestration in cropland in other studies ranges between 9 Mt (Frank et al. 2015) and 58 Mt CO_2eq per year (Lugato et al. 2014). The latter estimate would correspond to about 1‰ of present stocks which is a potential found to be reasonable in a study assessing the impacts of cover cropping, improved crop rotation, organic farming, agroforestry and conversion of arable land to grassland in Bavaria (Wiesmeier et al. 2020). Such practices have also been considered in the Commission's models.

Conclusion: Assumptions on costs lack important types of costs that are relevant for implementation of mitigation measures and realising the potential. Moreover, emission reduction and sink enhancement potentials in the LULUCF sector develop in a non-linear way over time. The available time span of less than 10 years until 2030 is too short for achieving significant effects on the carbon sink, especially regarding increased afforestation. However, a higher potential can be expected in subsequent decades. According to the European Commission's Impact Assessment, the underlying models provide conservative estimates of the mitigation potential and focus only on selected mitigation measures (excluding wetlands, settlements, other land, HWP, and rewetting of forested organic soils). Notably, costs for rewetting of former wetlands are excluded from the assessment resulting in a likely underestimation of costs for this significant mitigation potential.

4 National case studies on mitigation potentials and costs

In two case studies we explore national perspectives on the proposed LULUCF revision by taking Germany and Finland as examples. We first assess the national LULUCF removal targets, presented in Annex IIa of the proposal, by contrasting them with historic data, national and EC projections. Further, we look into available bottom-up data to reflect on mitigation measures and their costs considered in the EC impact assessments.

4.1 Germany

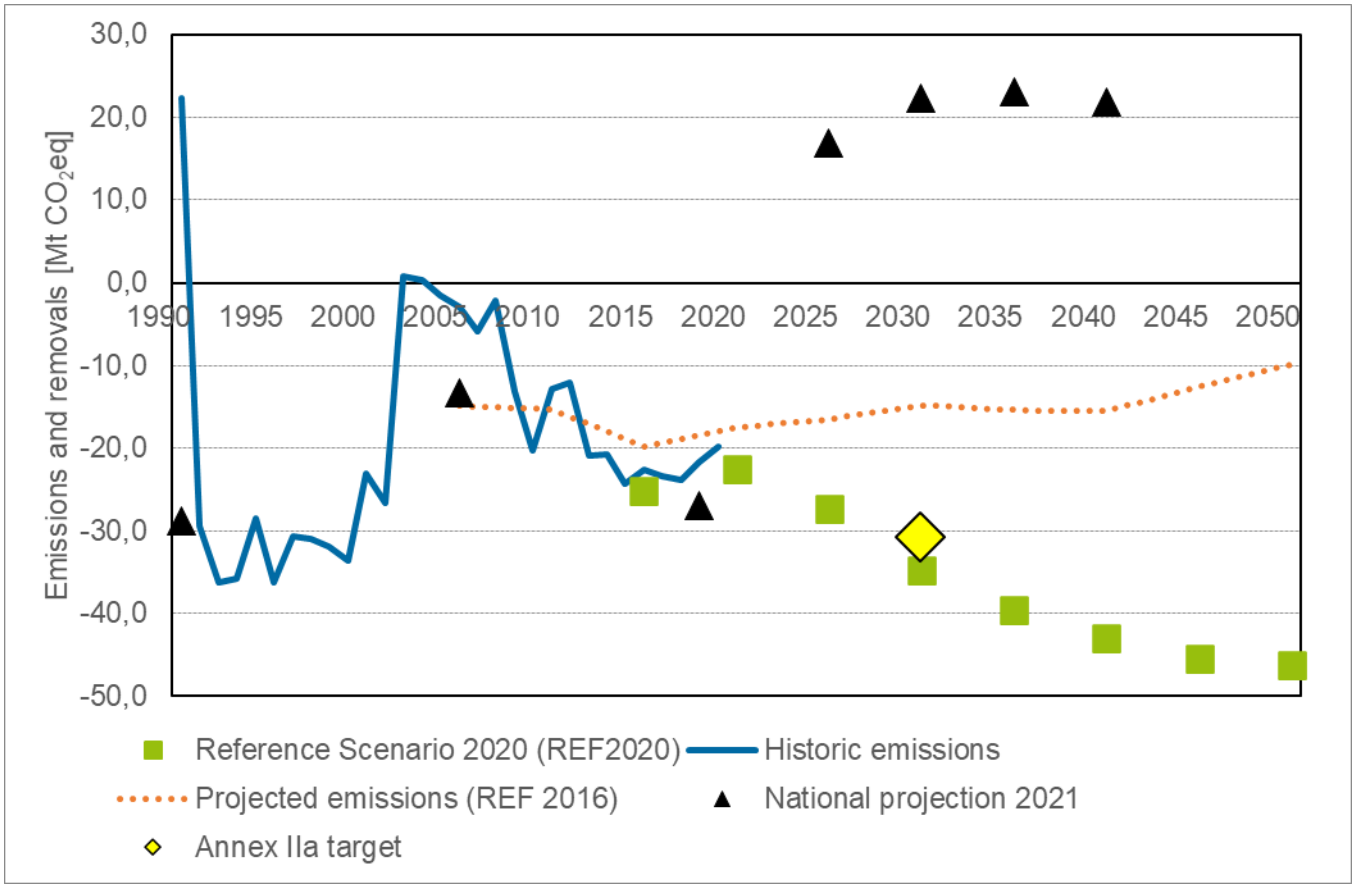
Comparing EU mitigation cost estimates with national data requires a more detailed breakdown of assumptions at national level. National level assumptions have not been published with the impact assessment. However, the EC has recently published national level results of the EU Reference Scenario 2020[6]. The Reference scenario has been reviewed by national experts from EU Member States in a consultation process. It forms the baseline scenario to which specific policy scenarios and variants are compared to assess options discussed in the impact assessment.

[6] https://ec.europa.eu/energy/data-analysis/energy-modelling/eu-reference-scenario-2020_en

Figure 4-1 presents historic and projected emissions and removals from LULUCF for Germany and its LULUCF target. The EU Reference scenario 2020 projects a strong increase of net removals from the sector. In fact, Germany is expected to reach its national net sink target of about 30 Mt CO_2eq at **no** additional costs. This is in contrast to national assessments (Osterburg 2019; Repenning et al. 2019). By contrast, the earlier EU Reference Scenario 2016 expected a stabilization of the LULUCF sink at rather low level and a continuous decline over the simulation period.

Germany's own national projection estimates that the LULUCF sector, which was a net carbon sink until 2018, will become a net source of emissions over the two decades from 2020-2040[7]. This is mainly due to an assumed strong decline of the forest carbon sink. Analysis by Oeko-Institute showed that despite a very likely recent decline of the sink due to increased disturbances in German forests by storm damage, drought and bar beetle infestation, the projected gap between the national target and future net sink is likely to be overestimated in Germany's national projection (Hennenberg et al. 2021), amounting to rather 12.3 instead of 44 Mt CO_2eq as suggested by other sources.

