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IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Regulation of the European Parliament and the Council

amending Regulations (EU) 2018/841 as regards the scope, simplifying the compliance rules, setting out the targets of the Member States for 2030 and committing to the collective achievement of climate neutrality by 2035 in the land use, forestry and agriculture sector, and (EU) 2018/1999 as regards improvement in monitoring, reporting, tracking of progress and review

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Glossary

Term or acronym	*Meaning or definition*
accounting	The use of standardised rules for taking into account emission and removal estimates in the context of target compliance.
biomass	Organic material both above ground and below ground, and both living and dead, e.g. trees, crops, grasses, tree litter, roots etc.
carbon pool	A system which has the capacity to accumulate or release carbon. Examples of carbon pools are forest biomass, wood products, soils, and atmosphere.
carbon stock	Mass of carbon stored in a carbon pool.
emission factor	A coefficient that relates the activity data to the amount of chemical compound which is the source of later emissions. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.
forest reference level	An estimate, expressed in tons of CO2 equivalent per year, of the average annual net emissions or removals resulting from managed forest land within the territory of a Member State in the periods from 2021 to 2025 and from 2026 to 2030, based on the criteria set out in Regulation (EU) 2018/841.
forest management	A system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest.
GHG	Greenhouse gas
harvested wood product	Any product of wood harvesting that has left a site where wood is harvested.
ILUC	Indirect Land Use Change
LULUCF	Land Use, Land Use Change and Forestry
natural disturbances	Any events or circumstances that cause significant emissions in forests and the occurrence of which is beyond the control of the relevant Member State, and the effects of which the Member State is objectively unable to significantly limit, even after their occurrence, on emissions.
NECP	National Energy and Climate Plan
LULUCF Regulation	Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 https://europa.eu/!WC78xY
removals	any process, activity or mechanism that removes a greenhouse gas, an aerosol, or a precursor to a greenhouse gas from the atmosphere

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

1.1. The European Green Deal

The European Green Deal[1] aims to transform the EU into a fairer and more prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases by 2050 and where economic growth is decoupled from resource use. The climate neutrality objective has been endorsed by the European Council[2] and Parliament[3] and is laid down in a legally binding manner in the proposed European Climate Law[4].

The European Green Deal also aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive. It must put people first, and pay attention to the regions, industries and workers who will face the greatest challenges.

The necessity and value of the European Green Deal have only grown in light of the very severe effects of the COVID-19 pandemic on our health and economic well-being. Unprecedented near term investments will be needed to reverse the negative impacts of the COVID-19 crisis on jobs, incomes and businesses. In this regard, the agreed Next Generation EU recovery instrument and its centerpiece, the Recovery and Resilience Facility, with a budget of EUR 672.5 billion, will strongly support the green and digital transitions, with at least 37% allocation to the first and 20% to the latter.

1.2. The "Fit for 55" package

With its Communication on stepping up Europe's 2030 climate ambition (the 2030 Climate Target Plan)[5], the Commission proposes to raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030 in a responsible way. This is a substantial increase compared to the existing target of at least 40%. It is in line with the Paris Agreement[6] objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C.

The December 2020 European Council (hereafter referred to as European Council) confirmed these climate targets[7]. It asked for delivering the target collectively by the EU in the most cost-effective manner possible, preserving EU's competitiveness and taking account of Member States' different starting points, specific national circumstances and emission reduction potential. It gave further guidance on key elements for a 2030 Climate and Energy Policy Framework. The European Council invited the Commission to rapidly present all the remaining relevant proposals to this end so as to swiftly inaugurate the legislative process. To this end, the Commission has started the next steps towards implementing these targets and will review the relevant climate-related policy instruments.

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[1] COM(2019)640, https://europa.eu/!uM68tX

[2] European Council conclusions, 12 December 2019, https://europa.eu/!yN48NG

[3] European Parliament resolution of 14 March 2019 on climate change and resolution of 28 November 2019 on the 2019 UN Climate Change Conference in Madrid, Spain (COP 25), https://europa.eu/!tb49fv

[4] COM(2020)80 final amended by COM(2020)563 final, https://europa.eu/!GH37Bu

[5] COM(2020)562 final, https://europa.eu/!uR93tq

[6] http://unfccc.int/paris_agreement/items/9485.php

[7] European Council conclusions, 10 and 11 December 2020, https://europa.eu/!KU68MG

This Impact Assessment focuses on the revision of the Land Use, Land Use Change and Forestry (LULUCF) Regulation[8], which covers the CO2 emissions and removals and other GHG emissions resulting from our management of land, forests and biomass, for the period 2021-2030. This Regulation has brought nature-based carbon removals in the EU climate framework for the first time, to reflect their role in reaching climate neutrality. The importance of the LULUCF sector has been reinstated when the European Commission proposed, with the Climate Target Plan, to include this sector in the formulation of the -55% target for 2030. The contribution of net removals to the 2030 Union climate target should be limited to 225 million tonnes of CO2 equivalent. In the context of the overall political agreement, the Commission reaffirmed in a corresponding statement its intention to propose a revision of the LULUCF Regulation in line with the ambition to increase net carbon removals to levels above 300 million tonnes of CO2 equivalent in the LULUCF sector by 2030.

Therefore, this Impact Assessment aims to inform three policy options to increase net removals in the LULUCF sector, which were first identified in the Climate Target Plan: moving towards a more ambitious contribution from the sector, looking into the flexibility between the LULUCF and the Effort Sharing sectors, and creating a combined target for agricultural emissions and LULUCF emissions and removals.

Among the other "Fit for 55" initiatives, the revision of the Effort Sharing Regulation (ESR) is the one that can mostly affect the scope, choices or impacts of this initiative. In particular, the choice about the scope of the ESR can directly affect the feasibility of a combined target for the LULUCF and the agriculture sector, because the agriculture sector is currently within the scope of the ESR.

1.3. The LULUCF sector

The land use, land use change and forestry (LULUCF) sector covers anthropogenic greenhouse gas emissions and carbon removals occurring on land ecosystems, i.e. carbon stock changes in soils and biomass, as well as carbon removals in long-lasting wood products. This sector provides the basis for human livelihoods and well-being including the supply of food, freshwater and multiple other ecosystem services, as well as biodiversity.

Actions that can protect the stored carbon or that can enhance the carbon sequestration capacity of the land include planting trees, restoring forests, practicing agroforestry, adopting agricultural and forestry practices that protect and enhance soil carbon, protecting wetlands, restoring peatlands, or promoting long-lasting and circular wood products. The climate impact of agricultural activities such as livestock rearing and fertiliser use are covered under the Effort Sharing Regulation[9].

The views of stakeholders

Stakeholders who replied to the Open Public Consultation on the revision of the LULUCF Regulation expressed their opinion on which kind of actions should be prioritised in the LULUCF sector. They considered the following actions as important or very important: Afforestation, reforestation and forest restoration (77%); Protection and restoration of wetland and peatland ecosystems (69%); Soil carbon increase in agricultural land (69%); Carbon storage in long-lasting wood-based materials and

[8] REGULATION (EU) 2018/841, https://europa.eu/!dD98cC
[9] REGULATION (EU) 2018/842, https://europa.eu/!NU43BG

products (66%); Agro-ecology and agro-forestry, as well as grassland management (55%). See Annex 10.2.3 for more details.

The LULUCF sector is connected to all ecosystems and economic activities that rely on the land and the services it provides. Therefore, the LULUCF Regulation presents synergies with many other EU policy initiatives that cover land-related activities. **Error! Reference source not found.** shows such relationships in a schematic manner.

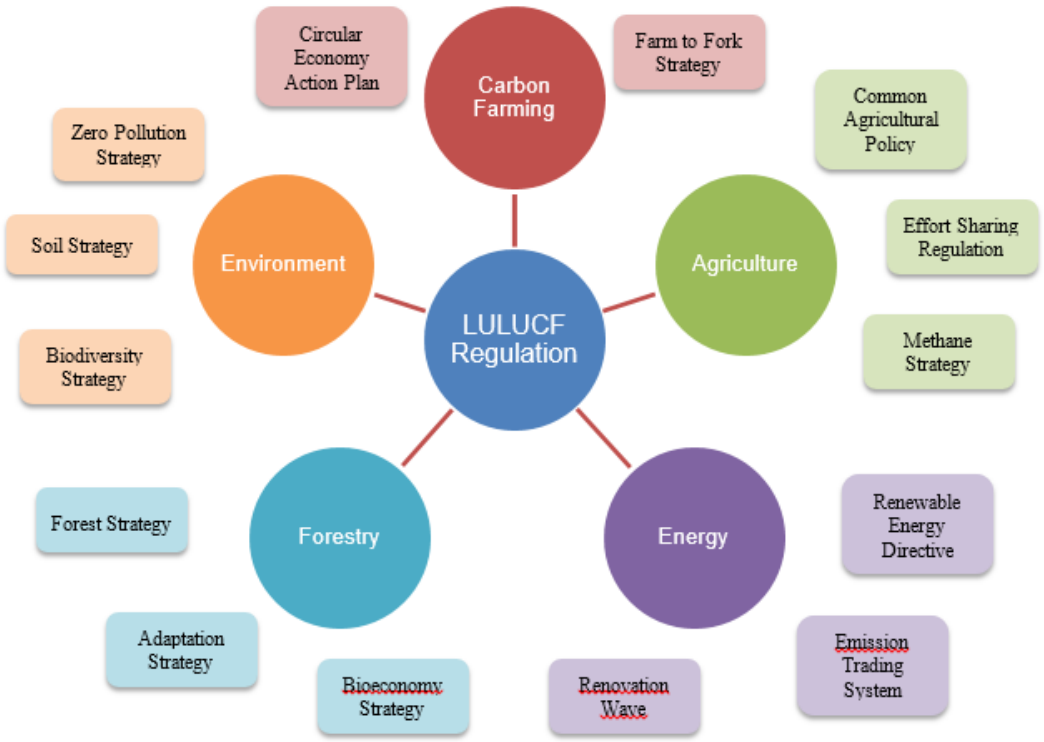


Figure 1- Relationship between the LULUCF Regulation and other EU policy initiatives

1.4. The current LULUCF Regulation

The LULUCF Regulation primarily addresses Member States by establishing a minimum level of climate mitigation performance in the LULUCF sector; it does not set any reporting or compliance requirements for individual land managers.

Under the current LULUCF rules, the minimum amount of removals that the LULUCF sector should provide at the EU level in 2030 is around -225 MtCO2eq[10]; the minimum commitment levels in each Member State are designed to ensure that land management practices do not become *worse* from the perspective of climate change mitigation. If removals are smaller than these levels, a Member State may generate LULUCF debits, and if they are larger, it may generate LULUCF credits. The LULUCF Regulation commits Member States to avoid creating any debit[11]; if this happens, a Member State must step up emission reduction efforts in its Effort Sharing sectors to compensate the deficit[12], or it can buy LULUCF credits from other Member States. Finally, Member States can use a limited amount of LULUCF credits to help achieve ESR national

[10] See Section 10.4.2 for more information on how this number is computed.

[11] This is the so-called 'no-debit' commitment enshrined in Article 4 of REGULATION (EU) 2018/841, https://europa.eu/!dD98cC

[12] If LULUCF accounted emissions exceed accounted removals, ESR annual emissions allocations are deleted, de facto increasing the ESR target for the Member State. This governance is assured through Art 9 of REGULATION (EU) 2018/842, https://europa.eu/!NU43BG

targets [13] (so-called 'flexibility'). More details about the LULUCF Regulation are provided in Section 5.1.

2. PROBLEM DEFINITION

2.1. What are the problems?

This section identifies three specific problems related to the contribution of the LULUCF sector to a higher climate ambition in 2030 and to climate neutrality in 2050. These are:

1. The fact that net LULUCF removals have been significantly decreasing in recent years;

2. The presence of unexploited opportunities to address climate action in the land sector in an integrated manner;

3. Challenges to implement the accounting, monitoring and reporting rules as set out in the current LULUCF Regulation.

Figure 2 summarises these three specific problems (described in sections 2.1.1 to 2.1.3), their drivers (described in sections 2.2.1 to 2.2.3), and the corresponding objectives (described in sections 4.2.1 to 4.2.3).

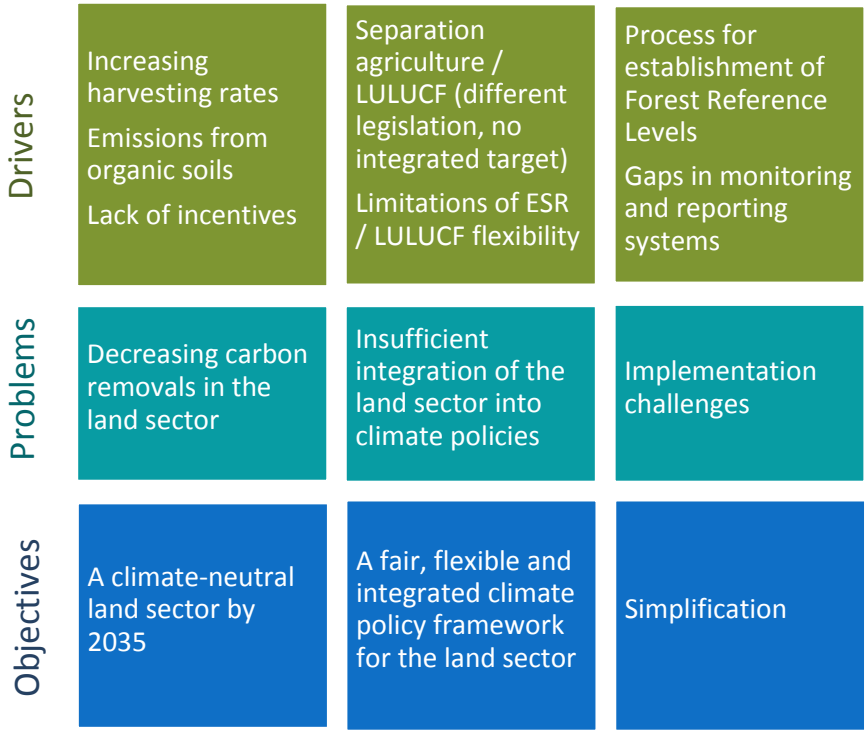


Figure 2 – Summary of the specific problems, their drivers, and the corresponding objectives

2.1.1. Specific problem #1: Decreasing carbon removals in the land sector

Land-based mitigation action can have very long lead times, which means that it can take years or decades for it to deliver the desired mitigation outcome; for instance, afforestation put in place now will only provide significant carbon removals in the

[13] REGULATION (EU) 2018/842, Article 7, https://europa.eu/!NU43BG

next decade(s). This fact, and the fact that land-based carbon removals will play an important role in achieving the EU's 2050 climate neutrality objective, means that the next decade will be crucial to take the actions needed to put the LULUCF sector on the right trajectory towards a climate-neutral EU. Such trajectory would require net LULUCF removals to increase from their current level to around -400 MtCO2eq in 2050 (depending on the parallel developments of technology-based carbon removals and of lifestyle changes[14]). Unfortunately, the recent trend has been going in the opposite direction: in only five years, from 2013 to 2018, almost a fifth of the net carbon removals in the LULUCF sector were lost (see more info in Box 1). Thus, the first specific problem that this initiative will address is the **decreasing carbon removals in the LULUCF sector**.

Box 1 – An overview of the LULUCF sector

The LULUCF sector in the EU GHG inventory results in net carbon removals (that is, removals outweigh emissions, or the amount of carbon sequestered from the atmosphere is larger than the amount of stored carbon which is released back into the atmosphere). In terms of land use categories, only Forest land provides net removals. Cropland is the largest source of emissions, followed by Settlements, then by Wetlands. In recent years Grasslands has been a small source of emissions.

CO2 emissions due to the combustion of biomass for energy are also captured under the LULUCF sector (when and where the biomass is harvested); see Annex 10.6 for more information on the treatment of biomass emissions in EU law. In addition, Harvested Wood Products store the carbon fixed by forests, delaying its emissions compared to wood used for energy.

Between 2013 and 2018, the EU27 saw its net LULUCF removals decline by 19%, from -325 MtCO2eq to -264 MtCO2eq, according to the 2020 national GHG inventory submission to the UNFCCC. This decline in carbon removals is driven by a mix of factors, including an increase in wood demand, an increasing share of forests reaching maturity in terms of production management, and an increase in natural disturbances such as insect infestations, storms, droughts and forest fires. This sharp decline contrasts with the general increase in removals that could be observed previously: between 1990, the beginning of GHG inventories, and 2006, year of the maximum reached, removals had grown from -255 MtCO2eq to -336 MtCO2eq.