Figure 4-1: Historic and projected emissions and removals from LULUCF for Germany and national level LULUCF targets



Source: own compilation based on referenced data sources

Regarding **management of forests**, the extension of rotation length for achieving higher carbon stocks is a measure assumed by the impact assessment. It can be achieved by temporarily reducing harvest levels. This causes opportunity costs for forest owners of foregone timber sales. A rough estimate of costs associated with an extension of rotation by 20 years in all forest stands in Germany

[7] https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/projektionsbericht_2021_bf.pdf

results in costs of annually 1.3 billion EUR for the entire forest area of Germany, or about 120 EUR per ha over a period of 35 years (Wiss. Beiräte BMEL 2016). The mitigation potential through carbon storage in forest biomass could be 10 Mt CO_2eq per year resulting in costs of 130 EUR/t CO_2eq.

Repenning et al. (2019) compared two alternative forest management scenarios based on Rosenkranz and Seintsch (2017) and estimated that the cost of nature conservation and forest adaptation programmes for achieving 7 Mt CO_2eq of annual removals in 2030 (only forest biomass and wood products) compared to a baseline could amount to 100 million EUR annually, resulting in abatement costs of 14 EUR/t CO_2eq.

Costs of **rewetting of organic soils** can be estimated by projects that carried out rewetting and that were scientifically assessed regarding the resulting changes in emissions. In the Federal State of Berlin the costs of four wetland restoration projects, each between 2 and 6.5 ha, were estimated to amount to 32 to 70 EUR/t CO_2eq. These costs included site preparation and hydrological restoration. Since the wetlands were not under managed land, no opportunity costs occurred. Annually the restoration yielded in reduced emissions of 15 t CO_2eq/ha[8].

These estimates are in line with other scientific literature that found that costs for organic soil protection range from 27 to 107 €/t CO_2eq, with an average of 67 €/t CO_2eq (Drösler et al. 2012). Repenning et al. (2019) estimated costs of wetland restoration by assuming costs for area acquisition by the state or compensation payments. These can amount 900 to 1250 EUR/ha (assuming a 20-year period). Additionally, technical costs occur for rewetting that are estimated to be around 400 EUR/ha. Assuming a mitigation potential through these measures of 15 to 30 t CO_2eq/ha and year, 55-87 EUR/t CO_2eq can be expected. A similar range (32 – 55 EUR/t CO_2eq) was estimated by Isermeyer et al. (2019).

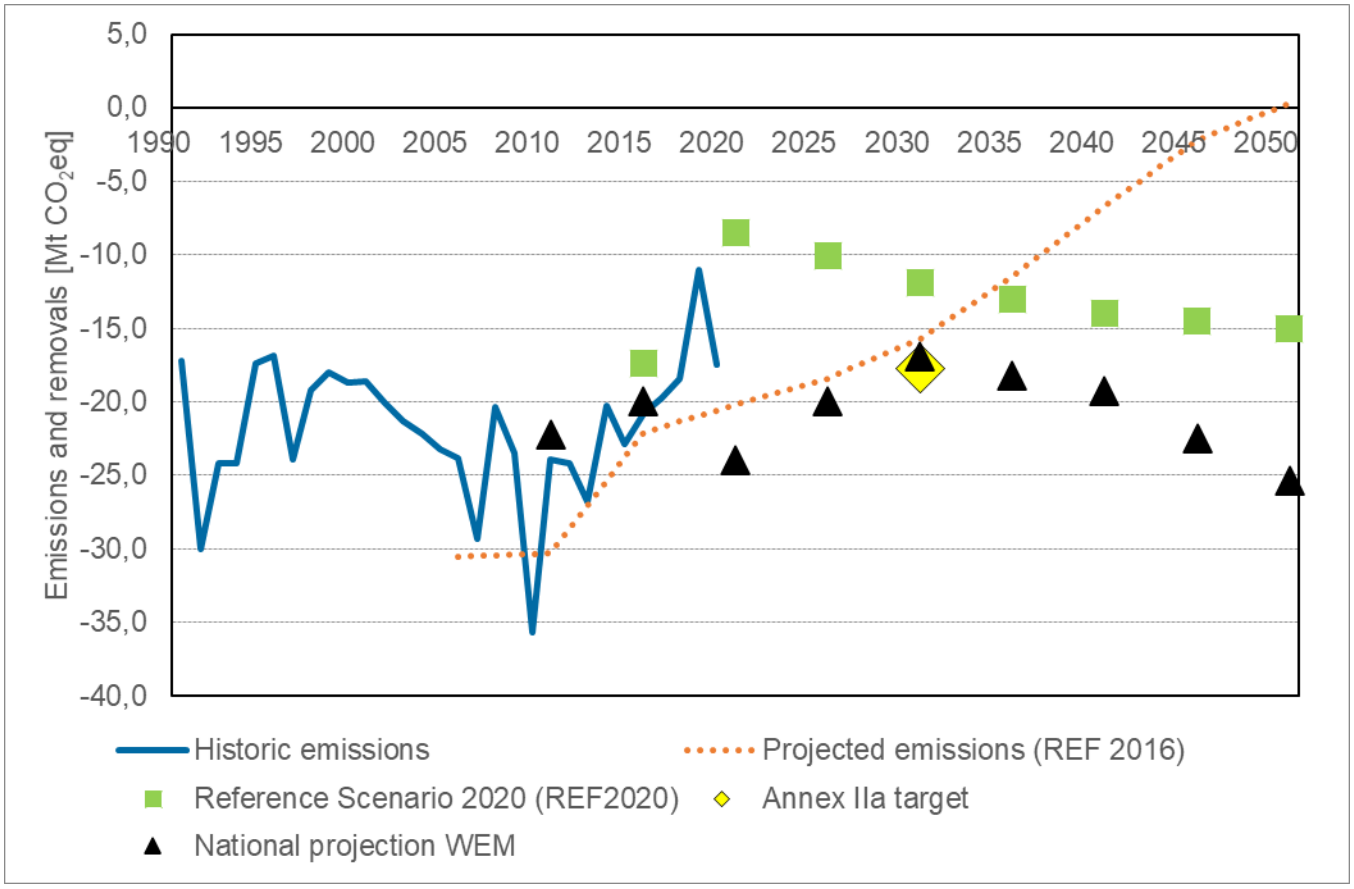
4.2 Finland

LULUCF is an important sector in Finland, where about 72 % of the land is forested. Finland's NECP-plan considers LULUCF and agriculture and includes policies and measures for the two sectors, notably on manure management, mitigation of emissions from organic soils, the increase of carbon storage, afforestation of organic soils, promotion of biogas production, active forest management, preventing land use change, and implementing a pilot for carbon sequestration and storage markets. Bioenergy is also considered, being well integrated into the forest system. The plan provides information on historical and future emissions and removal trends in each LULUCF category, including a description of the accounting baseline for forests (the national forest reference level, submitted as required by Article 8(3) of the LULUCF Regulation). The plan clarifies that it is possible for Finland to avoid creating any LULUCF debits, but specific estimates are not disclosed due to uncertainty

The plan refers to the common agricultural policy as a tool for reducing GHG emissions from agriculture. The NECP also includes additional targets to achieve carbon neutrality by 2035 and to become the world's first fossil free welfare society.