Not all land categories contribute equally to these variations. Between 2013 and 2018, forest net carbon removals have decreased by 18% (from -425 to -347 MtCO2eq) while net carbon removals in the Harvested Wood Product carbon pool have increased by 50% (from -28 to -42 MtCO2eq). Emissions from cropland have decreased by 10% (from 59 to 53 MtCO2eq) while emissions from grassland and wetlands have remained stable (respectively, around 8-9 and 17-18 MtCO2eq), and emissions from settlements have increased by 9% (from 41 to 45 MtCO2eq). Figure 3 shows the evolution of LULUCF emissions and removals in the EU27 from 2005 to the latest reported year, 2018.

[14] More precisely, the modelling underpinning the "A Clean Planet for All" communication shows that 2050 climate neutrality would require net LULUCF removals around -350 MtCO2eq assuming a significant deployment of technology-based carbon removals, or -475 MtCO2eq with less technological solutions but changes in lifestyle, including diets. See Figure 87 in the in-depth analysis accompanying that Communication.

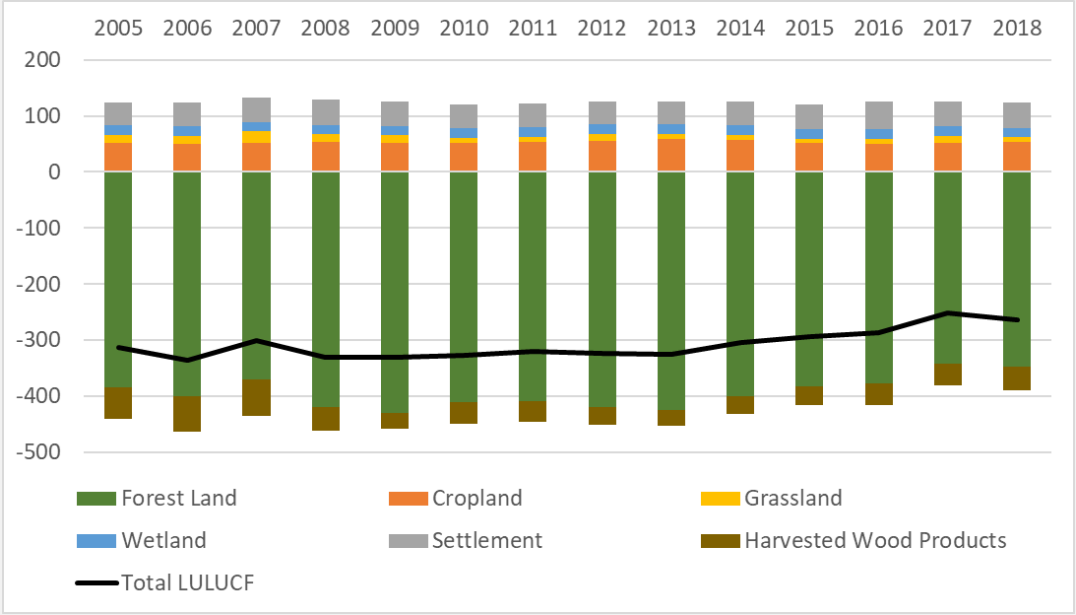


Figure 3 – Recent trends in the LULUCF sector, EU27. Unit: Mt CO2eq.

2.1.2. Specific problem #2: Insufficient integration of the land sector into climate policies

Besides its capacity to store and sequester carbon, land provides many other important products and services: it supplies the bioeconomy sectors with food, feed and feedstocks, provides habitats for biodiversity and many ecosystem services vital for life (e.g. water and air purification), and protects us from some of the consequences of climate change (e.g. floods and desertification). The **interdependence** between these functions and the capacity of the LULUCF sector to sequester carbon from the atmosphere calls for an integrated approach to climate action in the land sector, in order to optimise land use planning and identify win-win practices.

The potential to increase land-based carbon removals and the associated costs are unevenly distributed across Member States. A key factor is the area available for climate action, which depends on topographic or economic factors. Furthermore, the type of soil and land use, combined with other climate-related factors and latitude, all impinge on the potential to enhance removals. The mitigation potential and costs also differ within the land sector; for instance, in the same Member State there can be more opportunities for increasing removals than for decreasing agricultural emissions, or vice versa. Thus, the policy framework needs to provide some flexibility to address the climate performance of the land sector. The current framework addresses this need by allowing to use the overachievement of ESR targets for LULUCF compliance, or vice versa (for more information on the current framework, see Section 5.1); however, the analysis of the National Energy and Climate Plans indicates that the current flexibility opportunities are not an integral part of Member States' climate strategies (see section 2.2.2 for more details). This points to a need to revise the policy framework to make it more conducive to an optimisation of land use, and to promote a more strategic view of the role of the land sector in the achievement of Union and national climate targets.

2.1.3. Specific problem #3: Challenges to implement the accounting, monitoring and reporting rules as set out in the current LULUCF Regulation

The LULUCF rules determine the extent to which mitigation performance in the LULUCF sector can contribute to the current 2030 EU target (-40%). The current 2030

EU target is expressed in terms of a reduction of emissions from other sectors than LULUCF; the LULUCF sector can affect its achievement via the flexibility with the ESR. Therefore, the LULUCF Regulation defines a set of accounting benchmarks to determine the threshold for this flexibility: this is the so-called "no-debit" target, whose under- or over-achievement triggers, respectively, a deletion of ESR allowances or the (limited) use of LULUCF credits for ESR compliance (for more information on the current Regulation, see Section 5.1). The preparation for the implementation of the LULUCF Regulation has shown that these accounting rules create some regulatory costs; in particular, the benchmark for Managed Forest Land, the so-called Forest Reference Level (FRL)[15], is technically[16] and politically complex (see more details in Section 2.2.3). A study analyzed further possible challenges with regard to technical implementation in view of LULUCF compliance[17].

These accounting rules were originally designed in the Kyoto Protocol context, mainly to address issues such as lack of confidence in LULUCF estimates, additionality, permanence, and the risk to dilute efforts in other sectors. Importantly, these rules have always been applied when LULUCF was *not* included in the base year upon which the economy-wide emission reduction percentage was calculated (i.e. under the Kyoto Protocol and for the current –40% EU target in 2030). The "credits" or "debits" resulting from the application of the accounting rules were then added on top of the other sectors to assess compliance towards the emission reduction target. Therefore, this accounting approach may not be strictly needed anymore, given the way that the new 2030 target (-55%) is expressed in the Climate Target Plan, and which is now under discussion in the context of the Climate Law. To be coherent with the economy-wide target recommended by the Paris Agreement and with the EU's 2050 climate neutrality target, the new -55% target is expressed in terms of *net* emissions and thus fully includes the LULUCF sector. In this context, considering the full amount of LULUCF emissions and removals reported in GHG inventories for the compliance towards the 2030 target would ensure methodological consistency with the way LULUCF is included in the 1990 base year. This hints at the possibility to treat the LULUCF sector like any other sector, subject to a single removal target rather than governed by a set of accounting benchmarks.[18]

The LULUCF Regulation also introduced new monitoring and reporting requirements. These are necessary because the current systems used for monitoring and reporting LULUCF emissions and removals are not yet granular enough to pick up the impacts of measures taken at the individual actor level (e.g. measures supported by the Common Agricultural Policy); often the necessary data exist (especially in the CAP datasets) but they are not integrated in the climate inventories. This creates a policy gap; for instance, it is less important for a Member State to use budget from the CAP to promote climate-

[15] More information on the concept and history of the Forest Reference Level is provided in Box 2 in section 5.1

[16] For a summary of the main technical challenges of establishing Forest Reference Levels, see Korosuo, A. et al., (2020) Forest reference levels under Regulation (EU) 2018/841 for the period 2021-2025, EUR 30403 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-32258-0, doi: 10.2760/0521, JRC121803. (https://europa.eu/!rq47KN) and "Final synthesis report – Support for capacity building in Member States to implement Forest Reference Levels and improvements of greenhouse gas inventories as requested by the LULUCF Regulation" (https://data.europa.eu/doi/10.2834/890150)

[17] Study on the requirements for compliance with the regulation on Land Use, Land Use Change and Forestry (LULUCF) and associated regulations (https://op.europa.eu/s/pjFW)

[18] More information on the drivers, problems and options related to LULUCF accounting rules can be found in the note "Amend the LULUCF accounting rules to make the no-debit rule more stringent", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100).

friendly action related to LULUCF if this action does not appear in the climate inventories and thus does not contribute to achieving national climate targets. Similarly, if monitoring and reporting systems do not provide specific climate information on areas of special importance for biodiversity (e.g. areas covered by restoration targets, areas covered by primary and old-growth forest) or distinguish between monocultures and bio-diverse forests, there is a missed opportunity to strengthen synergies between climate action and biodiversity action. Approaches to further improve monitoring and reporting systems will be discussed in Section 9.

2.1.4. Evaluation of the current policy framework

In preparing for the implementation of the LULUCF Regulation (which only came into force in 2021), the Commission has carried out some steps. The analysis of the National Energy and Climate Plans (NECPs)[19] overall showed that the LULUCF sector is yet to be treated as an integrated component of Member States' climate strategies (Specific problem #2). The process of establishing the Forest Reference Levels for each Member State has revealed the challenges behind the implementation of this complex accounting rule, and capacity building activities to support some Member States in preparing for the implementation of the LULUCF Regulation have highlighted the challenges behind the gaps in national monitoring and reporting systems (Specific problem #3).

2.2. What are the problem drivers and how will the problem evolve?

2.2.1. Drivers behind decreasing carbon removals in the land sector

Emissions and removals by **forests** are the largest components of the LULUCF balance. An in-depth analysis of the recent GHG inventory[20] highlights that the forest regrowth period that took place from 1960 to 2005 started to reverse in 2005 due to a combination of problems. Since about 2013, the annual removals on forest land have been decreasing at roughly 12 MtCO2eq per year, a trend that emerged in a number of EU regions (to varying amounts). The change since 2013 is due to a mix of factors, including an increase in wood demand, an increasing share of forests reaching harvest maturity and an increase in natural disturbances[21]. Already in 2017 and 2018 several European countries, in both Southern and Northern Europe, were hit by unprecedented forest fires, which coincided with record droughts and heatwaves. The last two decades have shown that an increasing amount of forests in Europe has become vulnerable to insect outbreaks, especially to bark beetles attacks in Central and Eastern Europe, which can lead to salvage logging.[22] Finally, the ageing of forests leads to declining forest growth rates. Afforestation and deforestation play less of a role in the total LULUCF performance, although afforestation has also decreased since 2010.

In addition, **emissions from organic soils** have still not decreased significantly, in particular due to the continuation of cropping practices that disproportionately contribute to emissions; an example are drained peatlands, a type of land which stores approximately five times more carbon than forests and about half of Europe's total soil organic carbon. **Wetlands** in Europe have been suffering from a continued degradation

[19] COM/2020/564 final (https://europa.eu/!xc64CH).

[20] Note "The decline in the forest carbon sink and its drivers", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100).

[21] Forzieri, G. et al. (2021), Emergent vulnerability to climate-driven disturbances in European forests. Nat Commun 12:1081 (https://doi.org/10.1038/s41467-021-21399-7).

[22] COM(2020)777, "EU Climate Action Progress Report 2020", pp. 15-16 (https://europa.eu/!By94Yn).

from multiple pressures. Finally, and despite a reduction in the last decade, **land take**[23] in EU28 still amounted to 539km2/year between 2012 and 2018 (EEA 2019[24]); half of the deforestation emissions results from the conversion of forest land to settlements.

The views of stakeholders

The stakeholders who replied to the Open Public Consultation on the review of the LULUCF Regulation selected the following as the most important drivers behind the decline of land-based removals: Conversion of carbon rich land; Unsustainable land management practices; Natural Disturbances. See Annex 10.2.3 for more details.

Before the start of the new 2021-2030 compliance period under the LULUCF Regulation, emissions from the LULUCF sector were not included in the national climate targets under EU law. This may have stopped Member States from internalising in their national policies some important **positive and negative climate externalities** related to land management[25]. Examples of such externalities are the benefits of embedding carbon into long-lasting and circular bio-based products, or the emissions from the burning of biomass for the production of bioenergy (a clear issue was that the use of biomass for energy was directly incentivized, as the corresponding emissions were not counted towards domestic climate targets until the LULUCF Regulation entered into operation in 2021 [26]). Furthermore, the potential contribution of soil protection (e.g. peatland protection and restoration) to reducing GHG emissions has not yet been incorporated into soil protection law[27], and the activities necessary for soil protection under the CAP are generally not prioritised due to the low level of awareness among national and local authorities[28].

This **lack of incentives** at the Member State level has trickled down to the individual land managers, who do not get any revenue from climate mitigation action: in particular, farmers are price takers in oligopolistic markets and have little ability (and incentives) to differentiate products according to their climate footprint. Besides, climate action sometimes comes with large opportunity costs for land managers (for example, the income foregone and the decrease in land price when converting agricultural land to forest land, or rewetting it if it was drained). Since there is no value assigned to carbon storage, there is also no incentive to protect this 'carbon asset' beyond some regulatory standards and subsidies (e.g. under the CAP). Negative externalities from land activities that create emissions are not sufficiently internalised in the final prices; a more ambitious "polluter-pays" approach would trigger the price signals that are needed to also drive

[23] EEA definition of land take: change in the area of agricultural, forest and other semi-natural land taken for urban and other artificial land development.
[24] https://europa.eu/!Nk49yx.
[25] For more analysis on the market externalities that constitute a barrier to more sustainable land use, see Note "Externalities and missing markets", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100).
[26] Emissions from harvests were however covered by the Kyoto Protocol commitments; a recent report by the JRC describes how contradictory incentives provided by LULUCF and the Renewable Energy Directive targets also apply to possibly contradictory stakeholder interests; Camia et al. (2021), "The use of woody biomass for energy production in the EU" (https://europa.eu/!Bn46df).
[27] Ekard et al. (2020) "Peatland Governance: The Problem of Depicting in Sustainability Governance, Regulatory Law, and Economic Instruments", Land, 9, 83; doi:10.3390/land9030083
[28] J. Augier et al. (2020) "Evaluation study on the impact of the CAP on the sustainable management of soil. Final Report to DG Agriculture", Alliance Environnement

behavioural change at the level of consumers. Lack of technical knowledge and support at the level of farmers also hampers the uptake of new practices and technologies.

Finally, there are some specific barriers to change related to forests. For instance, one third of private European forests consists in small parcels owned by multiple small owners who do not actively manage their forest, and forest rotations range from 40 to 140 years, which confers substantial inertia to forest management and its responsiveness to price signals.

Likely evolution of this problem

Climate change and biodiversity loss will exacerbate the natural disturbances that have been driving LULUCF emissions in recent years, such as forest fires, heatwaves, droughts, storms or pests. Slow onset events, such as land and ecosystem degradation or sea level rise are equally destructive over the long-term. Forest growth is generally projected to increase in northern Europe and to decrease in southern Europe, but with substantial regional variation. At the same time, forest tree species are shifting towards higher altitudes and latitudes as a result of climate change. This migration – and indeed other adaptation actions – lags behind the changes in climate, which may lead to a decline in European land biodiversity and removals due to increased natural disturbances. Global warming will likely increase disturbances from fires and insect outbreaks in increasingly large areas of Europe; the probability of high-to-extreme wildfire danger is projected to rise as a result of changing weather patterns, and forest insect pests are projected to increase in most regions of Europe. These combined impacts affect forests considerably, as well as the functioning of related ecosystems and services. Overall, both the current and the projected trends of the carbon removal determinants (forest growth, natural mortality, harvest), as well as the Member State projections up to 2025, suggest declining net forest carbon removals in the short term[29]. Non-forest ecosystems including grasslands, wetlands and soils, are also affected by increasing impacts of climate change such as drought.

On the more positive side, the 2018 EU inventory showed a slight rebound of removals compared to 2017, a year which was heavily affected by forest fires in Italy and Portugal[30]. While the impact of natural disturbances will be noticed at the level of individual land managers and small Member States, the overall impact on total removals at the EU level is expected to be limited over the next 10 years. The Commission's Policy scenario, which considers changes in the biomass demand from the energy sector, projects that LULUCF removals could in the next decade remain around today's level at no additional cost (i.e., assuming no carbon price). Moreover, a much higher level of removals (above -300MtCO2eq in 2030) could still be achieved via a range of relatively inexpensive near-term mitigation actions (e.g. improved forest management, set-aside of organic soils), even considering the likely increased pressures on forests and harvesting rates due to the higher demand for short-lived products and bioenergy (see Annex 4 for more details).

In contrast, the national projections provided by Member States in the National Energy and Climate Plans estimate that net LULUCF removals in 2030 may be approximately one third smaller than they were in 2005. In addition, the minimum compliance level set out in the LULUCF Regulation is only approximately -225 MtCO2eq. in 2030, which

[29] Grassi, G., et al. Brief on the role of the forest-based bioeconomy in mitigating climate change through carbon storage and material substitution, European Commission, 2021, JRC124374

[30] See summaries of reporting for these Member States at https://ec.europa.eu/clima/policies/strategies/progress_en#tab-0-1

would still represent a loss of 13% of the average removals reported in 2016-2018 (-267.7 MtCO2eq) (see Figure 4). All in all, without a revised and more ambitious policy framework, there is a risk that national policies will not drive LULUCF performance to the level that is considered feasible in the Commission's modelling scenarios, with negative consequences also for adaptation, biodiversity, and a sustainable and circular bio-economy.

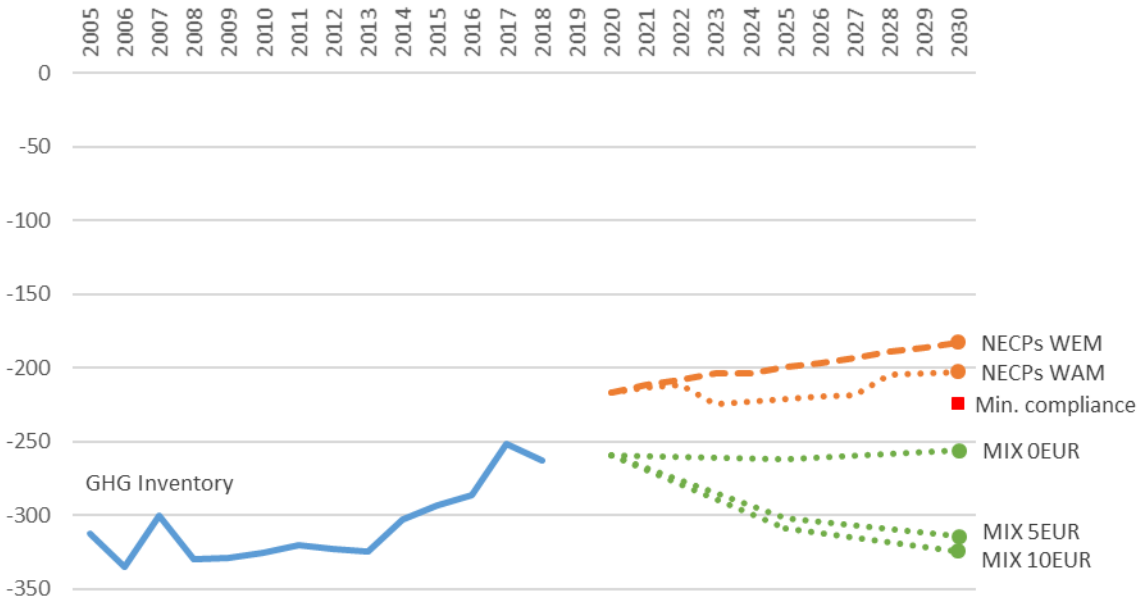


Figure 4 – LULUCF projections from National Energy and Climate Plans (NECPs, orange lines) with existing measures (WEM) or with additional measures (WAM) and from the Commission's Policy scenario (green), without a carbon price (MIX 0EUR) and at a carbon price of 5 and 10 EUR/tCO2 (MIX 5EUR and MIX 10 EUR, see annex 10.4.1 for more details). Unit: Mt CO2eq. The Figure shows that, if Member States carry out the planned policies and measures indicated in their National Energy and Climate Plans, they would collectively not meet the minimum level of removals required by the LULUCF Regulation (-225 MtCO2eq). However, the Commission's Policy scenario projects that a better performance (above the minimum compliance level) is possible at no additional cost, and an increase of net removals above -300 MtCO2eq is feasible at a very low carbon price (MIX 5EUR and MIX 10EUR).

2.2.2. Drivers behind the insufficient integration of the land sector into climate policies

Separation of Agriculture and LULUCF

The current policy framework maintains a regulatory separation between Agriculture, which is fully included in the national emission targets under the ESR, and LULUCF, which only contributes to the EU-wide climate target through the ESR-LULUCF flexibility (as explained in Section 2.1.3). Thus, emissions from agricultural activities and emissions or removals from other land uses may take place on the same land parcel and yet be recorded under two different pieces of legislation and with two different approaches. This separation does not allow for a fully integrated and comprehensive view of the climate benefits and costs of land-based action at the Union level but also at the Member State level; it creates barriers that may hinder effective policy design and implementation.

Limitations of the ESR-LULUCF flexibility rules

Most NECPs provided information on planned mitigation actions in the LULUCF sector, but only very few of them gave indications on the intended use of the ESR-LULUCF

flexibility rules to achieve national climate targets. Almost all plans mentioned that they intend to achieve the "no-debit" (minimum) commitment, without any plan to overachieve it and generate LULUCF credits.[31]

Some implementation-specific drivers (e.g. uncertainty about LULUCF estimates, the fact that the lengthy FRL process was not yet completed by the time of drafting the NECPs) play an important role for this lack of an integrated approach to mitigation action across ESR and LULUCF sectors[32]. Another fundamental role is played by the expectation that the demand for LULUCF credits will be quite small, which depresses the incentives to produce such credits. This low demand is driven by three factors. First, LULUCF targets are often below the current LULUCF performance in most Member States, so there is no expected need to buy LULUCF credits from another Member State for compliance with the LULUCF target. Similarly, ESR targets are also considered by Member States to be attainable without any need for LULUCF credits. Third, even if ESR targets were made more stringent with the current revision, the fact that a Member State can only use 'domestic' LULUCF credits for its ESR compliance (and not credits purchased from another Member State) significantly reduces the pool of potential 'buyers' of LULUCF credits.

Lack of a climate target for the land sector

The land sector has no integrated climate target. The agricultural sector contributes to the overall non-ETS target set by the Effort Sharing Regulation (ESR), together with transport, buildings, waste and F-gases, while the LULUCF sector has its own accounting target. In its proposal for the next CAP, the Commission introduced several climate-related elements[33], established a legal obligation on Member States for greater overall ambition on environment and climate[34], and indicated that the CAP Strategic Plans should be consistent with the overall national climate strategies and with measures as described in the National Energy and Climate Plans[35]; however, the CAP is not a climate policy, and therefore does not include an explicit climate mitigation target. A single climate target for the land sector could give a clearer direction to the climate ambition of the CAP Strategic Plans and to national land-related policies in general.

Risks related to this problem

Without a more integrated policy framework, and without stronger incentives to use flexibility rules towards a cost-effective creation of LULUCF removals, there is a risk that mitigation opportunities do not happen where they are the most cost-efficient, and that the LULUCF sector continues to be considered as an outsider in climate policies and strategies. Continuing with a fragmented policy approach to land-based climate mitigation could undermine the incentives for Member States to act on land use and forestry, and hinder the potential of the LULUCF sector to deliver the carbon removals that are needed to put the EU on the path to climate neutrality in 2050.

[31] COM/2020/564 final, https://europa.eu/!xc64CH

[32] For more details, see note "Strengthening the linkages between the LULUCF Regulation and the ESR", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100).

[33] See section 6.1.3 for more details on CAP support for the take-up of climate-friendly agricultural practices, and Annex 10.6.3 for an overview of the climate-related recommendations for CAP Strategic Plans that the Commission published in December 2020.

[34] COM(2018) 392 final, Article 92 (https://europa.eu/!cy47Kc).

[35] COM(2018) 392 final, Article 97(2)b (https://europa.eu/!cy47Kc).

2.2.3. Drivers behind the implementation challenges

In 2019, capacity building activities were conducted in eleven Member States to support the establishment of Forest Reference Levels (FRLs) and the improvement of monitoring and reporting systems. During this activity[36], some clear challenges were identified.

In the case of the FRLs, the main difficulties encountered by Member States were: documenting forest characteristics in the reference period (2000-2009), selecting and calibrating the right modelling framework, ensuring that the modelling framework was able to reproduce the historical trends, and modelling emissions and removals in deadwood. The process[37] for laying down FRLs for the first compliance period of the LULUCF Regulation (2021-2025) took two years with another year of preparations of FRLs in Member States[38], and required a very high level of technical competence in Member States. The process to review and assess FRLs has been time consuming (15 meeting days of the LULUCF Expert Group with approximately 70 participants). The Commission estimated at around EUR 4.5 Mio the shared cost of this process between Commission and Member States. Despite all efforts, there is still ambiguity in interpretations of specific components of the FRL, which results in heterogeneity among Member States FRLs.

The main drivers behind the gaps in national monitoring and reporting systems include[39]: low awareness of existing datasets due to weak inter-institutional arrangements, data gaps (in particular for establishing historic baselines), lack of human resources and lack of specialised skills. While monitoring and reporting systems for forests are quite well advanced in all Member States, they may not be fully fit for providing a rapid indication of changes caused in particular by disturbances, increasing harvesting levels, or even afforestation and reforestation. Furthermore, soil data is scarce, incomplete and uncertain, due to the high costs of extensive and repeated soil monitoring, and to the fact that there have been little economic and policy incentives for improving these data so far. In particular, the policy incentives to invest in better monitoring of agricultural land have up until recently been weak because LULUCF was not yet part of the 2020 EU targets, and accounting for agricultural land was not mandatory under the Kyoto Protocol (only seven Member States included it in their Kyoto Protocol accounts). Analysis carried out to support this Impact Assessment[40] estimated that very large carbon gain and losses from soils go unreported; accurate estimates of emissions and removals, based on good information on land use activities and local emission factors, cover at most 37% of EU cropland, because most Member States use default IPCC methods. As long as soils remain such a 'blind spot' of climate policies, it is challenging to design effective policies and incentives.
For more information on how to improve reporting systems in a cost-effective way, see Section 9 and Annex 10.8.

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[36] "Final synthesis report – Support for capacity building in Member States to implement Forest Reference Levels and improvements of greenhouse gas inventories as requested by the LULUCF Regulation" (https://data.europa.eu/doi/10.2834/890150).

[37] For more information, see Korosuo, A., et al. (2020), ibid., "Forest reference levels under Regulation (EU) 2018/841 for the period 2021–2025" (https://europa.eu/!rq47KN).

[38] SWD(2020) 236 final, "Assessment of the revised National Forestry Accounting Plans 2021-2025", (https://europa.eu/!WC47Yd).

[39] "Final synthesis report – Support for capacity building in Member States to implement Forest Reference Levels and improvements of greenhouse gas inventories as requested by the LULUCF Regulation" (https://data.europa.eu/doi/10.2834/890150).

[40] Note "Soil carbon", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100).

Likely evolution of this problem

If the Forest Reference Level concept is maintained, the process to establish the national levels would have to be repeated in 2024-2025 for the 2026-2030 compliance period. If the accounting rules are not simplified with the current revision, there is a risk of high regulatory costs combined with a difficulty in designing, implementing and communicating about national LULUCF policies.

Without exploiting the opportunities offered by digital and satellite-based technologies, and in the absence of targeted policy interventions to build capacity and simplify reporting frameworks, there is a risk that gaps in monitoring and reporting systems persist, which would undermine effective policy implementation and policy planning.

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

The proposal is based on Article 192(1) of the Treaty on the Functioning of the European Union (TFEU), which gives the Union the right to act in order to achieve objectives of its policy on the environment. The objectives of the Union policy on the environment as defined in Article 191(1) of the TFEU include, inter alia, preserving, protecting and improving the quality of the environment; a prudent and rational utilisation of the natural resources such as land and forests and promoting measures at international level to deal with regional or worldwide environmental problems, in particular combating climate change.

3.2. Subsidiarity: Necessity of EU action

Climate change is by its nature a trans-boundary problem. Its effects are global, irrespective of the location of e.g. sources of GHG emissions. Similarly, opportunities to remove and store carbon and reduce emissions in the land sector are unequally distributed across the EU. Therefore, these challenges cannot be solved by national or local action alone, since individual action is unlikely to lead to optimal outcomes. Coordinated EU action can effectively supplement and reinforce national and local action and enhance climate action. Coordination of climate action is necessary at European level and, where possible, at global level, and EU action is justified on grounds of subsidiarity. Since 1992, the EU has worked to develop joint solutions and drive forward global action to combat climate change.

3.3. Subsidiarity: Added value of EU action

The coordination of the reduction of greenhouse gas emissions across the European Union benefits from coordination at the EU level given the EU's single market. An increase in the 2030 target for EU GHG reductions will impact most, if not all, sectors across the EU economy. The increase of that target may furthermore require policy responses in many fields, including beyond climate, forestry and land use policy. The impacts of such ambition increase and related policies on growth and jobs creation, fairness and cost-effectiveness are examples of elements that can be better considered at the EU level.

The LULUCF Regulation sets a framework to ensure that Member States take the necessary actions related to land use and forestry. As such, it depends on action by Member States (reflecting the externalities related to land management) and has strong linkages with other policies, in particular agriculture, biodiversity and habitat protection, adaptation, and also energy policy due to the renewable energy aspects. There are many

reasons for regulating the LULUCF sector at the EU level: interdependencies between the different policies involved and their cross-national impact, setting emissions reduction and removal targets per Member State as well as setting out principles, on which basis the Member States will report on their achievements and measure their progress towards reaching their individual targets and targets of the EU as a whole, as specified in the monitoring and reporting rules laid down in Regulation (EU) 2018/1999. Action at the EU level is therefore indispensable and coordinated EU policies have a much bigger chance of leading to a true transformation towards a climate neutral economy by 2050. Coordinated action at the EU level furthermore facilitates the full consideration of the different capabilities to act among Member States. The EU single market moreover acts as a strong driver for cost-efficient change.

Finally, EU-level climate policy adds significant value for international climate action and global efforts to halt biodiversity loss. Since 1992, the EU has worked to develop joint solutions and drive forward a global agreement to fight climate change. These efforts have helped to achieve the Paris Agreement in 2015. International climate policy and climate and environmental diplomacy have been strengthened as a result of coordination of European climate policy at the EU level, both of which are crucial in a world in which the EU accounts for only around 10% of global GHG emissions.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives

The European Green Deal is the crucial stepping stone towards making Europe a climate-neutral continent (i.e. achieve net zero GHG emissions) by 2050. The Communication on stepping up Europe's 2030 climate ambition[41] frames the Commission proposals for the 2030 Climate Target Plan.

The general objective of this initiative is to make the LULUCF Regulation fit for reaching at least 55% net greenhouse gas emission reductions by 2030 compared to 1990, in line with the 2030 Climate Target Plan, as a staging post to achieving climate neutrality by 2050.

4.2. Specific objectives

4.2.1. A climate-neutral land sector by 2035

The 2018 Commission Communication "A Clean Planet for All"[42] makes clear that we need carbon removals to increase significantly if we are to achieve climate neutrality in 2050. Thus, to be on track for climate neutrality in 2050, the EU needs to reverse the recent decline in land-based removals and start implementing actions to increase removals already in this decade, in order to account for the long lead times of land-based climate mitigation.

The views of stakeholders

The need to enhance land-based carbon removals was well recognized by stakeholders who provided feedback to the Commission's Inception Impact Assessment (see Annex 10.2.2). However, while respondents from the bio-based sector favour an approach that

[41] COM(2020)562 final, https://europa.eu/!uR93tq
[42] COM/2018/773 final, https://europa.eu/!VU93kN

rewards active forest management and views Harvested Wood Products (HWPs) as an important type of removals, environmental NGOs strongly disagree with this approach and would rather see a preservation of the existing carbon storage and removals.

The modelling behind the Climate Target Plan shows that the at least -55% target would be economically feasible even if the LULUCF sector becomes as small as -225Mt in 2030 (which is the minimum level of removals required to comply with the current LULUCF Regulation, according to current LULUCF accounting rules). Nevertheless, the same modelling[43] also shows that keeping carbon removals at today's level (around -260Mt) is possible with no additional policies by Member States, and that, with additional action, an integrated land sector (LULUCF and Agriculture) "*would have the potential to become rapidly climate-neutral by around 2035 in a cost-effective manner, and subsequently generate more removals than greenhouse gas emissions*"[44] (see Figure 5). In a more detailed discussion about the actions needed to realise these projections, the Impact Assessment accompanying the Climate Target Plan (in its section 9.2) explains that the mitigation potential of non-CO2 agriculture emissions (currently covered by the Effort Sharing Regulation) relies on actions such as: anaerobic digestion with biogas recovery, livestock breeding, feed additives, nitrification inhibitors, more efficient fertilizer use, as well as changes in dietary choices and alternative protein production from aquaculture. As regards the LULUCF sector, the Climate Target Plan projections (see Figure 5 below) assume that the use of biomass for energy will remain stable until 2030, while the mitigation potential in the short-term is based on limiting deforestation and some additional soil carbon sequestration and sustainable forest management practices. Another highly promising action, i.e. protecting organic soils from intensive agricultural use, is not covered directly by the modelling in the Climate Target Plan, but another Commission study[45] considers it as one of the most efficient solutions to reduce GHG emissions in agriculture.