[8] https://www.stiftung-naturschutz.de/fileadmin/user_upload/pdf/Klimaschutzabgabe/KlimaabgabeExposeKleinePelzlaake_2013.pdf

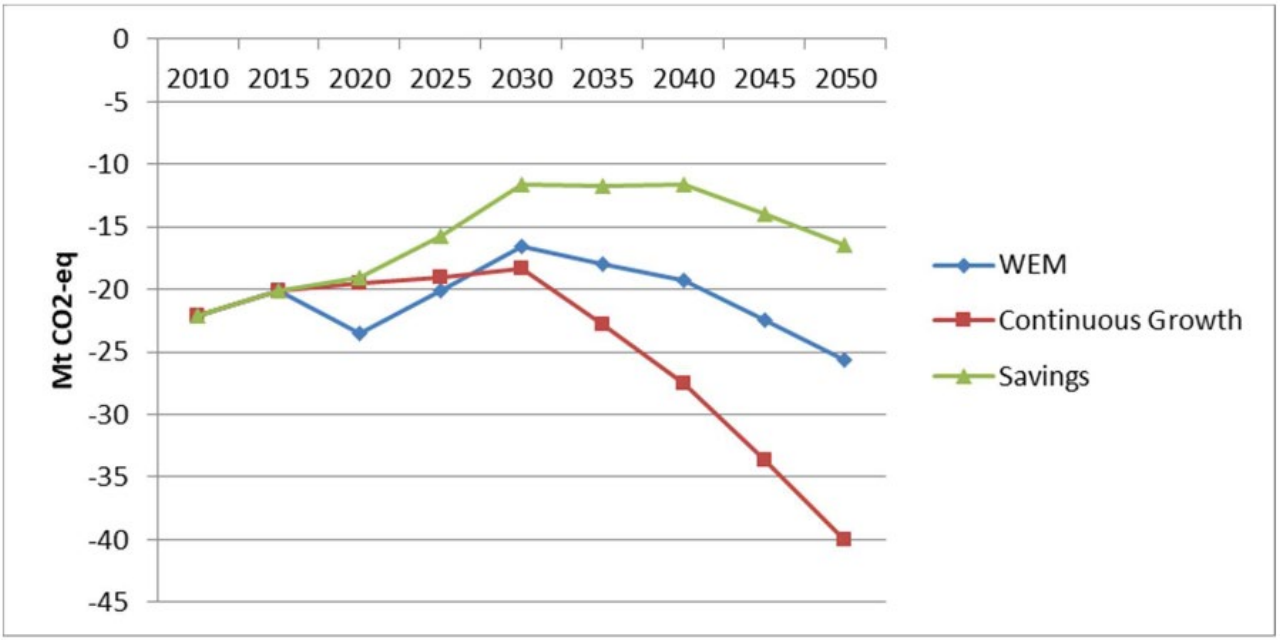
Figure 4-2: Historic and projected emissions and removals from LULUCF for Finland



Source: Own compilation based on UNFCCC CRF data, EC 2021 and Ministry of Economic Affairs and Employment 2020.

Finland has developed a long-term strategy for achieving its national GHG-neutrality target set for 2035, which includes three scenarios (Ministry of Economic Affairs and Employment 2020). The reference scenario depicts the development with currently existing measures (WEM), while the other two scenarios describing alternative low-emission pathways to achieve the target. All three projected scenarios assume that the LULUCF sector remains a net sink (Figure 4-3). The WEM scenario sees the LULUCF sector's net sink at -17 Mt CO_2eq in 2030 and -25 Mt CO_2eq in 2050. Under the Continuous Growth scenario, the LULUCF sector's net sink will first remain at the current level before reaching 40 Mt CO_2eq. in 2050. The Savings scenario projects the smallest sink for the LULUCF sector well below 20 Mt CO_2eq. until 2050. Under the Savings scenario it is assumed that a change in forest industry production structures and the resulting annual roundwood removals amount to 90 Mm^3 after 2035, while the Continuous Growth scenario assumes roundwood removals of 80 Mm^3.

Figure 4-3: Alternative projections of the LULUCF sink in Finland



Source: Ministry of Economic Affairs and Employment 2020

Baul et al. (2017) analysed the impacts of alternative forest management scenarios and harvest intensities on climate change mitigation potential in managed forests in Finland over a 40-year period, including carbon storage in biomass, products and reduced emissions through substituting fossil-intensive materials and fuels but excluding abiotic and biotic risks to forests. Changing the target diameter from 22 cm to 26 cm resulted in increased net removals of 0.1 to 0.2 t CO_2eq/ha/a but caused a decrease of the Net Present Value (a measure of economic profitability of forest production applying a 3% interest rate) by about 200 to 400 EUR, implying mitigation costs of 20 to 50 EUR/t CO_2eq of reduced harvest intensity.

4.3 Observations regarding mitigation potentials and costs

In the case of Germany, the underlying EU Reference scenario is overly optimistic regarding future sink development, implying that the national target can be reached without additional measures. This result stands in strong contrast to Germany's own national projection, which projects a negative development of the sink. It can be hypothesized that this assumption leads to the conclusion that also the new national target proposed in the LULUCF regulation can be reached at very low costs (5-10 EUR/t CO_2eq.). However, bottom-up estimates of mitigation costs based on a short literature review for Germany range between 27 and 103 EUR/t CO_2eq for the rewetting of organic soils and about 130 EUR/tCO_2eq. for forest management change.

For Finland, the European Commission's impact assessment projects that Finland's national target for 2030 is well above its projected net sink in the EU Reference scenario 2020. This implies that reaching the national target is associated with higher costs for Finland. According to national bottom-up estimates, mitigation costs of reduced harvest intensity could be around 66 EUR/t CO2eq. However, national projections with existing measures come relatively close to Finland's target set by Annex 2a of the proposal, indicating that it can be reached without much additional costs.

Table 4-1 presents cost estimates for the two considered mitigation options in the two Member States as an overview. Compared to cost estimates of the Commission's impact assessments, there is

especially a high discrepancy between estimates of costs for the rewetting of organic soils (note that EU estimates do not consider costs for rewetting but only assume abandonment of these areas) but also costs for changes in forest management are higher when looking at bottom-up estimates.

It has to be noted that the cost estimates are not entirely comparable as bottom-up estimates typically reflect more a business perspective, while costs based on marginal abatement cost curves rather represent economic costs from a national perspective. However, as certain types of costs have not been considered by the Impact Assessment, these estimates probably underestimate the efforts and public expenditures required by Member States for realising mitigation potentials in the sector.

Table 4-1: Comparison of mitigation cost estimates by bottom-up (country-specific and empirical data) and top-down (EU modelling) estimates

Type of estimate	Unit	Management of forests	Rewetting/Abandonment of organic soils
Bottom-up Germany	**[EUR/t CO_2eq]**	0-130	27 - 107
Mitigation potential	**[t CO_2eq/ha/a]**	0.6-0.9	15-30
Mitigation potential	**[Mt CO_2eq/a]**	7-10	3.9-7.8
Bottom-up Finland	**[EUR/t CO_2eq]**	20-50	
Mitigation potential	**[t CO_2eq/ha/a]**	0.1-0.2	
Mitigation potential	**[Mt CO_2eq/a]**	0.9-1.8	
Top-down EU	**[EUR/t CO_2eq]**	5-10	5-10
Mitigation potential	**[Mt CO_2eq/a]**	35	25

Source: Own compilation based on literature.