Thus, the first specific objective of this initiative is to achieve a climate-neutral land sector by 2035. This objective breaks down in two parts:

- An increase in LULUCF net removals, and
- A decrease in agricultural emissions.

Based on the graph in Figure 5, in order for the land sector to be on track for climate neutrality in 2035, in 2030 net removals should be **above -300MtCO2eq**[46], while agricultural emissions should be around 360 MtCO2eq. The second part of this objective – the reduction of agricultural emissions – is also covered in the ESR impact assessment because agricultural emissions are currently within the scope of the ESR.

[43] For more information on the assumptions behind these modelling projections, see the Impact Assessment (SWD(2020) 176 final) accompanying the Communication Stepping up Europe's 2030 climate ambition (section 6.10), and Annex 4 of this Impact Assessment.

[44] COM(2020)562 final, https://europa.eu/!uR93tq, p. 17

[45] "EcAMPA 3 – Economic assessment of GHG mitigation policy options for EU agriculture", https://europa.eu/!uv84uR

[46] As Figure 5 indicates, LULUCF net removals should be between -295 Mt (solid LULUCF line) and -340 Mt (dotted LULUCF+ line) in 2030 in order for the sector to be on track for 2035 land-based climate neutrality.

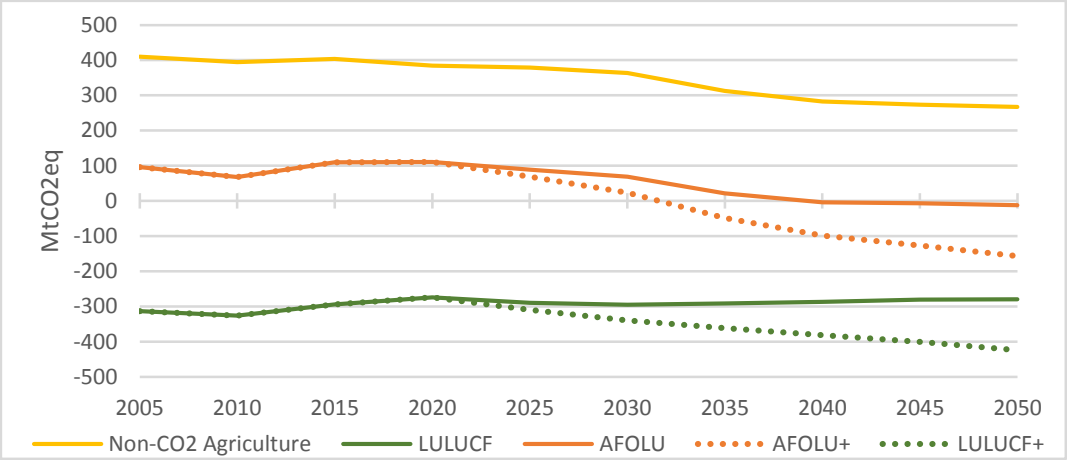


Figure 5 – Projected emissions and removals from the Agriculture and LULUCF sectors, EU27. Source: Impact Assessment accompanying the Climate Target Plan.

While the primary focus of the "Fit for 55" package is to achieve the 2030 climate target, in the case of the land sector it is considered important to signal a further, mid-term target for 2035. First, because nature-based actions have long lead times, notably for improved land use management practices, the development of large scale sustainable afforestation and the restoration of habitats. A mid- to long-term policy orientation can thus avoid lock-in of measures that may be counterproductive in the long-term. Planning certainty for the land sector appears even more important when one considers that this sector is projected to become the largest one in the EU GHG flux profile in 2050 (as fossil emissions become significantly reduced); it is therefore crucial to anchor it to a **trajectory** that can effectively deliver the long-term objective of EU-wide climate-neutrality in 2050. Last but not least, a 2035 policy horizon can provide for a clear long-term direction for the future (2028-2035) Common Agricultural Policy.

4.2.2. A fair, flexible and integrated climate policy framework for the land sector

As the opportunities to increase carbon removals are unevenly distributed across Member States, and the multi-functionality of land creates synergies and trade-offs, the revision of the LULUCF Regulation will need to ensure a fair, flexible, and integrated policy framework.

A **fair** policy framework should allocate any potential national target based on principles such as historical performance (e.g. past emissions) and capability (available land, cost-effective mitigation potential).

A **flexible** policy framework should allow Member States to choose which mitigation actions to prioritise across the economy, and to have access to inter-MS trading mechanisms to ensure that action happens where it is the most cost-effective.

Finally, an **integrated** policy framework should require Member States to reflect on the role of the LULUCF sector in their wider national climate strategy in a more integrated manner than what emerged from the NECP exercise, starting from the obvious connections to mitigation strategies in the agricultural sector, but also taking into account synergies with other land-related objectives (adaptation, biodiversity, sustainable and circular bioeconomy).

In the long term (i.e. beyond 2030), a cost-efficient policy framework to implement climate neutrality for the land sector (and further on net carbon removals, to achieve climate neutrality at the level of the whole economy) will be a market-based carbon trading system, operating at the level of the land or removal entity manager.

Conceptually, this approach will be analogous to the way in which the ETS requires compliance at the level of the industrial entities. Unlike the ETS, however, emissions allowances in a land-based carbon trading system should be progressively tied to removal certificates, to enforce a transparent pathway towards climate neutrality. Such a system would ensure a level-playing field for the internal agricultural market.

This approach will require a robust certification system and a widespread capacity of land managers to monitor their emissions and removals. Both these objectives are on the EU agenda for the years running up to 2030: a Carbon Removal Certification mechanism will be proposed by 2023 (as announced in the Circular Economy Action Plan), and by the end of 2021 a Carbon Farming Initiative (announced in the Farm to Fork Strategy) will promote result-based payments for land managers. Meanwhile, the CAP will continue to support the uptake of sustainable land management practices and technologies and to enable access to advisory services and monitoring tools. Thus, while other parallel policy initiatives will provide incentives for land-based mitigation at the level of individual land managers, the current revision of the LULUCF Regulation aims primarily to encourage Member States to design more ambitious land mitigation strategies. Nevertheless, by modernising the governance framework and upgrading the monitoring requirements, this revision also takes the first steps towards a more cost-efficient and integrated policy framework post-2030.

Figure 6 shows the different elements of an integrated policy approach to the land sector, creating both an overall policy framework (addressed to Member States) and direct incentives (addressed to land managers).

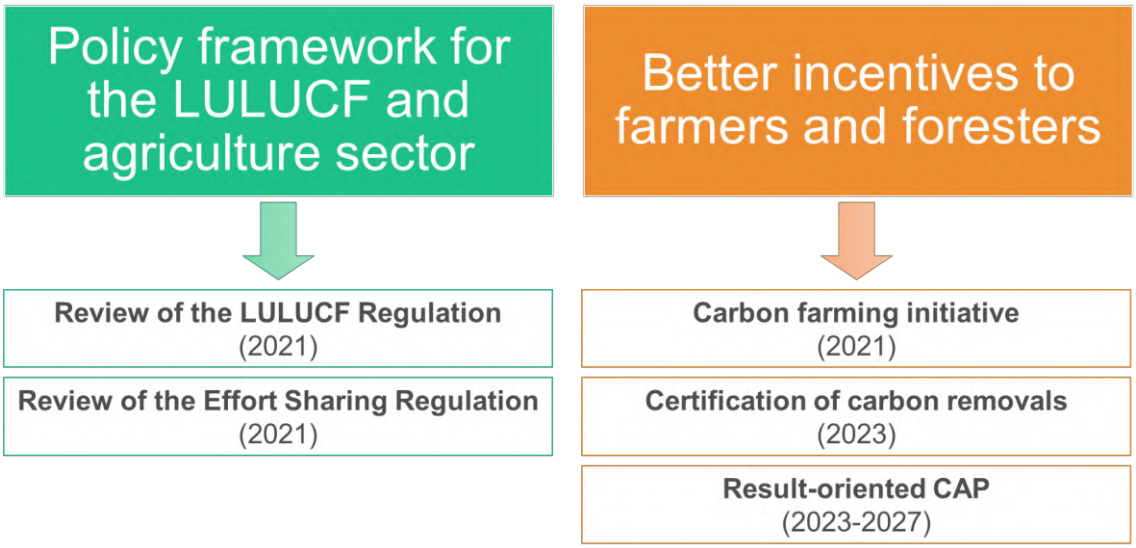


Figure 6 – Policy approaches: overall policy framework (addressed to Member States) vs direct incentives (addressed to land managers).

4.2.3. Simplification

As argued above, the current LULUCF rules are often complex and no longer needed given the new formulation of the -55% target; based on the lessons learnt, in particular with regard to the setting of the FRLs, a number of accounting concepts can be optimised and simplified. This can reduce implementation costs and improve the integration of the LULUCF sector in the overall national climate strategies.

In addition, monitoring and reporting systems need to better reflect the climate performance of the sector. Thanks to evolutions in land monitoring technologies, there are opportunities to map land use changes at low cost and in a timely fashion (e.g. by using approaches based on remote sensing, including from satellites such as the

Copernicus Sentinels and/or commercially available services); these maps will not only facilitate GHG reporting but also guide mitigation action to areas with highest potential for emission reductions, and more in general enable environmental action, biodiversity, nature protection and land planning.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1. What is the baseline from which options are assessed?

The baseline is the current LULUCF Regulation, which from 2021 integrates emissions and removals from the LULUCF sector into the EU climate policy framework for the first time; the Regulation addresses Member States and puts no direct requirements on individual land managers. Today the Regulation establishes rules to determine which emissions and removals are taken into account towards the target (so-called 'accounting' rules), in the same spirit as international conventions established under the Kyoto Protocol:

- For managed cropland / grassland / wetland: take into account emissions and removals in each compliance period[47] minus the average emissions and removals in the base period 2005-2009[48].
- For afforested or deforested land: the accounting rule takes into account all emissions and removals in each compliance period[49]. When a unit of land is afforested, it remains under this accounting rule for 20 years before being considered managed forest land; similarly, when a piece of land is deforested, it remains under this accounting rule for 20 years before being considered as the type of land use that it was converted to.
- For managed forest land (which also includes the carbon stored in harvested wood products): take into account emissions and removals in each compliance period minus the emissions and removals described by a benchmark (the 'Forest Reference Level')[50].

Box 2 – Definition and brief history of the Forest Reference Level (FRL)

A reference level is a projection of future emissions and removals, against which the actual emissions and removals in a given year are compared. This concept was first employed in the EU under the 2nd commitment period of the Kyoto Protocol; in that context, the projections (called Forest Management Reference Level, FMRL) could include policy assumptions, with the risk of inflating the real impact of mitigation actions[51]. Instead, in the LULUCF Regulation, the forest reference level (FRL) is exclusively based on the continuation of forest management practices and wood use as documented in a historical reference period (2000-2009), taking into account the age-related forest dynamics but excluding policy assumptions. As a result, the impact of

[47] There are two compliance periods: from 2021 to 2025 and from 2026 to 2030.

[48] REGULATION (EU) 2018/841, Art. 7, https://europa.eu/!dD98cC

[49] REGULATION (EU) 2018/841, Art. 6, https://europa.eu/!dD98cC

[50] REGULATION (EU) 2018/841, Art. 8, https://europa.eu/!dD98cC; "Guidance on developing and reporting Forest Reference Levels in accordance with Regulation (EU) 2018/841", https://europa.eu/!nx74BJ

[51] Grassi et al. (2018), "Science-based approach for credible accounting of mitigation in managed forests", https://cbmjournal.biomedcentral.com/articles/10.1186/s13021-018-0096-2

any change in management or wood use will be reflected in the climate accounts, like in any other GHG sectors. The only difference with other sectors is the impact of forest age dynamics: for instance, where forests are getting older, the FRL projection will take into account that continuing the past management may involve increasing total harvest. The rationale of this approach is to avoid penalising Member States for choices taken decades or centuries ago that have affected the age structure of their forests. Beyond the impact of age-related dynamics on total harvest, any change in the forest management practices or in the ratio between energy and material use of wood relative to 2000-2009 will be fully reflected in the LULUCF accounts.

The FRLs provide a more realistic counterfactual than the FMRLs; notably, they project a level of removals that is 59 MtCO2eq more stringent than that projected under the FMRLs. However, as discussed in Section 2.2.3, the technical complexity of the FRLs required a notable effort from the Member States and a long review process by the Commission and the LULUCF Expert Group. These efforts need to be weighed in when considering the benefits of the FRL approach for future policy development[52].

Taken together, these rules set out an accounting target, i.e. **a baseline that is the minimum compliance level for the LULUCF sector**. This level is expected to be around **-225 MtCO2eq per year on average, at EU27 level**[53,54], and it can be considered as a 'no-backsliding' provision: it is designed to ensure that land management practices do not become *worse* from the perspective of climate change mitigation. However, this level is far from being aligned with the trajectory towards a climate-neutral land sector in 2035, which would require removals above -300 MtCO2eq in 2030. It is also well below the removal potential estimated by the Commission's policy scenario: according to the projections in this scenario, a level of removals of -256 MtCO2eq can be achieved at zero additional cost per ton of CO2 by 2030, implying that the LULUCF targets in the baseline could be increased by up to 31 MtCO2eq of removals in 2030 without entailing any additional cost.

Figure 7 shows these estimated baseline targets, that is, the minimum levels of reported GHG removals (or, in some cases, emissions) for each Member State. For most Member States (17), these targets are lower than their recent (2016-2018) LULUCF performance: these Member States could still be meeting the target even if they produced more LULUCF net emissions than currently, lose a large part of their current removals, or even go from delivering net removals to delivering net emissions. Other Member States, in particularly those that saw a sharp decrease in LULUCF removals in recent years due to the impact of natural disturbances (e.g. forest fires, pest outbreaks, droughts) currently have a baseline target that is much more stringent than what their LULUCF sector has been able to deliver in recent years; this is because the FRL concept, which is the main driver of the target, is not meant to reflect recent natural disturbances.

[52] See also Korosuo et al. (2020), (https://europa.eu/!rq47KN) and Vizzarri et al. (in preparation) for details of the FRLs and their assessment

[53] Throughout this impact assessment, the word *baseline* refers to the current policy framework (which would imply a level of LULUCF removals equal to -225 MtCO2eq in 2030); this is distinct from the *reference* scenario (REF), which projects a "Business As Usual" scenario. See Annex 10.4 for more details.

[54] It is important to note that all numbers for baseline, targets, trajectories, and partly also the scenario modelling are linked to the 2020 GHG inventory submissions by Member States. Changes in subsequent GHG inventories, namely due to improved data and methods, will also require an update of the target. See Annex 10.4.2 for more detailed explanations.

A similar comparison can be made between the targets in the baseline and the projected mitigation performance of the LULUCF sector in the policy scenario. Here, almost half (12) of the Member States have a target that is below their mitigation potential, including two cases where the target allows for the production of LULUCF net emissions while the policy scenario projects a potential to deliver net removals.

The view of stakeholders

A majority (52%) of the stakeholders that participated in the Open Public Consultation on the LULUCF Review agreed that there should be more ambitious LULUCF targets than in the current baseline.