5 Discussion of remaining challenges for environmental integrity

5.1 EU certification standards for carbon removals with environmental integrity

In the European Commission's LULUCF proposal it envisions an inclusion of land-based mitigation in a future carbon market into which the revised LULUCF Regulation should provide a first step. In a Communication on Sustainable Carbon Cycles (COM(2021) 800 final) published on December 15, 2021, the European Commission further announced that it will propose a regulatory framework for the certification of carbon removals by the end of 2022, which is expected to form the basis for the carbon market access of landowners by 2028. Approaches already applied by certification standards of the voluntary carbon markets might be adaptable to compliance markets. However, **significant concerns remain as to the reliability of carbon crediting for some types of land-based activities** in the voluntary carbon market, as well the general impact of carbon markets on the environmental integrity of the EU's climate and environmental policy framework.

As briefly discussed in section 2.4, **non-permanence remains a key concern for land-based mitigation options**. It constitutes the largest risk for environmental integrity of the integration on LULUCF in the overall EU mitigation target. The coming Impact Assessment underlying these future regulatory proposals will thus clearly need to explicitly assess the challenges with regards to the reversibility of biogenic carbon storage for specific mitigation options in the LULUCF sector and propose practical and yet robust solutions for addressing them.

Furthermore, bioenergy options tend to increase the issue of non-permanence by reducing the residence time of carbon in the biomass unless they are paired with options of CO_2 capture and storage (BECCS) or use of CO_2 as a feedstock (BECCU). The Commission also plans a more comprehensive coverage of carbon storage in biobased products that goes beyond classical accounting of harvested wood products and will form a basis for setting incentives for more efficient carbon cycling through cascade use. **There is the general risk that such a scheme increases overall biomass demand for such uses beyond sustainable levels**. In the EU, biomass harvest is currently a large driver of non-permanence given high shares of direct biomass use for energy (Camia et al. 2021). Thus, any intensification of biomass removals beyond sustainable levels, especially from forests, should be avoided.

Last but not least, the EU's regulatory approach to carbon markets should also take into account the considerable differences between mitigation options with regards to their **expected impacts on biodiversity, soil protection and the climate resilience of ecosystems**, e.g. comparing afforestation with fast growing monocultures or restoration of natural ecosystems.

Without a high degree of environmental integrity and robust methodological standards, the quality of land-based carbon credits will be low. Reporting challenges would make it impossible to estimate reliable and realistic potentials, and thus prevent market dynamics to be anticipated at all. Moreover, the **unpredictability of potential credits would represent a significant compliance risk** for any buyer. Under such conditions it would be challenging to develop a successful market that generates a business models for carbon farming and necessary funding for management changes in forestry and agriculture. At the same time, if the likely high costs of robust monitoring, reporting and verification systems will have to be covered by the market, land-based carbon credits are also likely to become much more expensive than currently anticipated by the EC impact assessments.

5.2 Risks to environmental integrity from uncertainties in GHG inventories

The national targets set for individual Member States included in Annex IIa of the proposed Regulation were calculated based on historic net emissions reported by Member States in their submissions of 2020. Average historic emissions and removals by Member States included reported data for 2016, 2017 and 2018. The sum of EU27 for this period is -268 Mt CO_2eq. To achieve a net sink of -310 Mt CO_2eq in 2030, LULUCF net removals need to be increased by 42 Mt CO_2eq, or 16%. This difference is allocated to Member States by multiplying the share of total managed land area in the EU multiplied with the difference between historic net emissions and to the EU target of -310 Mt CO_2eq. This approach leaves a number of **Member States with net emission targets**, namely Denmark, Ireland, and the Netherlands. National binding targets between 2005 and 2030 are calculated by using net emissions reported by Member States for 2021, 2022, and 2023 and drawing a linear trajectory from the average historic value representing 2022 to the 2030 target value.

The estimation of national binding targets is thus based on historic data and the national share of total managed land area in the EU. The above presented considerations on mitigation potential and its costs have not been included explicitly to derive national targets. The assumption is made that historic levels of net emissions and removals can be considered close to a cost-efficient potential. However, often inventory data that do not capture recent national policies and developments (Böttcher and Reise 2020).

In total, LULUCF reported data have an uncertainty of the emission level of 28 %, which is comparable to other sectors, e.g. Waste (see Table 1.15 in European Union 2021). But there is a large spread of uncertainty ranges for different land-use categories. Level uncertainty based on Member State estimates for Forest land is about 14 %, Cropland 61 %, Grassland 354 % and

Wetlands 55 %. Moreover, LULUCF data is often subject to considerable recalculations, e.g. due to methodological changes in inventory compilation. This holds, for example, for Germany, which updated its national GHG submission for historic years in 2021, leading to a decrease of the estimated net LULUCF sink in 1990 by 50 Mt CO_2eq. For more recent years changes to the inventory for methodological reasons amounted to at least 5 Mt CO_2eq. Applying data from a more recent submission (2021) towards deriving the national LULUCF target for Germany would thus result in a national target of -23 Mt CO_2eq, about 7 Mt CO_2eq less than the proposed target in Annex 2a of the Commission proposal (see Annex I).

This example shows that **changes in GHG inventories of large EU Member States due to recalculations can make a timely and sanctioned climate protection regime largely ineffective**, or at least have considerable consequences for other sectors. The proposed revision of the LULUCF Regulation aims to strengthen the monitoring and review system at EU level to address this challenge. However, in view of persisting large uncertainties of emission and removal estimates for the LULUCF sector, its **fungibility with carbon units from other sectors needs to be very clearly constrained.**

Flexibility granted could, for example, include a safety margin or buffer to accommodate for uncertainties related to methods, data, and trends. Alternatively, a discount rate could be applied for the exchange of carbon credits when using flexibilities. Examples for such discounting are applied by The REDD+ Environmental Excellence Standard (TREES) [9]. It uses a conservative approach allowing a maximum uncertainty level of 15 % (at the 90 % confidence level) beyond which the crediting level is reduced by the calculated percentage uncertainty, while the reported emissions are to be increased by the calculated percentage uncertainty.

In addition to uncertainties due to non-permanence of biogenic carbon storage, uncertainties of LULUCF reporting remain high. The Commission urges Member States to improve their GHG reporting. Ironically, however, advances in increased Tier level of reporting and inclusion of additional and more up-to-date data sources can cause disruption of historic data series (e.g. when switching methods) and increase relative uncertainty (e.g. due to inclusion of more processes).

There are also still categories not well represented in EU Member State accounts. For example, about 44% (74.4 of estimated 166.7 Mt CO_2eq) of emissions from organic soils are probably not included in Member State reporting that currently amounts to already 92.3 Mt CO_2eq (Martin und Couwenberg 2021).

In its Annex III, the LULUCF proposal requires Member States to increase coherence of reporting between different policies. There is also the **need for more consistency in reporting across Member States**. Therefore, there should be consistency checks of Member States reported data with international independent reference data (e.g. remote sensing-based maps on organic soils, use of common EU data sets like Copernicus if no national data is available, etc.).

5.3 Risks to environmental integrity from inadequate long-term governance

Emissions and removals from the sector are very much driven by long-term trends and historic management decisions. This requires sufficient foresight with adequate tools. Currently, a serious lack of integrated long-term planning of land use continues to persist in EU Member States regarding its role for climate change mitigation.

[9] https://www.artredd.org/wp-content/uploads/2020/04/TREES-v1-February-2020-FINAL.pdf

Member States are required to report information on policies and measures expected to be taken in the LULUCF sectors in integrated National Energy and Climate Plans (NECPs) under the Governance Regulation adopted in 2018. However, revealingly despite an aggregation of projections under the initial iteration of these reports showing that around a third of the 2005 EU carbon sink could be lost by 2030 (EC 2020), **EU Member States also plan to significantly increase their reliance on bioenergy** over the same period without explaining how and where they will source this biomass, or what impact it will have on climate or biodiversity (Smith et al. 2021). Member States are expected to revise their NECPs by mid-2024 and the European Commission's LULUCF proposal suggests drawing on these plans to make further proposals for the contribution of each Member State towards its proposed 2035 climate-neutral land-use sector target, including agriculture. However, for the NECPs to usefully serve this role the plans and the strategies and planning instruments that inform them will have to be significantly improved.

With the recent reform of the EU's Common Agricultural Policy, Member States are also for the first time asked to submit national CAP strategic plans by 31 December 2021 describing the interventions they have chosen in implementing the CAP and how they contribute to the ambitions of the European Green Deal. Based on these strategic plans, the Commission will then have six months to approve the plans ahead of their implementation in January 2023. While it is still too early to draw final conclusions on the process, a critical analysis by NGOs of ecoschemes in 21 draft CAP strategic plans and their potential contribution to climate change mitigation revealed that the initial measures chosen my Member States are far from adequate (BirdLife Europe, EEB, WWF 2021). For example, the draft plans revealed that no country was planning an eco-scheme to support and incentivize paludiculture (productive use of wet peatlands) on formerly drained peatlands, and only three countries (Germany, Ireland and Poland) intended to use eco-schemes to support agroforestry or tree planting, a crucial climate mitigation and adaptation strategy with many co-benefits. Unless significantly revised, the **national CAP strategic plans are thus unlikely to deliver sufficient governance for the implementation of the required mitigation measures**, leaving even larger question marks on the rather optimistic view on mitigation costs for Member States in the LULUCF sector.

6 A new proposal for the amendment of the LULUCF Regulation

On December 17, 2021, the rapporteur for the LULUCF Regulation in the European Parliament's ENVI Committee published a draft report with his proposals for an amendment of the LULUCF Regulation (European Parliament 2021). The report suggests fundamental changes to the European Commission's proposal of July 2021 that include:

- an **increased EU net sink target** for the LULUCF sector of 490 Mt CO_2eq by 2030 and respective increased nationally binding targets for EU Member States;
- a **separate "no-debit" target** at EU level for Cropland, Grassland and Wetlands land-use categories for 2030;
- a **reduction in options for flexibilities** and constraints on their use;
- a **stronger compliance mechanism** in the form of a financial penalty of EUR 375 per tonne of CO_2eq and a stronger link between underperformance and member state planning obligations;
- a significant **strengthening of public financing** for ecosystem-based approaches;

- a complete **withdrawal from the integration of LULUCF and Agriculture** into a common accounting framework and target after 2030.

The following sections briefly describe these changes and provide some initial reflections on the proposals with regards to the topics discussed in this paper.

6.1 Increased and extended EU net sink targets

The draft report of the ENVI committee rapporteur proposes a **significantly higher net removal target for the LULUCF sector of 490 Mt CO_2eq by 2030**. This net removal target can be considered at the high end of the range of technical mitigation potentials based on modelling studies (Böttcher et al. 2021b). While technically possible, the timeline for reaching the target is incredibly ambitious given the current limited level of action by member states and the time lag regarding the effectiveness of mitigation options in the land use sector. Meeting the target would thus realistically require Member States to quickly ramp up the scale of mitigation measures in each of the LULUCF sub-sectors, especially those related to organic soils and forests with a particularly large mitigation potential. In fact, the proposal justifies the significant increase in the target in the medium-term with the difficulty of scaling the long-term natural sink potential. The proposal argues that realizing this potential requires a clear vision to be set out and concrete action to be stepped up already over this decade, suggesting that the changes required after 2030 would otherwise have to happen unrealistically fast.

As already foreseen by the Commission's proposal, the draft report also proposes that by mid-2024, Member States will need to include relevant measures for ensuring a sustainable and predictable long-term contribution of natural carbon sinks within the EU in their updated integrated national energy and climate plans (NECPs). However, the draft report also proposes that the Commission should develop further **net GHG removal targets for the LULUCF sector for the years 2035, 2040, 2045 and 2050** on the basis of these plans after taking into account the advice of the European Scientific Advisory Board on Climate Change and the Union GHG budget foreseen under the EU Climate Law. This implies that the instrument of separate net sink targets will be continued after 2030 and the European Scientific Advisory Board on Climate Change will be given a prominent role in this target setting process, two major differences to what the European Commission suggested in July 2021.

Last but not least, the Commission proposal and the draft report of the rapporteur have in common that a technical correction of the national targets will be allowed to ensure methodological consistency between the targets in Annex IIa and inventory data for Member States that improve the methodology used for their inventories. However, the ENVI Committee requires additionally that such a correction be subject to an independent scientific review. **Technical correction can significantly impact the target of Member States** if there are large changes in historic net emissions or removals for the reference period (see section 5.2). Table A-1 in the Annex of this report provides estimates of the potential impact of these technical corrections for the national targets for an EU net sink target of 310 Mt CO_2eq and of 490 Mt CO_2eq based on national GHG inventories submitted in 2020 and 2021.

6.2 Separate "no-debit" target for Cropland, Grassland and Wetlands land-use categories

To foster stronger climate action in land-use categories that are currently often contributing net emissions to the LULUCF sector, such as Cropland, Grassland and Wetland, the draft report

suggests that an **additional sub-target of "no-debit"** should be introduced for these categories at EU level for 2030. Such a target can be useful for increasing awareness of the hidden emissions in the EU net LULUCF sink. However, its effective implementation will also require enormous improvements in the quality of member state GHG inventories for these categories in order to identify emission sources and respond with adequate mitigation measures.

The national GHG projections of Member States provide ample justification for the introduction of the proposed sub-target. According to data submitted by member states to the EEA[10] the **combined emissions from Cropland and Wetlands are only expected to be reduced slightly from 77.4 Mt CO_2eq in 2019 to 65.3 Mt CO_2eq in 2040** assuming existing measures. More worryingly, emissions from Grassland are even expected to increase from 11.9 Mt CO_2eq in 2019 to 15.2 Mt CO_2eq in 2040. Given the relatively high abatement costs for these sectors assumed in the European Commission's Impact Assessment (see above), the target can be considered very ambitious and quite difficult to realize in the given timeframe. If achieved, meeting this sub-target alone would allow the EU's net sink to reach 330 Mt CO_2eq in 2030, assuming that the sink in other categories remains unchanged from today.

6.3 Reduced flexibilities

The draft report of the ENVI committee rapporteur also proposes significant changes to options for flexibilities for Member States to achieve their targets. The original LULUCF Regulation allowed Member States to delete emission allocations under the ESR to compensate net debits resulting from LULUCF Regulation. The rapporteur's amendments to Article 12 mean that this **flexibility with the ESR** would **no longer available for Member States**. Under Article 12, the rapporteur also proposes more strictly regulating the trade of transfer surplus removals between Member States by imposing a **minimum price of EUR 250 per tonne of CO_2eq** and requiring that revenues be invested into projects promoting ecosystem-based approaches or protecting and restoring biodiversity.