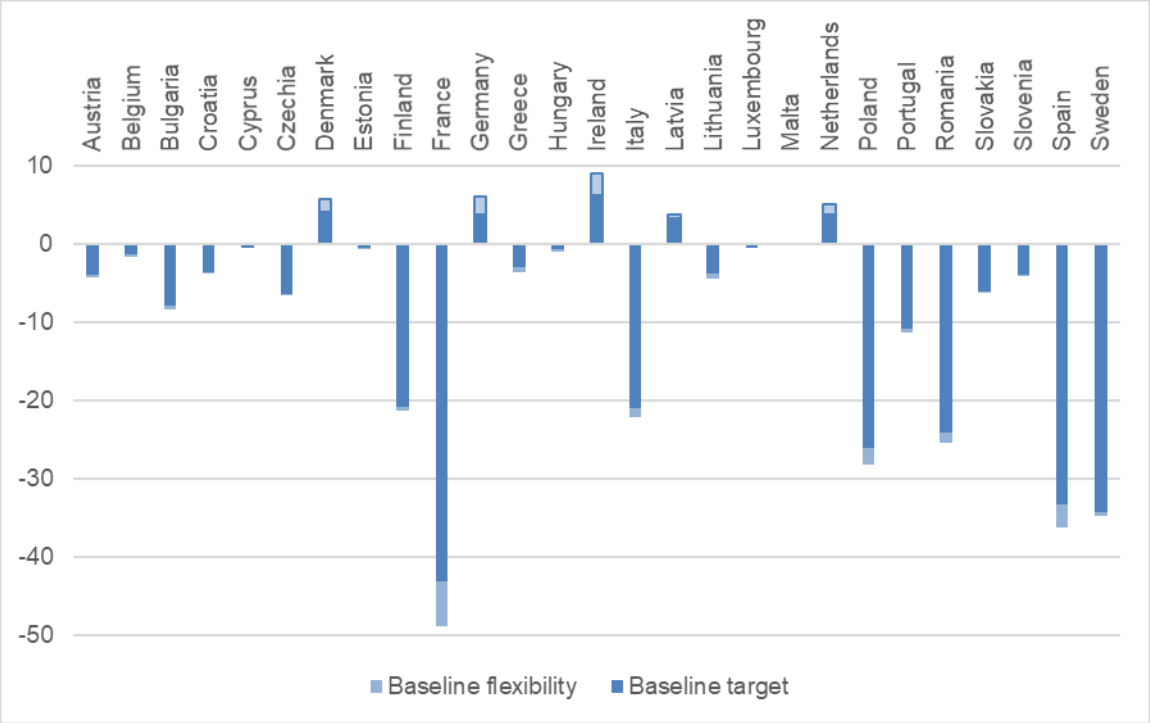


Figure 7 – Targets in the baseline. Light blue areas in negative bars are LULUCF removals in excess of the target which can be used for ESR compliance. In Member States where the targets corresponds to LULUCF emissions (positive bars), the overall target is indicated by the dark blue border, and the light blue areas correspond to unused LULUCF emission "allowances" which can be used for ESR compliance. Unit of measure: MtCO2eq.

Finally, Member States can create up to 262 MtCO2eq of LULUCF credits (i.e. removals in excess of the minimum compliance levels) over the 10-year period 2021-2030, i.e. an average of 26.2 MtCO2eq per year; these can be used to help achieve ESR national targets[55] (so-called 'flexibility'). For each Member State, the availability of LULUCF credits for ESR compliance is adapted to the share of agricultural emissions in ESR sectors. This is done to recognise that Member States with larger emissions from agriculture may find it more difficult to achieve their ESR targets, because the mitigation potential of agriculture is considered lower than in other sectors. The available quantities of LULUCF credits are shown as the lighter areas in Figure 7, assuming that they are equal to 1/10th of the overall flexibility amounts allocated to each Member State over the 10-year period. Member States can effectively transfer their accumulated LULUCF credits at the end of each compliance period to the ESR.

[55] REGULATION (EU) 2018/842, Article 7, https://europa.eu/!NU43BG

As presented in Section 2.1.2, the assessment of National Energy and Climate Plans (NECPs) shows that most Member States plan to ensure that their LULUCF performance is just good enough to meet their target, but very few of them give any indication of the extent to which they plan to generate and use LULUCF credits for ESR compliance. Thus, while providing for a flexible framework, the current rules do not create enough incentives for additional action beyond the "no-debit" targets. Because of the fact, mentioned above, that recent performance is already better than the accounting targets in many Member States, up to 84 MtCO2eq of LULUCF credits could potentially be generated in 2030, whereas the demand for such credits would only be around 52 MtCO2eq[56]. These estimates indicate that, in the baseline, the potential supply of LULUCF credits is likely to largely outweigh the demand, depressing the potential revenues from (and thus the incentives for) an overachievement of the target.

5.2. Description of the policy options

In line with the specific objectives of this Impact Assessment, the proposed policy options will: increase the legislative incentives for climate mitigation in the land sector; distribute the efforts fairly across Member States; set more efficient incentives; simplify the administration and compliance; and create synergies with other policy instruments. Table 1 – Overview of options, sub-options and their main elements.

Option		**Main elements**
Option 1 Self-standing LULUCF target in 2030	**Option 1.1** Changing the accounting rules for managed forest land	• MS benchmarks for managed forest land: historic average instead of Forest Reference Level • No other changes of accounting rules • Intra-LULUCF flexibility, but no flexibility with Effort-Sharing Regulation (ESR)
	Option 1.2 Setting a single removal target	• A single removal target per MS (based on recent emissions and removals and area of managed land) instead of complex accounting rules • Intra-LULUCF flexibility, but no flexibility with ESR
Option 2 Flexible LULUCF target in 2030		• MS target based on recent emissions and removals • Broader flexibility with ESR
Option 3 Fully integrated agriculture and LULUCF targets in 2030 towards land-based climate neutrality in 2035		• EU trajectory towards land-based climate neutrality in 2035 (based on recent emissions and removals and area of managed land) • Planning exercise for MS action • MS targets for integrated land-sector in 2030 and 2035

Table 1 – Overview of options, sub-options and their main elements.

[56] 84 MtCO2eq (respectively, 52 MtCO2eq) is the sum of the differences between removals in the MIX projection and in the baseline target in those Member States where this difference is positive (respectively, negative).

5.2.1. *Option 1: Self-standing LULUCF target*

As described in Section 5.1, the current framework uses accounting rules to define a minimum climate performance for each land accounting category. This first option looks at alternative ways to design national LULUCF targets, either by simplifying the accounting benchmark for managed forest land (Option 1.1) or by setting a single removal target based on all emissions and removals reported in the inventory (Option 1.2).

Under this first option, it is assumed that no flexibility channel exists between the LULUCF sector and the ESR sectors. The level of removals resulting from the amended accounting rules (Options 1.1) or a single target (Option 1.2) corresponds to the climate ambition which is set for the LULUCF sector on its own, and not as a threshold that defines the interaction between LULUCF and ESR sectors (as in the current Regulation). Although this feature was not part of any of the options outlined in the Climate Target Plan communication, it is included here to acknowledge the support for this approach by many stakeholders (see box below). Option 2 will address the flexibility dimension.

The views of stakeholders

A separate target for carbon removals, with no flexibility with other sectors, is often indicated by some categories of stakeholders (in particular NGOs) as a choice that would ensure the environmental integrity of the framework. This was confirmed by the responses to the Open Public Consultation, in which the policy option to strengthen the flexibility with the ESR received the strongest opposition in the open text response out of all policy options. Many stakeholders wanted to fully remove any flexibility with the ESR and have a separate LULUCF target. The most often named reason why stakeholders opposed the concept of ESR/LULUCF flexibility was that it would lead to inaction in the ESR sectors by enabling offsetting of emissions.

Option 1.1: Changing the accounting rules for managed forest land

This option proposes to change the accounting rule for managed forest land[57] (which includes forest land which remains forest land, and the carbon that is stored in wood products which are harvested from this type of land) by using a historical benchmark instead of the FRL benchmark. One of the main reasons why the reference level approach was retained from the Kyoto Protocol framework was that it recognises the link between the age structure of forests and their mitigation potential. Indeed, a large part of the mitigation potential of existing forests depends on their age structure, which in turn depends on land management decisions made a long time ago; the point of the FRL projection is to cancel out the effects of the age structure to avoid creating winners or losers based on the legacy of past management decisions, and reflect mitigation action taken during the compliance period (see Box 2). However, as argued in Section 2.2.3, this approach has been criticised for being too burdensome and open to interpretation.

[57] More options for changing the accounting rules (also for other land accounting categories) are possible, and some are presented in the note "Amend the LULUCF accounting rules to make the no-debit rule more stringent", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100). Option 1.1 focuses on changing the accounting rule for managed forest land because this change entails the largest impact on the overall accounting target.

In order to simplify the accounting framework while also mitigating age structure effects, the reference period for the benchmark should be as close as possible to the compliance period. Indeed, the closer the reference period is to the compliance period, the less important will be the effect of forest age structure.

For the purposes of the impact assessment, therefore, the calculations are carried out based on the latest available reported data, here aligned with the start level in the current ESR implementation, i.e. 2016-2018[58]. 13 years (from the middle of the reference period to target date 2030) is a relatively short period in terms of forest management, which typically covers a cycle of 40 to 140 years in a production forest. Possibilities for management-driven changes to the age class structure would therefore be limited.

The average reported emissions and removals from Managed Forest Land in the period 2016-2018 was -351.0 MtCO2eq, which corresponds to 34.8 MtCO2eq of additional removals with respect to the Forest Reference Levels (-316.2 MtCO2eq). This simplification of accounting rules, therefore, raises the ambition of the LULUCF Regulation from the current -224.9 MtCO2eq to **-259.7 MtCO2eq**. The distribution of this increase in the target across Member States is provided in Annex 10.5.

Option 1.2: Setting a single removal target

Another approach to step up the ambition of the LULUCF rules is to define directly the amount of net removals that must be delivered at the EU level in 2030. In other words, a LULUCF target is set as the amount of removals reported in the greenhouse gas inventories, instead of through a set of accounting benchmarks. As argued in Section 2.1.3, the accounting approach creates complexity and hinders the integration of the LULUCF sector in the overall policy framework; beside its simplification benefits, a single removal target based on reported values is also coherent with the 2030 climate ambition as formulated in the Climate Target Plan, where all reported LULUCF removals contribute to the -55% target.

The design of this option requires two decisions: the overall target for net removals at the EU level, and the criterion to allocate the effort among Member States. In this assessment, based on the emissions and removals as reported in the GHG inventory submission of 2020, the target is assumed to be **-310 MtCO2eq in 2030**, in line with a trajectory towards a climate-neutral land sector in 2035 (the first specific objective, see Section 4.2.1). The proposed allocation across Member States is based on two elements:

- Each Member State maintains its recent level of reported removals and emissions; in this assessment the average of the period 2016 to 2018 – the same start level as applied under the ESR[59] – resulting in an EU starting level of 267.7 MtCO2eq.

- The remaining gap to the EU-target of 310 MtCO2eq in 2030 (e.g. 42.3 MtCO2eq of removals if compared to the average of 2016 to 2018) is allocated in proportion to the area of managed land in each Member State.

Annex 10.4.2 provides more details on how the targets are computed.

[58] This period corresponds to the starting level from which emission reductions apply under the ESR (REGULATION (EU) 2018/842, Article 4(2), https://europa.eu/!NU43BG).

[59] See footnote 58

5.2.2. *Option 2: Flexible LULUCF target*

A flexibility mechanism from the LULUCF sector to ESR sectors can provide incentives to enhance LULUCF removals *beyond* the minimum compliance level. Land-based mitigation action could become cheaper or easier to implement than foreseen at the moment of deciding targets. It is therefore important that a Member State can consider land-based mitigation as an integrated part of its mitigation toolkit, and be incentivised to overachieve its LULUCF target if this appears to be the most cost-effective tool at its disposal.

Under the current rules, access to the flexibility mechanism reflects a 'no-backsliding' principle[60]: it requires that the mitigation performance of the LULUCF sector should not be worse than in a counterfactual where management practices had remained the same. However, under these rules the level of LULUCF removals is allowed to become as small as -225MtCO2eq in 2030 – lower than the current performance of the sector.

Option 2 therefore proposes a stricter interpretation of the 'no-backsliding' principle. It requires that the mitigation performance of the LULUCF sector should not be worse than *its recent level*: only if the performance is better than its recent level can a Member State generate LULUCF credits for compliance with its ESR target. For the purposes of the impact assessment, this option calculates an EU target of **-267.7 MtCO2eq**, based on the average of the latest available data from 2016 to 2018. Like in Option 1.2, the target is set in terms of the overall amount of emissions and removals reported in the inventory, and not against accounting benchmarks. The result of this target allocation for each Member State is provided in Annex 10.5.

Contrary to Option 1.2, the incentives for additional action beyond the recent level of mitigation would not come from a higher LULUCF target but from the demand for LULUCF credits from the ESR. To increase the power of this trading incentive, it is proposed that the *use* of this trading flexibility should be broader: Member States should have the possibility to use LULUCF credits not just for compensating their *own* ESR debits but also to sell them to other Member State for their ESR compliance.

Obviously, there are other possibilities: it would be perfectly possible to combine the incentives for additional action that this impact assessment analyses under Option 1.2 (e.g. a target of -310 MtCO2eq in 2030) with those arising from ESR-driven demand, as analysed under Option 2. Such possibilities have not been identified in this Impact Assessment as separate options for reasons of simplicity of the analysis, as well as because a choice of this kind would be highly dependent from choices made in respect of the future architecture of the ESR (as explained further in Section 7.3).

5.2.3. *Option 3: Fully integrated agriculture and LULUCF target*

In this option, emissions from agriculture are put together with LULUCF emissions and removals under a single "land sector" pillar.

This option features three elements: (i) a planning process to ensure land-based climate neutrality in 2035; (ii) national binding targets for the land sector in 2030; (iii) national binding targets for the land sector in 2035.

[60] This principle is enshrined in the Paris Agreement, Article 4.3, http://unfccc.int/paris_agreement/items/9485.php

Thus, this option differs from the other options in two ways. First, it has a wider sectoral scope, in order to better capture the interaction between livestock farming, fertiliser use and land management, and to promote an integrated policy approach to land-based climate mitigation. Second, it extends beyond 2030, in order to directly address the first objective of this revision: by setting a trajectory towards a climate-neutral land sector by 2035, it provides planning certainty to address the long lead times of land-based mitigation action.

An integrated policy framework that explicitly aims at a climate-neutral land sector can also be seen as a prototype to develop the implementation of the climate-neutral EU-wide economy in 2050, an objective laid out in the 2018 Communication "A Clean Planet for All"[61] and enshrined in the proposal for an EU Climate Law[62]. The land sector is a prime candidate to pilot this implementation approach, because it encompasses both emissions and removals (indispensable to achieve neutrality) and is projected to become the largest sector in the EU GHG flux profile in 2050 (as fossil emissions become significantly reduced).

- **Planning process**

A governance system is set up to ensure that Member States collectively achieve the 2035 land neutrality objective, based on a planning process that outlines strategies to decrease agricultural emissions and increase land-based net removals in an integrated manner, through existing policies (first and foremost, the Common Agricultural Policy) and financial incentives for the reduction of agricultural emissions and the increase of carbon removals.

In this option, Member States submit national plans where they explain their contribution to the 2035 objective. The plans should include considerations of the linkages with adaptation, biodiversity and bio-economy goals, in order to address all synergies and trade-offs related to land planning and land management. They should also explain the expected role of different sources of finance, such as CAP funds, EU regional funds, other national funds, State Aid, or private sources (e.g. creation of carbon farming voluntary markets – see a description of carbon farming business models in Annex 10.7).

The planning process should be integrated as a new element within the existing National Energy and Climate Plans (NECP) process. The Commission would review the plans and provide recommendations in case the progress would be insufficient towards the targets, which are defined below.

- **2030 binding targets for the land sector**

Due to the different biophysical conditions across the Member States, it would neither be fair nor efficient to expect that each Member State reaches climate neutrality on its own in 2035. In some Member States the combined land sector will deliver net removals, while in others it may still create net emissions, depending on the combined reduction potential of livestock, fertiliser, and land management activities. As explained in Annex 10.4.2, this option proposes two formulas to compute each Member State's contribution to the 2035 neutrality objective. The first formula distributes the contributions proportionally across Member States based on their recent emissions and removals. The second formula is based on the same principles as the fairness distribution key of the Effort Sharing Regulation, taking account of the differences in GDP per capita. The **2030**

[61] COM/2018/773 final, https://europa.eu/!VU93kN

[62] COM(2020)80 final amended by COM(2020)563 final, https://europa.eu/!GH37Bu

targets are then found on the linear trajectory between the 2016-2018 reference period and these 2035 contributions.

It is important to note that Member States would not have separate targets for land-based removals and for non-CO2 emission reductions; only the overall balance, or the aggregate sum, of emissions and removals would count for the achievement of the 2030 targets.

- **2035 binding targets for the land sector**

Binding national targets for 2035 will be established after the completion of the planning process outlined above and be based on a dedicated Impact Assessment. This process will take place following the review task set for the Commission in the current legislation, "no later than six months after each global stocktake" (art. 17 of the current LULUCF Regulation). This would place the discussion on the process and modalities for implementing the EU-wide land-based neutrality objective at a binding Member State level in late 2023 or 2024.

The computation of these targets could include an adjustment of the trajectories defined for the determination of the 2030 targets; in particular, the starting levels could be updated with data from newer inventories. In such a way, unforeseen circumstances such as new trends in forest removals or progress on agricultural land management under the CAP can be reflected in the 2035 targets.

The 2035 targets could be complemented with EU-level measures. These could include: the creation of an emission / removal trading system specific to the land sector; the creation of a fund to purchase land-based credits certified according to a Carbon Removal Certification mechanism [63]; EU targeted measures to reduce agricultural emissions. If appropriate, these EU measures will be based on a dedicated Impact Assessment that will take the most recent data and policy context into account.

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

6.1. Impact indicators

The assessment and comparison of the various options is based on the following quantitative and qualitative indicators.