Under Article 13, requirements for the managed forest land flexibility are increased. Amendments in the draft report would require Member States to demonstrate progress in relation to their efforts regarding the conservation of habitats (in relation to EU Habitats and Birds Directives) and ensure that the planned measures for **sink enhancement and conservation foreseen in their Long Term Strategies under the Governance Regulation contribute also to enhancing biodiversity and reduces vulnerability to natural disturbances**. Furthermore, the draft report proposes tightening the newly introduced Article 13b of the Commission's proposal that provides Member States flexibilities for the period 2026 to 2030 if they face impacts of natural disturbances. The rapporteur suggests that the "Natural disturbances solidarity mechanism" is reduced by 50% to allow for **compensation for natural disturbances at a maximum of 89 Mt CO_2eq**.

6.4 Strengthened compliance

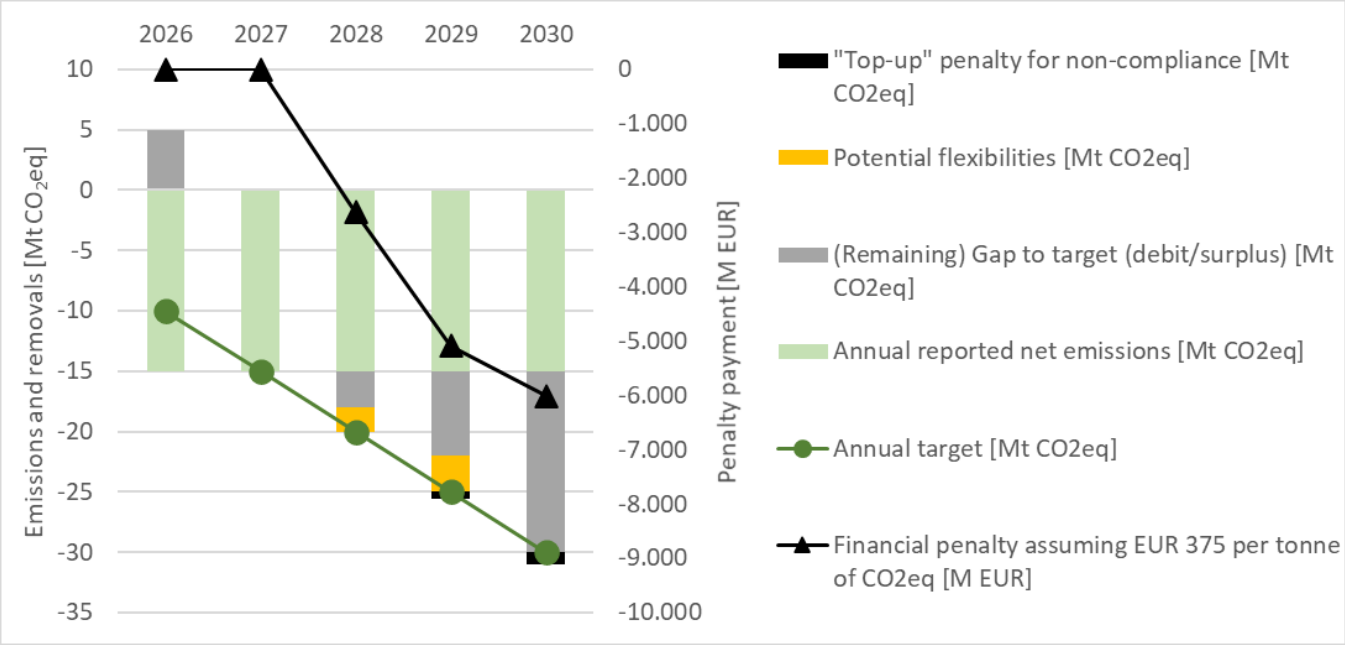
The draft proposal of the rapporteur proposes significantly strengthening the compliance mechanism under the LULUCF Regulation by imposing a **financial penalty of EUR 375 on Member States for each tonne of CO_2eq in excess of the annual national target** in the given year after 2026. This penalty would be applied following a comprehensive review to be carried out by the European Commission in 2032.

[10] https://www.eea.europa.eu/data-and-maps/data/greenhouse-gas-emission-projections-for-8

Furthermore, the rapporteur proposes that this penalty should come on top of existing compliance rules under the LULUCF Regulation, which impose a penalty for non-compliance in the form of a "top up" to member state targets. Under these "top up" rules 108 % of the gap between the assigned target and the net removals reported in the given year are to be added to the greenhouse gas emission figure reported in the subsequent year by the Member State.

While it is unclear from the wording of the text whether the two penalties will be applied separately or in a cumulative fashion, the proposal amounts to a **significant stick to incentivize climate action**. To put the proposed financial penalty into perspective Figure 6-1 provides a hypothetical case of non-compliance with the use of flexibilities and application of the "top-up" penalty.

Figure 6-1: Hypothetical case of non-compliance with use of flexibilities and application of "top-up" penalty



Source: Own compilation

Finally, the draft report also introduces an enhanced governance process for target achievement in the LULUCF sector by strengthening the link between the underperformance of Member States and their medium and long-term planning requirements. The draft report proposes that Member States which fail to meet their annual targets in two consecutive years will also be required to **revise their National Energy and Climate Plans and Long-term Strategies, and ensure additional action is taken**. These revisions are to take place within six months of the second year in which the Member State concerned fails to meet its annual targets. For example, a Member State failing to meet its annual target in 2026 would have to submit a revised NECP and Long-term strategy and adopt additional policy measures by 30 June 2028. Furthermore, the draft report proposes that the European Commission should be permitted to issue recommendations on how the plans should be revised and open an infringement procedure where its finds have been insufficiently amended to meet the annual targets of the Member State concerned.

6.5 Financial support for ecosystem-based approaches

The draft report includes a number of proposals relating to the financing of measures needed to deliver on the LULUCF regulation targets, with a particular emphasis on “ecosystem-based approaches”.

First, the draft report requires that the European Commission submit a report to the European Parliament and the Council within six months after entry into force of the regulation **assessing the consistency of different funding instruments** under the Union budget and the EU’s Recovery and Resilience Facility (RRF) with the commitments and targets in the LULUCF Regulation. This report should also identify ways of **increasing financial support for ecosystem-based approaches in forests and agricultural land**. In this context, the draft report specifically mentions the Common Agricultural Policy (CAP), LIFE, the Cohesion Funds, Horizon Europe, the RRF, the Just Transition Fund and EU ETS revenues as potential sources of funding.

Second, the draft report makes several concrete proposals with regards to financing these ecosystem-based approaches. The rapporteur proposes requiring Member States to use at least 5 % of public revenues under the EU ETS to **support land managers implementing ecosystem-based approaches in forest and agricultural land**. The rapporteur also suggests that Commission be empowered to adopt delegated acts to collect the previously mentioned financial penalties for non-compliance after 2032 and proposes this money be used for financing similar programs. Finally, rapporteur proposes requiring Member States purchasing allowances under LULUCF regulation to pay a minimum price of EUR 250 per tonne of transferred removal and requires the country selling the allowances to use all of the revenues generated from these transfers towards increasing removals by promoting ecosystem-based approaches and protecting and restoring biodiversity.