6.1.1. Environmental impacts

The most important impact of the revision will be an increase in LULUCF removals, to enhance the contribution of the sector to the more ambitious EU 2030 climate target announced in the Climate Target Plan (-55%). This is linked to the first objective of this Impact Assessment, a climate-neutral land sector by 2035 (see Section 4.2.1). This impact affects Member States authorities, who will need to design ambitious land policies to deliver these targets, and land managers (farmers, forest managers) who will be the actors on the ground; more in general, this impact affects all European and world citizens, as climate action is a public good that is cross-border in nature.

This impact is assessed by comparing the EU removal target in 2030 to:

[63] This mechanism was announced in the EU Circular Economy Action Plan (https://europa.eu/!Cp63VQ) and should be put in place in 2023

- the trajectory for land-based climate neutrality in 2035 (as indicated in Section 4.2.1, LULUCF removals should be above -300 MtCO2eq in 2030 to put the sector on this trajectory); and

- the mitigation potential of the LULUCF sector projected by the Commission's policy scenario (MIX), according to which keeping carbon removals at a level around -256 MtCO2eq (slightly lower than today) is possible with no additional costs per ton of CO2eq. [64]

In the case of Option 3, where the target covers the entire land sector (i.e. not only the LULUCF but also the agricultural sector), the assessment will compare the target only to the projected mitigation performance of the land sector; alignment with the objective of a climate-neutral land sector is ensured by the way the targets are computed.

All proposed targets are attainable by implementing a range of different actions, from peatland restoration to improved forest management, from afforestation to the promotion of long-lasting wood products (e.g. in construction).

The views of stakeholders

In the feedback to the Inception Impact Assessment, the following expected environmental impacts were mentioned most frequently in relation to a more ambitious LULUCF Regulation: increased carbon sequestration; preservation of landscapes and ecosystems, including water systems and peatlands; preservation of forests as carbon sinks and biodiverse systems; afforestation and reforestation where there has been intense logging; improved soil fertility and carbon content; reduction of emissions and substitution of fossil-based materials.

While the only environmental impacts assessed here are quantified in terms of GHG emissions and removals, action to enhance removals is highly synergistic with nature-based solutions and sustainable management of agricultural and forestry resources; a careful selection of the actions needed to achieve the targets will lead to win-win outcomes in terms of other environmental objectives. Annex 10.6 provides many examples of win-win solutions for mitigating climate change while at the same time preserving biodiversity, landscapes and ecosystems (see also **Error! Reference source not found.** below), improving land adaptation and resilience to climate change impacts, and replacing fossil-based materials to produce energy or other goods. For instance, a recent JRC report on the use of woody biomass for energy production in the EU[65] finds that afforestation on former agricultural land with mixed species plantations or with naturally regenerating forests would be beneficial both for climate change mitigation and for biodiversity (see Figure 19 in Annex 10.6.2). The optimal mix of actions for carbon removals is not determined only by the ambition of LULUCF targets, but rather corresponds to an integrated policy approach that enhances these synergies and balances many types of financial and regulatory incentives; indeed, in many cases, there are considerable synergies between higher removal targets, adaptation strategies, the higher ambition in the EU Biodiversity strategy, enhanced sustainability requirement for EU biomass, and more sustainable food production. The EU also promotes research and innovation activities in this area: for instance, Horizon Europe (Cluster 6) will allocate at

[64] For a comparison of the targets in all options with the projected potential by Member State, see Annex 10.5.

[65] Camia et al. (2021), "The use of woody biomass for energy production in the EU" (https://europa.eu/!Bn46df)

least €123 million to support the contribution of the agriculture and forestry sectors to the European Green Deal. Thus, the revision of the LULUCF Regulation is only one element in a set of EU policy initiatives which, together, will encourage Member States to design national policies that harness these win-win solutions. See Annex 10.6 for more information on the articulation between the relevant EU policy initiatives on land-related topics.

Box 3 – Links between higher removal targets, higher resilience and biodiversity

Climate change and biodiversity loss are interdependent and mutually reinforcing emergencies and closely interconnected threats, and therefore they need to be addressed together: climate change is one of the main drivers of biodiversity loss, while biodiversity loss and ecosystem degradation have implications for climate change through feedbacks, and for the capacities and limits of nature-based adaptation and mitigation efforts. Synergies and trade-offs between mitigation, adaptation and biodiversity have been the object of strong research efforts and raised policy interest to put forward nature-based solutions[66], with a particular focus on land. Meeting higher carbon removal targets and higher resilience of land while addressing biodiversity challenges will require strong actions to change land management practices, in combination with adequate spatial planning, including the expansion of protected areas, the restoration of degraded areas and the sustainable management of land and forests, targeting a balance between CO2 removals and higher carbon stocks in all carbon pools.

More information on this topic can be found in Annex 10.6.1.

Other environmental impacts

The modelling underpinning this Impact Assessment does not include impacts of higher net removals on air pollution or ecosystems health. However, the Impact Assessment accompanying the Climate Target Plan analysed these impacts in economy-wide scenarios that achieve the -55% reduction in net emissions in 2030. It found that, in those scenarios, air pollution would decrease by 60%, with positive impacts on human health (reduction in premature deaths and morbidity) and other positive economic implications (reduced air pollution control costs, reduced health damage). Achieving the -55% target would also reduce the areas of ecosystems subject to acidification (by 4.7 thousand km2) and to excess nitrogen deposition (by 8.7 thousand km2).[67]

6.1.2. Distributional impacts

The options include different proposals on how to define benchmarks and targets at the level of Member States; Annex 10.5 provides graphs and tables for an overview of these

[66] Nature-based solutions are defined as solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services. For more information on the EU and nature-based solutions: https://europa.eu/!bu88Gq. For the recent policy brief "The solution is in nature": https://europa.eu/!Jf47Gr.

[67] For more details, see section 6.3 of the Impact Assessment accompanying the Climate Target Plan at https://europa.eu/!gC43Cr

targets across Member States. The fairness of the target distribution is assumed to be related to the capacity of a Member State to deliver mitigation action in the LULUCF sector. Like the environmental impacts, also this impact mainly affects Member States who need to design policies to achieve the target; it is assumed that the distribution of the targets among Member States trickles down to the various groups of actors on the ground in a proportional manner.

To assess this impact, the analysis will compare the target distribution to:

- The recent mitigation performance of the LULUCF sector. This indicator looks at how well the proposed target distribution reflects the latest LULUCF inventory (average 2016-2018), which takes into account the recent circumstances of the sector (e.g. impacts of natural disturbances, recent management practices).

- The 2030 mitigation potential: this indicator reflects the alignment of the proposed target distribution with its projected capacity to deliver land-based mitigation according to Commission's policy scenario (MIX) (see Annex 10.4.1 for a more detailed description of this scenario).

The comparison relies both on absolute differences to identify how many Member States receive a target that is more ambitious than their recent or projected performance, and on correlations to assess the extent to which higher targets are assigned to Member States with the highest recent or projected performance (a high correlation coefficient indicates that the distributional allocation is very similar and can thus be considered fair).

6.1.3. Economic impacts

Economic impacts will affect both national policy-makers, who decide on how to use the flexibility opportunities provided by the policy framework, and actors of the bio-economy that deliver climate action on the ground.

The views of stakeholders

In the feedback to the Inception Impact Assessment, the economic impact mentioned most frequently in relation to a more ambitious LULUCF Regulation was the growth of the bio-based sector through increased use of HWPs in substitution of fossil-based materials. The expected social impacts included: the creation of new business opportunities, the promotion of territorial cohesion, and repopulation in rural areas.

The analysis assesses:

- The overall costs of achieving the targets are mainly associated with the actions put in place by the actors of the bio-economy, and in particular: forest management (change rotation length, thinning and harvest intensity), avoided deforestation, afforestation, and fallowing of histosols. These cost estimates are based on Marginal Abatement Cost (MAC) curves from Commission's modelling tools. 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 CO2eq) for a specific scenario and year. Emission reduction potentials are non-linear over time; for instance, the mitigation potential of afforestation after a modelling period of 10 years are small compared to the potentials after 30 or 50 years.

The choice of the best pathway to achieve the national targets should depend not only on cost considerations, but also on the interconnected need to protect the biodiversity and promote a sustainable bio-economy. For instance, higher removal targets could drive bioenergy subsidies towards more sustainable and biodiversity-friendly sources of biomass (in synergy with the sustainability criteria for biomass established under the Recast Renewable Energy Directive, which are also being revised as part of the Fit for 55 package), and other bioeconomy sectors could receive a boost (for instance, the production of long-lasting wood products for furniture or construction materials, which would be accounted as temporary carbon removals). Thus, higher LULUCF targets could promote a shift of the bio-economy sectors towards sustainable, long-lasting and circular uses of natural resources, leading to jobs and growth in these sectors. Annex 10.6.2 gives more information on these links while Annex 10.4.1 includes an explanation of how they are modelled in the Commission's scenarios.

- The expected revenues from land-based climate action.

The views of stakeholders

Stakeholders who replied to the Open Public Consultation on the Review of the LULUCF Regulation identified the following financing approaches as important or very important: Subsidies (e.g. Common Agricultural Policy or national policies) (72%); a dedicated EU or national fund (61%); revenues from selling land-based carbon credits (49%). See Annex 10.2.3 for more details.

Three sources of revenues can be identified: public subsidies, private markets, and inter-Member State trade of LULUCF credits.

In the agricultural sector (and, to some extent, in the forestry sector), the main source of public subsidies is the Common Agricultural Policy (CAP). With a budget of 344 EUR billion in the 2021-2027 period (of which 40% earmarked for climate action), the new CAP gives Member States a large flexibility to design their support schemes to achieve a set of 10 specific objectives, one of which is climate change mitigation and adaptation. Available instruments to compensate or reward climate action are: the design of basic standards (conditionality), hectare-based payments for practices that contribute to climate change mitigation or adaptation on agricultural land (eco-schemes), compensation for climate-friendly management practices or investments in rural areas (Rural Development measures). Some of the specific drivers behind the decline in LULUCF removals, such as farmer's lack of knowledge and low uptake of new practices and technologies, can also be targeted by CAP measures. Another important potential source of public support is the budget made available under the "Next Generation EU", which can be channelled to the land sector through the Recovery and Resilience Plans, submitted by Member States and currently being assessed and adopted.

Private markets can reward climate action via, for instance, labelling schemes to target consumers willing to pay a higher price for climate-friendly products. In recent years, another major source of private funding has emerged: corporations, but also private citizens, buy land-based carbon removals in voluntary carbon markets[68] in order to compensate for their (residual) climate footprint. A Carbon Farming Initiative,

[68] The Report "2020 State of the Voluntary Carbon Markets" by Ecosystem Marketplace finds that corporate carbon-neutral pledges fueled a record transaction volume of at least 104 MtCO2e in 2019, which is an increase of 6 percent over 2018.

announced by the Commission in the Farm to Fork Strategy, will promote this new business model for rural areas, creating new income and jobs for rural areas (see Annex 10.7 for an overview). To support carbon farming approaches, the Commission will propose in 2023 a regulatory framework on the certification of carbon removals.[69] As mentioned in the Circular Economy Action Plan and in the EU Adaptation Strategy, carbon removals should be carried out in full respect of the biodiversity objectives.

Finally, the flexibility mechanisms within LULUCF as well as with the ESR allow Member States to trade LULUCF credits among them, which can create additional revenues for governments who overachieve their LULUCF target. These mechanisms are designed to allow Member States to achieve their climate target in the most cost-efficient way by focusing resources on the actions with lower abatement costs, and are essential to achieve a flexible policy framework (Specific Objective #2, Section 4.2.2).

Given that the LULUCF Regulation addresses primarily Member States, this impact indicator will focus on the last type of revenues. Clearly, higher removal targets will affect national policies which will in turn impact individual bio-economy actors; however, when it comes to assessing the revenues resulting from different options on these actors, it can be assumed that the national revenues will trickle down proportionally to the individual level through the available types of public support mentioned above. For each option, this indicator will assess the extent to which flexibility mechanisms are likely to be used, based on the expected demand and supply for these credits; these are estimated by looking at the gap between the proposed national targets and the projected performance of the sector in each Member State, based on the Commission's scenario modelling.

Three levels of flexibility exist: intra-LULUCF flexibility is the possibility to sell LULUCF removals in excess of the target to other Member States (Options 1 and 2); ESR-LULUCF flexibility is the possibility to use LULUCF removals in excess of the target to achieve ESR targets (Option 2); and full land flexibility is the possibility to achieve the land targets with integrated action in either the agricultural or the LULUCF sector (Option 3).

6.1.4. Administrative impacts

Administrative impacts are understood in terms of regulatory costs that affect Member States authorities in charge of the implementation of LULUCF and other land-related policies. These include the costs of implementing the policy, the costs due to low integration with other policies, and the monitoring costs.

- Implementation costs: this qualitative indicator assesses the extent to which the implementation of the policy has been simplified (Specific Objective #3, Section 4.2.3). At a minimum, this is related to abandoning the FRL concept compliance period (option 1.1). An additional layer of simplification is represented by those options that, besides moving away from the FRL concept, also move away from other accounting benchmarks by setting a single target based on reported emissions and removals (options 1.2, 2, and 3): this approach decreases the regulatory costs linked to the compliance exercise and simplifies the

[69] To identify and prioritise the research and innovation needs related to Carbon Farming, the Horizon Europe Work Programme for 2021-22 will include research actions to improve the monitoring and verification of land-based removals.

communication about the policy (this last impact is not tangible but should nevertheless be mentioned, because the complexity of the LULUCF accounting rules has been likely to hinder full integration of this sector into climate policy-making).

- Synergies: this qualitative indicator is linked to the objective of an integrated policy framework for the LULUCF sector (Specific Objective #2, Section 4.2.2). While Option 1 presents very little or no integration of the LULUCF sector in the overall climate policy framework, Option 2 presents some integration via the flexibility between the LULUCF Regulation and the ESR; Option 3 offers the highest level of integration by setting a climate target that covers the land sector in a comprehensive way. A comprehensive target for the land sector would provide a clear climate steer to the Common Agricultural Policy and promote synergies with other land-related policies (e.g. climate adaptation, biodiversity). These synergies are likely to result in more effective and cost-efficient policy design in the long term, as the policy approach is made 'future-proof' and in line with the projected contribution and needs of the land sector.

- Monitoring costs: this qualitative indicator is linked to the costs of improving national systems to monitor the climate performance of the LULUCF sector in a robust way. The current monitoring and reporting systems have improved during the implementation of the LULUCF Decision (2013-2020) but they are still not granular enough to reflect climate action taken on the ground in an accurate way (see Section 2.1.3). In particular, enhancements and synergies with monitoring under other policy areas (biodiversity, agricultural policy) should be leveraged. Thus, for all the options to be implemented effectively (and in particular those with targets based on reported emissions and removals, that is, option 1.2, 2 and 3), it is necessary to improve these systems significantly in the next years; specific requirements are discussed in Section 9. While these requirements will entail some costs[70], there is also large scope for cost-efficient improvements by drawing on existing datasets and remote sensing technologies; moreover, better policy monitoring allows to better target areas with the largest mitigation potential, thus resulting in more effective and cost-efficient policy making. As these requirements are proposed as a horizontal element of the revision, and not as a specific feature of some selected options, these impacts can be considered to be the same across all options.

6.2. Impacts of Option 1: Self-standing LULUCF target

6.2.1. Option 1.1: Changing the accounting rules for managed forest land

- **Environmental impacts**

This option would require EU removals at the level of **approximately -259.7 MtCO2eq**. This level is just below the recent mitigation performance of the LULUCF sector and just above the projected mitigation potential under the policy scenario; it would not be enough to put the EU on track for a climate-neutral land sector.

[70] In France for example, the cost of national soil carbon monitoring has recently been estimated to be between 2 and 6.5 million euros per year (Voltz et al., 2018). A coarse upscaling proportional to land area puts the figure at 15-55 million euros per year for the EU. For more details on this topic, see Note "Soil carbon", prepared by external consultants under a support contract led by COWI (https://data.europa.eu/doi/10.2834/201100).

- **Distributional impacts**

For 14 Member States, the target under this option is less stringent than their recent performance from 2016 to 2018. The same is true for 15 Member States with regard to their potential projected by the policy scenario. For the remaining Member States, the target is more ambitious but in most cases still very close to the Member State's recent and projected performance (at zero marginal cost per tonne in the MIX projection).

Overall, the targets under Option 1.1 correlate very well with the recent performance or with the projected potential: the correlation coefficient is, respectively, $r = 0.99$ and $r = 0.93$. Targets based on a recent historic benchmark for managed forest land perform very well in terms of allocating more stringent targets to the Member States that show the best recent performance, largely overcome issues relating to age class structure of forests, and offer the largest projected potential to deliver climate change mitigation in the LULUCF sector.