Third, the draft report proposes empowering the European Commission to adopt delegated acts to develop **common criteria for the selection of projects to receive financing for ecosystem-based approaches**. The related amendments emphasize that these criteria should be “objective, science-based and transparent”, should “reward practices whose climate and environmentally benefits are scientifically proven and that lead to the sustainable and long-term increase of carbon sequestration in soils and biomass while ensuring societal co-benefits”. Moreover, the proposal requires the Commission to consult the European Scientific Advisory Board on Climate Change and civil society and relevant stakeholders before adopting the delegated act.

Given the potentially high public financing costs for meeting the LULUCF targets identified in this report and the observed limited prioritization of natural sinks in national CAP strategic plans, these proposals are a critical improvement of the Commission proposal. It is difficult to estimate the total volume of revenues that these proposals would generate. However, based on the existing EU funding sources to be mobilized, current ETS projections and the potential scale of the revenues generated by financial penalties, it can be assumed that proposed mechanisms would generate revenues **totalling multiple billion euros per year**. Moreover, based on the conditions proposed for the use of the funding, these additional revenues would not only be dedicated to ecosystem-based approaches and climate mitigation in the LULUCF sectors, but be targeted at proven and environmentally sound projects and secured over a longer time-horizon.

6.6 The removal of AFOLU provisions without a sub-target for agriculture

Finally, the draft report removes all provisions of the European Commission's proposals that would initiate a transition to an integrated Agriculture and LULUCF land-use or "AFOLU" sector after 2030. More specifically, the rapporteur proposes deleting provisions that would integrate non-CO_2 emissions from Agriculture into the LULUCF Regulation after 2030 and removes the proposed collective commitment by Member States to climate-neutrality in the land-sector by 2035. In the justifying these deletions the rapporteur argues that he "sees no benefit for bringing non-CO_2 emissions of agriculture into LULUCF, [and sees a] risk of hiding emissions from the agricultural sector behind forest sink […] without incentives for the agricultural sector to decrease emissions."

The continued separation would indeed arguably reduce the risk caused by reversals of removals by natural carbon sinks and the asymmetry of GHG emission reduction and sink enhancement by maintaining a strict firewall between the two (Zickfeld et al. 2021). In doing so, the proposal also prevents net-removals in the land-use sector being used to compensate agricultural non-CO_2 emissions in the period post-2030. However, by preventing the transition to an AFOLU regime and the commitment to a climate-neutral AFOLU sector by 2035, the draft report also arguably weakens the regulatory framework with regards to non-CO_2 emissions from agriculture on the whole.

While agricultural non-CO_2 emissions are to remain regulated under the ESR until 2030, no sector target is currently foreseen for the agriculture sector at EU level. This failure to address agriculture more specifically is problematic given that the ESR has historically failed to deliver significant emission reductions in the agriculture sector. According to EEA data, while emissions in the sectors covered by the ESR have declined by roughly 10 % between 2005 and 2019, agriculture contributed only about 3 % of the total emissions reduction effort in this period despite representing the third largest source of ESR emissions and 12 % of total EU-27 GHG emissions (EEA 2021). Moreover, based on projections reported by Member States, little further progress is currently expected in the agriculture sector, with emissions only expected to decline by an additional 4% by 2030. In fact, based on a review of member state NECPs and related planning documents, as few as nine Member States have currently even set quantitative GHG emissions reduction targets for the agriculture sector: Croatia, France, Germany, Ireland, Lithuania, Luxembourg, Slovenia, Spain and Sweden.

In this context, the common commitment of Member States to a climate-neutral land sector by 2035 could represent an important binding target framework in which agricultural non-CO_2 emissions would come under increasing pressure to reduce emissions. This is because the target could prove difficult to achieve without significant emissions reductions in the Agriculture sector. For example, if the LULUCF sink was still at the European Commission's proposed 2030 target of -310 Mt in the year 2035, Agricultural non-CO_2 emissions would have to decline from an estimated 384 Mt CO_2eq in 2020 to 310 Mt CO_2eq in 2035, a reduction of nearly 20 %. The earlier the target date for a climate-neutral land-sector is imposed, the more stringent it would also prove in practice. For example, setting a target for achieving a climate-neutral land-use sector by 2030 would require these emissions reductions to be achieved in the Agriculture sector by this date, or to be compensated by higher LULUCF sinks.

A separate approach that would more directly regulate non-CO_2 emissions in the Agriculture sector would be to introduce a dedicated and binding sectoral target for these emissions. For example, the European Environmental Bureau (EEB) has proposed setting a binding target for the Agriculture sector of 350 Mt CO_2eq by 2030 (-20 % compared to 2005 level), next to a binding net-zero target for agriculture-related land use emissions by 2030, as proposed in the draft report for the LULUCF Regulation in the ENVI committee (EEB 2021). Moreover, they propose strictly limiting the use of flexibilities between emitting sectors and the LULUCF sectors to between the residual emissions

from Agriculture and the LULUCF sink from agricultural lands. This approach would have the advantage of explicitly setting a policy target for the Agriculture sector while limiting the risk that flexibilities would undermine this ambition, and could in principle be implemented outside of the AFOLU regime by setting a sectoral target for agricultural non-CO_2 emissions in the ESR. However, based on her draft report from 17 January 2022 the rapporteur for the Effort Sharing Regulation, Jessica Polfjärd of the EPP, does not include such a sectoral target among her proposals.

7 Conclusions

The Commission proposal for a revision of the LULUCF Regulation constitutes a paradigm shift in multiple ways, including changes to the rules for accounting of LULUCF, introducing absolute EU and national binding targets for the period 2026 to 2030, establishing a land-use pillar that includes both LULUCF emissions and removals and non-CO_2 emission from the agriculture sector after 2030, increasing fungibility of fossil and biogenic carbon expressed by the full integration of LULUCF in the overall 2030 EU climate target. The proposal also aims at enhancing quality of monitoring and reporting in EU Member States. This is especially needed for a number of specific land-use categories and sub-categories, including those on organic soils.

It can be concluded that assumptions from the EC impact assessment underlying the proposal for a revision of the LULUCF Regulation are partly underestimating mitigation costs and therefore overestimating the mitigation potential in the lower cost range (0-10 EUR/t CO_2eq). This could be confirmed for Germany and Finland through bottom-up case-study analysis. A particularly large discrepancy exists between estimates of costs for the rewetting of organic soils. However, additional inconsistencies are found between baseline assumptions, i.e. how much mitigation can be assumed for no additional costs.

The models applied in the European Commission's impact assessment also do not cover all aspects of mitigation measures, e.g. by referring mostly to opportunity costs but not technical implementation costs. This applies especially for options regarding rewetting of organic soils.

These findings suggest that the public expenditures required by Member States for realising mitigation potentials in the sector are also likely to be significantly underestimated.

Finally, based on the observations above the paper identifies a number of remaining challenges that need to be addressed for **ensuring environmental integrity** of the integration of LULUCF in EU climate policy. These include

- ensuring permanence of land-based mitigation especially as a precondition for a further enhancement of fungibility and transfer including carbon markets;
- tackling remaining uncertainties in GHG inventories; and
- ensuring sufficiently robust long-term planning for more coherent governance of the land-use sector.

The suggested amendments to the Commission's proposal by the rapporteur of the European Parliament's ENVI committee would in part address the challenges identified in this report. The suggested amendments strengthen the LULUCF Regulation regarding financing, address the issue of permanence by imposing a strict firewall between the land-use sectors and the Effort Sharing Regulation and significantly enhance the governance and scientific oversight. The draft report also proposes significantly increasing the 2030 LULUCF target to 490 Mt CO_2eq and introducing a new net-zero target for the agriculture-related land-use categories, both of which represent a significant

increase in the ambition-level of the LULUCF Regulation. However, the proposals in the draft report also raise important new questions. Given the challenges assessed in this report regarding costs, today's insufficient regulatory framework in Member States and the slow speed of mitigation measures in the land-use sector, implementation by Member States of the proposed climate targets seems to be hardly reachable by 2030. Moreover, a de facto prohibition of carbon markets for natural removals and reversal of the Commission proposal to transition to an AFOLU regime after 2030 takes clear positions on regulatory questions that represent difficult trade-offs due to potential risks for environmental integrity, but in doing so also sacrifices the potential financial and regulatory opportunities presented by these options.

Annex I Sensitivity of national targets to changes in reported data

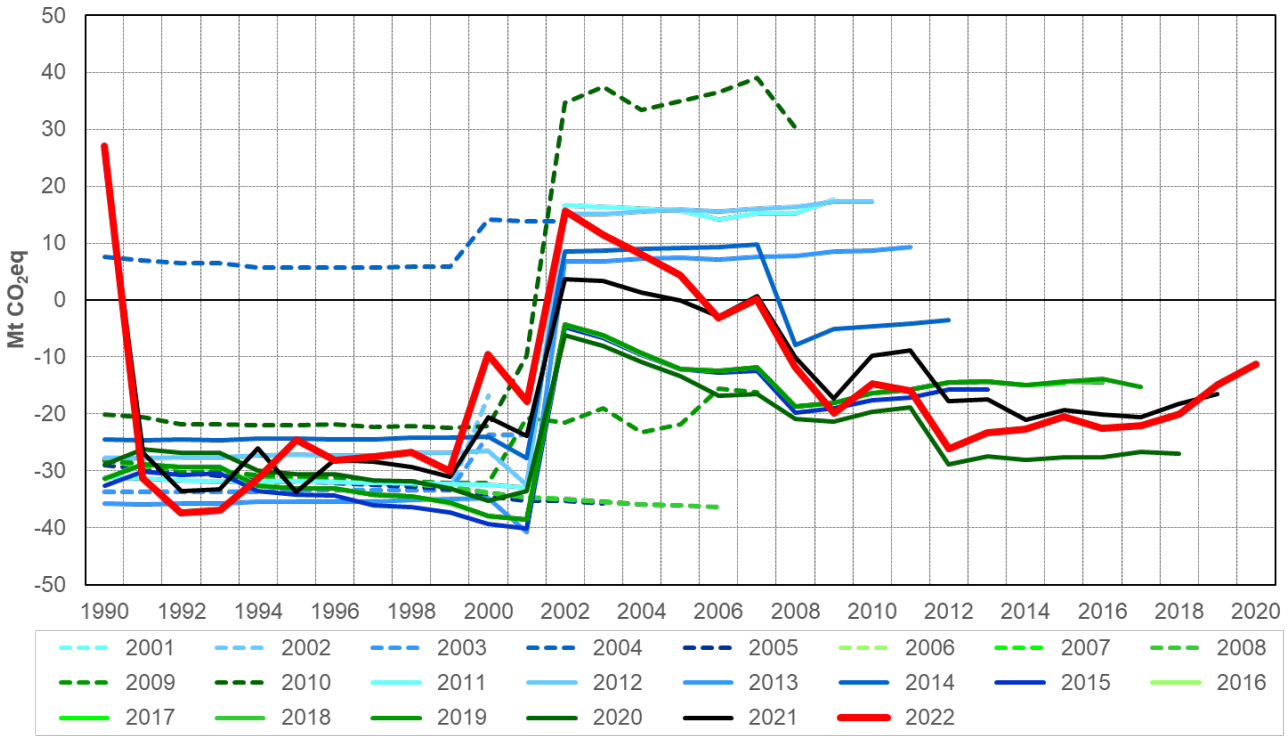
Table A-1: Calculation of national targets using 2021 submission, Mt of CO_2eq

Member State	Submission 2020			Submission 2021		
	Historic average (2016-2018)	National target in 2030 according to Annex IIa	Amended national target in 2030 according to Annex IIa	Historic average (2016-2018)	Technically corrected target (total - 310 Mt)	Technically corrected amended target (total - 490 Mt)
Austria	-4.8	-5.7	-9.6	-4.6	-5.4	-8.9
Belgium	-1.0	-1.4	-2.7	-1.3	-1.6	-2.9
Bulgaria	-8.5	-9.7	-14.7	-9.4	-10.4	-15.1
Croatia	-4.9	-5.5	-8.0	-5.2	-5.8	-8.1
Cyprus	-0.3	-0.4	-0.6	-0.3	-0.3	-0.8
Czechia	-0.4	-1.2	-4.7	-2.0	-2.7	-6.0
Denmark	5.7	5.3	3.5	2.3	1.9	0.1
Estonia	-2.1	-2.5	-4.4	-1.8	-2.2	-4.1
Finland	-14.7	-17.8	-30.0	-13.6	-16.2	-30.9
France	-27.2	-34.0	-62.5	-32.3	-38.5	-66.4
Germany	-27.0	-30.8	-46.8	-19.6	-23.1	-38.0
Greece	-3.2	-4.4	-9.3	-3.6	-4.7	-10.4
Hungary	-4.8	-5.7	-9.7	-4.9	-5.8	-9.7
Ireland	4.3	3.7	1.1	5.4	4.8	1.8
Italy	-32.6	-35.8	-49.2	-32.3	-35.2	-47.8
Latvia	0.0	-0.6	-3.4	-1.6	-2.2	-4.9
Lithuania	-4.0	-4.6	-7.7	-6.8	-7.4	-10.1
Luxembourg	-0.4	-0.4	-0.5	-0.4	-0.4	-0.5
Malta	0.0	0.0	0.0	0.001	0.0	0.0
Netherlands	5.0	4.5	2.7	4.7	4.3	2.6
Poland	-34.7	-38.1	-52.0	-34.0	-37.1	-50.0
Portugal	-0.4	-1.4	-5.5	-0.3	-1.1	-5.1
Romania	-23.1	-25.7	-35.9	-28.5	-30.8	-40.7
Slovakia	-6.3	-6.8	-8.9	-6.3	-6.8	-8.8
Slovenia	0.1	-0.1	-1.0	0.9	0.7	-0.1
Spain	-38.3	-43.6	-66.2	-38.8	-43.6	-64.7
Sweden	-43.3	-47.3	-64.1	-37.2	-40.5	-60.4
EU-27	**-266.9**	**-310.0**	**-490.0**	**-271.5**	**-310.0**	**-490.0**

Source: Own compilation based on UNFCCC reported data, European Commission 2021, European Parliament 2021

Annex II Historic recalculations of the German national GHG inventory, sector LULUCF 2001 to 2021

Figure A-1: Net emissions and removals from LULUCF as reported in Germany's national GHG inventory in submission 2001 to 2022 covering years 1990 to 2020



Source: Matthes 2021; UBA 2022

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