- **Economic impacts**

The level of removals required under this option is very close to the level that the policy scenario assumes to be feasible at zero additional cost per tonne of CO2 (256 MtCO2eq). By comparing national MIX projections (at zero additional costs per ton of CO2) with the national targets, it can be estimated that the annual supply and demand for LULUCF credits in 2030 would be around 48 MtCO2eq and 51 MtCO2eq, respectively[71]. Thus, there would be potential for trade between Member States but most Member States will likely prefer to increase own mitigation actions instead of buying from other Member States.

Moreover, under this option there is no flexibility between the LULUCF sector and the ESR sectors: in other words, there is no possibility to use over-performance under LULUCF for ESR compliance and vice-versa. While such a separate removal target for the land sector can provide reassurances that the improvement in the performance in the LULUCF sector does not dilute the pressure to reduce emissions in other sectors[72], the absence of any flexibility between the LULUCF sector and the ESR also implies that no additional incentives exist to overachieve the target, which is just above the projected performance of the sector with no additional action.

- **Administrative impacts**

Implementation costs: Moving from the FRL accounting rule to a recent historic baseline provides two advantages: it reduces administrative burden, and it sets a more objective benchmark, less dependent on the choice of complex methodological approaches.

The views of stakeholders

This option was discussed extensively in November 2020 during a workshop with

[71] 48 MtCO2eq (respectively, 51 MtCO2eq) is the sum of the differences between removals in the MIX projection (at zero additional costs per ton of CO2) and the targets in those Member States where this difference is positive (respectively, negative). Under the current LULUCF regulation, a flexibility mechanism exists to address such differences in credits and debits between Member States. Under certain conditions, Member States that find themselves at non-compliance with emissions accounted against the FRL, are entitled to benefit from a certain amount of the surplus of the other Member States. This flexibility mechanism can only enter into force in the case, *inter alia*, that the "no-debit" rule is fulfilled at EU level.

[72] Ref. McLaren et al., "Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions" (https://doi.org/10.3389/fclim.2019.00004).

national experts, many of which were members of the LULUCF Expert Group and therefore had been personally involved in the FRL review process. The majority of these experts were of the view that the EU should not continue with the use of the FRL concept (a view also shared by a majority of the respondents to the Open Public Consultation on the LULUCF Review), and considered the FRL review process as too burdensome.

Synergies: The absence of any flexibility between the LULUCF sector and the agricultural emissions covered by the ESR may hinder a strategic policy approach to improve the mitigation performance of the land sector in an integrated manner. This may undermine synergies in policy planning which may result in less cost-effective national climate policies across agriculture, forestry, and land use sectors in general.

Monitoring costs: As for all options, the enhanced monitoring and reporting requirements described in Section 9 would entail some costs, but these costs can be minimised if existing datasets and remote sensing technologies are exploited, and can be partly compensated by more effective policy making made possible by better monitoring systems.

***In conclusion**, this sub-option presents some simplification benefits because it abandons the FRL concept, but the lack of flexibility and of integration in the overall climate framework may hinder cost-effective policy design. The choice of a recent reference period for forests ensures a fair distribution of effort as it cancels out the impact of the forest age structure and recognises recent natural disturbances. It only implies a slightly more ambitious performance than in the Commission's projections for 2030, which can be achieved at a very low cost, but does not offer incentives to exceed the target.*

Option 1.1	**Environmental impacts**	**Distributional impacts**	**Economic impacts**	**Administrative impacts**
Main elements: • Benchmark managed forest land: historic average instead of FRL • No flexibility with ESR	Target is approx. 260 MtCO2eq. Not in line with trajectory towards land neutrality objective.	The recent reference period for forests reflects the current forest age structure dynamics and recent natural disturbances.	Low additional cost with respect to the baseline. Small potential for trade of LULUCF credits; no flexibility with ESR hinders overall cost-efficiency.	Simplification (no FRL) but still some complexity due to remaining accounting provisions No synergies / integration between the LULUCF and the Agriculture sector
Assessment	✓	✓	0	✓

Table 3 — Summary of main elements of Option 1.1, its impacts, and qualitative assessment (✓✓✓ Very positive; ✓✓ Positive; ✓ Mildly positive; 0 No or negligible impact; ✗ Negative)

6.2.2. Option 1.2: Setting a single removal target

- **Environmental impacts**

This option proposes an EU target for net removals of **-310 MtCO2eq in 2030**. This level of removals is higher than the projections in the policy scenario at zero additional

cost per ton of CO2, but is consistent with putting the LULUCF sector on the trajectory of a climate-neutral land sector in 2035.

- **Distributional impacts**

By construction, these targets imply an improvement over the recent performance for all Member States; collectively, Member States need to deliver 42.3 MtCO2eq more than in the recent period (2016-2018).

It is noteworthy that the targets for 14 Member States are still below the policy scenario projections at a carbon price of 5 EUR/tCO2, while they would require additional effort for the remaining 13 Member States.

Overall, the targets under Option 1.2 correlate very well with the current performance or with the projected potential: the correlation coefficient is, respectively $r = 0.999$ and $r = 0.97$; thus, targets based on a recent reference period and on the area of managed land perform very well in terms of allocating more stringent targets to the Member States that show the best recent performance and the largest projected potential to deliver climate change mitigation in the LULUCF sector. This is because the choice of a recent reference period as the main allocation criterion ensures, like in Option 1.1, that the impact of the age structure of the forests (addressed in the current regulation through the FRL) cancels out, and the impacts of recent natural disturbances and the impacts of recent changes in forest management are well reflected.

- **Economic impacts**

The level of removals required under this option is around 54 MtCO2eq higher than the level that the policy scenario assumes to be feasible at zero additional cost per ton of CO2 (256 MtCO2eq). Such gap can be filled at a relatively low costs per ton of CO2 (between 5 EUR/tCO2 and 10 EUR/tCO2), as explained in Annex 10.4.1. A carbon price of 5 EUR/tCO2 could deliver an additional 58.3 MtCO2eq for an incremental cost of EUR 291 Mio per year; 10 EUR/tCO2 could deliver another 10 MtCO2eq for an incremental cost of EUR 100 Mio.

The Common Agricultural Policy offers the financial support to finance the incurred costs for the additional carbon removals. Alternatively, farmers and foresters could sell the additional carbon removals on the voluntary carbon market. Assuming that carbon credits would trade at a price of around EUR 10, farmers and foresters could expect additional revenues of up to roughly EUR 700 million for the additionally generated 68.3 MtCO2eq. Compared to annual costs of EUR 391 Mio per year, farmers and foresters could expect a sufficient gross margin to cover administrative and set-up costs, risks related to natural disturbances, and a return on the invested capital. See also Section 10.7 for more explanations on the business model behind carbon farming.

Finally, the 13 Member States with a target higher than the estimated level of removals in their policy scenario at a carbon price of 5 EUR/tCO2 may want to compensate their annual debits (in total 41 MtCO2eq) through buying LULUCF credits from the other 14 Member States who expect to have total annual credits of 45 MtCO2eq[73]. These

[73] 45 MtCO2eq (respectively, 41MtCO2eq) is the sum of the differences between removals in the MIX projection at 5 EUR/tCO2 and the target in those Member States where this difference is positive (respectively, negative). As explained in more detail in Annex 10.5, under the current LULUCF regulation, there exists a flexibility mechanism where Member States that find themselves with a debit will receive a certain amount of credits from the surplus of the other Member States. This flexibility mechanism can enter into force in case that the "no-debit" rule is fulfilled at EU level.

imbalances can create important trading opportunities within the LULUCF sector. However, another potential source of demand for LULUCF credits, namely from those Member States who may not achieve their ESR target, is not exploited because of the absence of any flexibility between the LULUCF sector and the ESR (as in Option 1.1).

- **Administrative impacts**:

Implementation costs: A single target which is based on the emissions and removals reported in the inventory instead of being based on a set of accounting benchmarks significantly simplifies planning, implementation, compliance, and communication about the policy.

Synergies: See above (Option 1.1).

Monitoring costs: See above (Option 1.1).

***In conclusion**, this option contributes to simplification and increased climate ambition by setting a single removal target which is well above the level of removals required in the baseline and is aligned with the trajectory towards a climate-neutral land sector in 2035. The higher ambition requires additional mitigation action in more than half of the Member States, but this can be achieved at a relatively low cost. Higher targets also boost the demand for LULUCF credits and thus the incentives to overachieve targets where possible. However, this option performs less well in terms of flexibility and synergies with other land-related policies.*

Option 1.2	**Environmental impacts**	**Distributional impacts**	**Economic impacts**	**Administrative impacts**
Main elements: • Single removal target • No flexibility with ESR	Target is -310 MtCO2eq removals in 2030 In line with land neutrality trajectory	Target distribution reflects recent circumstances and future potential	Additional action can be delivered at a relatively low cost Strong potential for trade of LULUCF credits No flexibility with ESR hinders overall cost-efficiency	High level of simplification No synergies / integration of the LULUCF and the Agriculture sector
Assessment	✓✓✓	✓✓	✓	✓✓

Table 4 – Summary of main elements of Option 1.2, its impacts, and qualitative assessment (✓✓✓ Very positive; ✓✓ Positive; ✓ Mildly positive; 0 No or negligible impact; × Negative)

6.3. Impacts of Option 2: Flexible LULUCF target

- **Environmental impacts**

The removal target is set at **-268 MtCO2eq**; however, the actual amount of removals that this option can deliver could be higher, depending on the level of ambition set for the ESR. If ESR targets are ambitious enough to require the use of a significant amount of LULUCF credits, incentivising Member States to overachieve their LULUCF targets, this option may be aligned with the objective of a climate-neutral land sector in 2035. For instance, if the amount of LULUCF credits that can be used for ESR compliance remains on average **26 MtCO2 per year**, like in the current ESR, and if the demand for

these credits is large enough that they are all supplied, then the removals in 2030 could be up to -294 MtCO2eq, which is line with the trajectory towards a climate-neutral land sector in 2035. In addition, the possibility to sell LULUCF credits to other Member States for *their own* ESR compliance broadens the pool of potential buyers of LULUCF credits, which can provide additional incentives to overachieve LULUCF targets (see 'Economic impacts' for more details).

- **Distributional impacts**

Under this option, the targets are more ambitious than the 2030 policy scenario at zero additional costs per ton of CO2 for only 14 Member States[74].

Overall, the targets under Option 2 correlate very well with the projected potential in 2030 ($r = 0.96$)[75]. As under Option 1, targets based on a recent reference period perform well in terms of allocating more stringent targets to the Member States that show the largest potential to deliver climate change mitigation in the LULUCF sector in 2030.

- **Economic impacts**

The level of removals required under this option is around 12 MtCO2eq higher than the level that the policy scenario assumes to be feasible at zero additional cost per ton of CO2 (-256 MtCO2eq). Such a small gap can be filled at a low cost per ton of CO2 (well below 5 EUR/tCO2), as explained in Annex 10.4.1. As explained with option 1.2, the additional costs can be covered by financial support from the Common Agricultural Policy or by revenues from selling carbon credits on voluntary carbon markets.

When considering the possibility to trade LULUCF credits for LULUCF compliance, the 14 Member States with a target higher than the estimated level of removals in their policy scenario may want to compensate their annual debits (in total 45 MtCO2eq) through buying LULUCF credits from the other 13 Member States who expect to have total annual credits of 34 MtCO2eq and can produce even more removals at modest costs[76].

In addition, this option opens the possibility to trade LULUCF credits for ESR compliance. According to the rules set out in the ESR, each Member State can use a maximum amount of LULUCF credits generated domestically for ESR compliance. Whether this option makes it more difficult or easier to generate LULUCF credits for a Member State's own ESR compliance depends on whether the new threshold (i.e. the new target) is more or less stringent than in the baseline (respectively, this is the case in 17 and 10 Member States). However, this option also introduces the possibility to use LULUCF credits bought from *another* Member State for a Member State's ESR compliance. Thus, the potential buyers of LULUCF credits are not only those Member States that under-achieve their LULUCF target, but also those that under-achieve their

[74] By construction, there is no difference between the targets in Option 2 and the recent mitigation performance.

[75] By construction, there is perfect correlation with the recent performance levels – same levels as the targets.

[76] 34 MtCO2eq (respectively, 45 MtCO2eq) is the sum of the differences between removals in the MIX projection at zero additional costs per ton of CO2 and the target in those Member States where this difference is positive (respectively, negative). As explained in more detail in Annex 10.5, under the current LULUCF regulation, there exists a flexibility mechanism where Member States that find themselves with a debit will receive a certain amount of credits from the surplus of the other Member States. This flexibility mechanism can enter into force in case that the "no-debit" rule is fulfilled at EU level.

ESR target. While the ESR rules continue to impose a limit on the amount of LULUCF credits that each Member State can use for its own ESR compliance[77], there is no limit on the amount of LULUCF credits that a Member State can supply to other Member States for their own ESR compliance; thus, Member States with the most cost-efficient mitigation potential are encouraged to significantly overachieve their LULUCF target (even beyond the additional removals that they can use for their own ESR compliance) to meet the demand from this larger, EU-wide pool of potential buyers.

- **Administrative impacts**

Implementation costs: Given that national targets are set against the emissions and removals reported in the inventories, and not against accounting benchmarks, the impacts of this option on this indicator are similar to those of Option 1.2.

Synergies: The creation of a stronger EU-wide trade of LULUCF credits can promote a more integrated strategy for climate mitigation in the land sector (i.e. agriculture and LULUCF) across Member States. For instance, a Member State with a combination of high GDP (and hence a high ESR target), an agricultural sector with high non-CO2 emissions but low mitigation potential, and small potential to deliver LULUCF removals, can purchase LULUCF credits and thereby cover the costs of LULUCF mitigation in another Member State that has a lower GDP (and hence a lower ESR target) and more land available for climate action. Thus, Member States have a stake in the effectiveness of land policies put in place in other Member States; this can foster cross-border synergies and is aligned with a vision for a fully integrated and cost-efficient approach to climate mitigation in the land sector EU-wide.

Monitoring costs: See above (Option 1.1).

***In conclusion**, this option delivers a fair and flexible policy framework. The targets ensure "no-backsliding" with respect to the current LULUCF performance; while these targets would not be enough to achieve climate neutrality in the land sector in 2030, the broader possibilities for EU-wide trade of LULUCF credits for ESR compliance could create the incentives to overachieve these targets. Like in Option 1.2, a single target set in reported terms delivers significant simplification.*

Option 2	**Environmental impacts**	**Distributional impacts**	**Economic impacts**	**Administrative impacts**

[77] These amounts are discussed in the Impact Assessment accompanying the proposal for a revision of the Effort Sharing Regulation.

Main elements: • Flexibility with ESR • Broader trading possibilities • Single removal target equal to recent LULUCF performance	Target is 268 MtCO2eq removals. Strong demand for LULUCF credits (e.g. very high ESR targets) could create incentives to overachieve targets and put the sector on the trajectory for land-based neutrality in 2035.	High correlation with projected LULUCF performance indicates a fair distribution of efforts	Additional action can be delivered at a low cost. Broader trading opportunities with ESR promote a cost-efficient allocation of mitigation action across borders.	High level of simplification Good synergies thanks to strengthened flexibility opportunities.
Assessment	✓✓(✓)	✓✓	✓✓	✓✓

Table 5 – Summary of main elements of Option 2, its impacts, and qualitative assessment (✓✓✓ Very positive; ✓✓ Positive; ✓ Mildly positive; 0 No or negligible impact; × Negative)

6.4. Impacts of Option 3: Fully integrated agriculture and LULUCF target

- **Environmental impacts**

This option proposes an EU target for the land sector of **40 MtCO2eq in 2030**, which means that agricultural emissions should exceed land-based removals by no more than 40 MtCO2eq. This is more ambitious than the corresponding projections in the policy scenario with zero additional cost (120 MtCO2eq in 2030), and is by construction consistent with a trajectory towards **land-based climate neutrality in 2035**, when agricultural emissions shall not exceed land-based removals at EU level.

The optimal mix of mitigation action for livestock and fertilizer use compared to land-based removals will depend on the relative costs of the different actions, but also on policy choices in line with Green Deal initiatives (e.g. Farm-to-Fork, biodiversity, biomass sustainability, Methane Strategy, and the greening of the CAP) and on developments on the demand side (e.g. meat consumption, alternative proteins). Indeed, even if many types of mitigation action in the LULUCF sector are possible at a relatively low cost and/or have large mitigation effects in the short term, more expensive LULUCF actions may carry more co-benefits for biodiversity and/or carry longer-term benefits for climate mitigation and adaptation, and should thus be prioritised. Similarly, even if mitigation action in the agricultural sector is in general more expensive, the pressure to decrease emissions in the agricultural sector must not be diluted by the possibility to compensate these emissions with cheaper LULUCF removals: climate action in the agricultural sector is essential for the many co-benefits that it can provide, such as improving the sector's resilience to the impacts of climate change, and reducing pollution and threats to ecosystems. Finally, in many cases the same type of climate action can deliver an improvement in terms of both agricultural emissions and LULUCF removals, and such synergies should be addressed in an integrated manner: for instance, the promotion of plant-based diets with less meat can both reduce agricultural emissions from the livestock sector[78] and free up land that can deliver carbon sequestration (e.g.

[78] The Commission's Communication "A Clean Planet for All" (COM/2018/773 final, https://europa.eu/!VU93kN) has presented eight scenarios to decarbonise the economy. One of the

biodiversity-friendly afforestation), besides its significant benefits for the health of EU citizens[79] (see Annex 10.6.4 for more information on the mitigation potential of dietary change).

Figure 8 illustrates the range of possible combinations between mitigation actions in the agricultural and LULUCF sectors. As the graph shows, the same mitigation outcome can be reached by doing more in agriculture and less in LULUCF, and vice versa. The orange dots indicate the combinations that can be reached at a low range of economic costs; however, as just argued, costs are only one of the considerations that should come into play in the choice of the optimal mitigation mix.

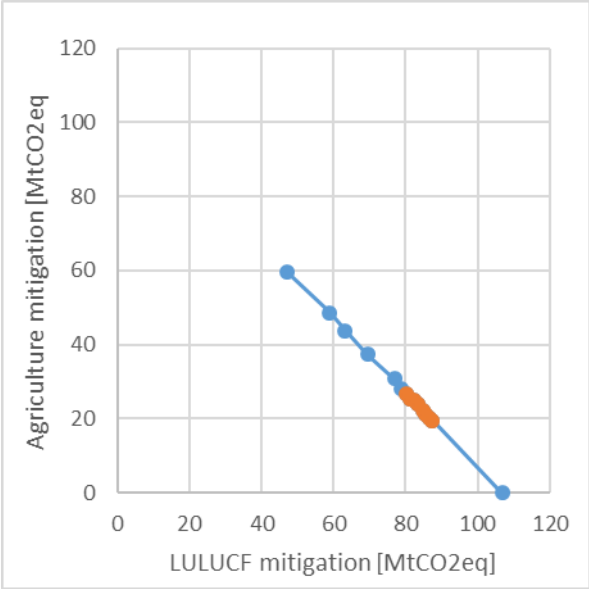


Figure 8 – Each point in the graph corresponds to a combination of additional LULUCF removals (x-axis) and additional emission reductions in Agriculture (y-axis) to achieve an EU climate neutral land sector in 2035. Points on the blue line correspond to combinations that deliver additional mitigation of 106 MtCO2eq; this level would bridge the gap that remains after the low-hanging fruits (the LULUCF and agricultural mitigation actions that are assumed at zero costs per ton of CO2eq) are carried out. The range shown in the graph goes from 47 MtCO2eq of LULUCF removals and a reduction of 59 MtCO2eq in agriculture on the top-left end of the blue line, to 106 MtCO2eq of LULUCF removals and no reduction in agriculture on the bottom-right end of the blue line. Orange dots indicate economic cost-efficient options for combined LULUCF and Agriculture action.

- **Distributional impacts**

Under this option, all Member States need to improve the mitigation performance of their land sector compared to their recent performance (2016-2018). The targets are more ambitious than the 2030 policy projections for 21 Member States; the gap that these Member States have to fill is quite large (89 MtCO2eq) and concentrated (five Member States count for more than half of this gap).

Overall, the targets under Option 3 correlate very well with the current performance or with the projected potential for the land sector: the correlation coefficient is, respectively, $r = 0.97$ and $r = 0.94$. Thus, targets under this option perform well in terms of

scenarios, aiming at a climate-neutral EU by 2050, includes climate-friendly consumers' choices. The modelling exercise showed that even moderate changes in the consumption of food of animal origin in line with the World Health Organization (WHO) recommendations can significantly reduce emissions from agricultural production.

[79] With about 40% of cancers preventable, Europe's Beating Cancer Plan (COM(2021) 44 final, https://europa.eu/!mg86Uu) promotes shifting to a more plant-based diet, with less red and processed meat and other foods linked to cancer risks and more fruit and vegetables.

allocating more stringent targets to the Member States that show the best recent performance and the largest projected potential to deliver climate change mitigation in the land sector.

- **Economic impacts**

Under this option, Member States can trade land credits without any restrictions and therefore optimise mitigation action across national borders. The full flexibility between the agriculture and LULUCF sector is a specific feature of this option: unlike the flexibility mechanism in the baseline and under Option 2, there is no regulatory limit on the amount of LULUCF removals that can compensate for emissions in the agricultural sector, and vice versa (although, as just argued, such constraints are imposed by other types of considerations). On the other hand, there is no flexibility between the land sector and the other sectors covered by the ESR. Thus, there is no risk that action in the land sector reduces the pressure to decarbonise other sectors that heavily rely on fossil fuels, such as transports or heating.

As under the previous options, the Common Agricultural Policy is available to support the costs for additional carbon removals as well as costs of reducing non-CO2 emissions. Farmers and foresters can, furthermore, generate additional revenues from the sale of carbon credits on voluntary carbon markets, helping to cover the costs for removals and emissions reductions.

- **Administrative impacts**

Implementation costs: As in Option 1.2 and Option 2, a single target which is based on the emissions and removals reported in the inventory instead of being based on a set of accounting benchmarks simplifies planning, implementation, compliance, and communication about the policy. The regulatory burden corresponding to the planning exercise is minimised by linking the submission to the NECP cycle and by building on the analysis done in the context of CAP Strategic Planning.

To minimise implementation costs, the planning process can be linked to the planning cycle of National Energy and Climate Plans (for which the next draft update is due by 30 June 2023). A dedicated section could be added with a specific template aimed at gathering information on the achievement of the collective target, in a similar way to current requirements to describe the contribution to the EU targets for renewable energy and energy efficiency. Moreover, the planning process can build on the discussions that are already taking place at the national level in the context of the CAP Strategic Plans: Member States will not start from scratch in their analysis, because important inputs such as the climate-related SWOT analysis and identification of needs will have already been carried out for the establishment of those plans; this analysis will nonetheless have to be updated given the larger scope of the exercise (with a larger role for non-agricultural land) and the specific 2035 objective of land-based climate neutrality.

The planning process can also improve transparency about the long-term planning direction of land-related policies, which is good for stakeholder involvement and investments.

Synergies: By integrating all climate action in the agriculture and LULUCF sector under the same piece of legislation, this option presents very high potential for policy synergies, which are likely to result in more effective and cost-efficient policy design. The full flexibility between the two sectors promotes a synergistic approach that takes into account the linkages between land use, livestock activities, fertiliser use, and forest management. The better alignment with the scope of actions that can be supported under

the Common Agricultural Policy can result in more effective use of the CAP budget for climate action. The 2035 policy horizon provides for a clear policy direction in the long-term, including for the future (2028-2035) Common Agricultural Policy.

Monitoring costs: See above (Option 1.1).

***In conclusion**, this option contributes to simplification and increased climate ambition by setting a single target for the land sector which is fully aligned with the trajectory towards a climate-neutral land sector in 2035. This option establishes binding 2030 targets according to the current performance of the land sector and the area of managed land in each Member State, which correlates well with the capacity to deliver mitigation. It also performs very well in terms of flexibility and synergies, as it creates an integrated framework for climate action in the land sector.*

Option 3	**Environmental impacts**	**Distributional impacts**	**Economic impacts**	**Administrative impacts**
Main elements: • Binding targets for the land sector (agriculture + LULUCF) • Planning exercise towards land-based climate neutrality in 2035	Target is 40 MtCO2eq net emissions for the land sector in 2030, which is fully in line with the trajectory towards land-based climate neutrality in 2035	High correlation with current and projected land mitigation performance indicates a fair distribution of efforts	The overall cost depends on the balance between mitigation action in the agriculture vs LULUCF Full flexibility between agriculture and LULUCF promotes cost-efficiency	High level of simplification Planning exercise in synergy with NECP cycle Full integration of LULUCF and Agriculture, alignment with CAP, long-term policy direction
Assessment	✓✓✓	✓✓	✓✓✓	✓✓✓

Table 6 – Summary of main elements of Option 3, its impacts, and qualitative assessment (✓✓✓ Very positive; ✓✓ Positive; ✓ Mildly positive; 0 No or negligible impact; ✗ Negative)

6.5. Summary of impacts

The following table summarizes the impacts for the three policy options:

	Environmental impacts	**Distributional impacts**	**Economic impacts**	**Administrative impacts**
Option 1.1	✓	✓	0	✓
Option 1.2	✓✓✓	✓✓	✓	✓✓
Option 2	✓✓(✓)	✓✓	✓✓	✓✓
Option 3	✓✓✓	✓✓	✓✓✓	✓✓✓

Table 7 – Summary of the qualitative assessment of the impacts of the different options (✓✓✓ Very positive; ✓✓ Positive; ✓ Mildly positive; 0 No or negligible impact; ✗ Negative)

The following box summarises the costs and benefits of the different options and who will be affected by them:

Box 4 – Summary of costs and benefits of the different options

The modelling results show that mitigation action must happen on all types of land – action on forest land or agriculture land alone is not enough to achieve the more ambitious targets. Therefore, all actors of the bioeconomy (farmers, forest managers, producers of bioenergy or long-lasting wood products) have a role to play. However, the modelling results also show that the **costs** of the needed mitigation action are relatively low. In particular, the carbon price of the additional action that is needed to achieve the targets in the different options are:

- Option 1.1: The level of removals required under this option (-260 MtCO2eq) is very close to the level that the policy scenario assumes to be feasible at zero additional cost per ton of CO2.
- Option 1.2: the target (-310 MtCO2eq) could be achieved at a carbon price between 5 EUR/tCO2 and 10 EUR/tCO2, or an estimated total cost between EUR 291 Mio and EUR 391 Mio per year.
- Option 2: the minimum target (-267.7 MtCO2eq) could be achieved at a very low cost per ton of CO2 (well below 5 EUR/tCO2). However, this option incentivizes the generation of LULUCF credits *above* the target via strengthened flexibility with the ESR: effectively, the amount of removals (and associated costs) is expected to be higher than the minimum target and similar to Option 1.2.
- Option 3: the carbon price range for cost-efficient mitigation actions is 16-23 EUR/tCO2eq for LULUCF and 1-41 EUR/tCO2 for Agriculture (depending on the relative contribution from each sector to the overall target). The total estimated cost in 2035 in the combined land sector ranges between EUR 531 Mio and EUR 605 Mio.

To put these numbers in perspective, the ETS carbon price is currently around EUR 50 per ton of CO2, and the budget earmarked for climate in the Common Agricultural Policy for the 2021-2027 period is EUR 138 billion (40% of the total EUR 344 billion).

In terms of **benefits**, given that the LULUCF Regulation addresses primarily Member States, the corresponding impact indicator in this impact assessment focuses on the revenues from inter-Member State trade of LULUCF credits. However, clearly, higher removal targets will affect national policies which will in turn impact both public and private markets for climate mitigation in agriculture. The Commission is working on the concept of carbon farming to promote carbon sequestration as a new green business model that can create a new source of income for land managers. A higher ambition for the LULUCF sector is expected to drive carbon farming approaches in the near future, but a precise quantification of the economic benefits for individual land managers was not possible in the context of this report.[80]

In terms of **administrative savings**, the simplification of the target and compliance framework places more emphasis upon the use of already reported datasets in the existing greenhouse gas inventory covered by the Governance Regulation (2018/1999). The main administrative costs of this reporting are therefore marginally reduced, since the provision of information by Member State administrations for compliance of accounting is simplified. For example, an estimated shared cost between Commission and Member States of EUR 4.5 Mio could be saved by changing the accounting rule for Managed Forest Land from the Reference Level approach to a net-net accounting. Potential savings also lie in the use of EU standardised datasets (such as taken from

[80] See the economic assessment of option 1.2 for an estimation of the potential maximum revenues for carbon removals.

related policy areas like the CAP and Restoration planning and monitoring), the incorporation of data from EU programmes such the EU Soil Observatory and LUCAS soil survey data, the EEA's Forest Information System for Europe, the provision Copernicus services – provided free to Member States – and the harmonisation of modelling tools between Member States. The development of these has already been encouraged for some years through LIFE—funded projects and technical assistance by the Commission to Member States.

7. HOW DO THE OPTIONS COMPARE?

The views of stakeholders

A qualitative analysis of the feedback provided to the Inception Impact Assessment indicates that stakeholders in general agreed on the need to increase the ambition of the LULUCF regulation in line with the new climate targets (57% of the 69 respondents who commented on this); all of those disagreeing (19%) expressed a concern that a strengthened regulation would lead to further obligations on the part of the bio-based sector. Of the 56 respondents providing feedback on the option to strengthen the flexibility between the LULUCF Regulation and the Effort Sharing Regulation, a majority (65%, mainly environmental NGOs and respondents from the bio-based industry), disagreed with increasing this flexibility, due to a concern that this could lead to a decrease in the ambition to reduce emissions in other sectors. Finally, 53 respondents provided feedback on the option to combine the agriculture and LULUCF sectors into a single climate policy pillar with a separate target; 43% of them disagreed with this option, expressing concerns such as an expectation for the forestry sector to offset emissions from the agricultural sector or to reduce wood harvest rates.

Respondents to the Open Public Consultation had a preference for more ambitious removal targets for the LULUCF sector, which was selected by 45% of them (mostly, academia, EU citizens and NGOs). In second place, the integrated targets for the land sector were preferred by 35% of the respondents, mostly the private sector. A strengthening of flexibility with the ESR was the most preferred option among 20% of respondents, mostly public authorities. For more information on stakeholders' view, see Annex 10.2.

7.1. Effectiveness

Effectiveness is the extent to which options are fit to achieve the general objective set out in Section 4 (-55% of net emissions in the EU economy by 2030), which is mainly connected to Specific Objective #1 (A climate-neutral land sector by 2035).

- **Specific objective #1: A climate-neutral land sector by 2035**

The two options with a target that is fully aligned with a climate-neutral land sector in 2035 are Option 1.2 and Option 3. The single LULUCF target in **Option 1.2**, set at -310 MtCO2eq of removals in 2030, would put the LULUCF sector on the trajectory needed to compensate for all remaining agricultural emissions in 2035. This option does not address directly agricultural emissions: in case this option is retained, the parallel contribution from the agricultural sector would need to be ensured by higher ESR targets. **Option 3** fully covers the LULUCF and the agricultural sector under the same policy target, which is by construction aligned with the objective: it promotes a fully integrated

policy approach to achieve land-based climate neutrality in 2035, and is therefore the more indicated option to achieve this objective.

Option 2 could potentially deliver enough removals to put the LULUCF sector on the desired trajectory, but this depends on the incentives to overachieve the targets in order to generate LULUCF credits. The option features two elements that can consolidate the demand for LULUCF credits and thereby increase these incentives: it sets higher LULUCF targets than in the baseline, and it allows the use of LULUCF credits purchased from another Member State for ESR compliance. A third and fundamental incentive to overachieve the target is the need for LULUCF credits in view of ESR compliance; therefore, the more ambitious the ESR targets are, the more this option is fit for this objective.

Option 1.1 increases the ambition of the target with respect to the baseline but not enough to be aligned with the first specific objective; the absence of any flexibility with the ESR makes it unlikely that Member States would overachieve this target.

7.2. Efficiency

Efficiency is the extent to which options can achieve the main objective of the initiative in a cost-effective way, that is, by minimising economic and regulatory costs, and by enhancing synergies. Thus, efficiency directly relates to Specific Objectives #2 (A fair, flexible and integrated climate policy framework for the land sector) and #3 (Simplification).

- **Specific objective #2: A fair, flexible and integrated climate policy framework for the land sector**

Fairness

Fairness is intended to measure the extent to which higher targets are allocated to Member States with the largest potential to deliver climate change mitigation, which is necessary to achieve the targets in a cost-effective way.

All options have a similar performance when it comes to providing a fair policy framework. As they all select a more recent reference period for target setting, the target distribution is always well correlated to the recent mitigation performance of the sector, which indicates a fair recognition of recent circumstances in the forest sector (natural disturbances, changes in management practices). The correlation with the projected potential of the LULUCF sector is also very high and comparable across all options.

Flexibility

As mitigation costs differ widely across Member States, cost efficiency can be be increased through a flexible framework such that Member States who have the land available to implement mitigation action can seek a compensation of the costs by selling the resulting removals to other Member States with lower mitigation potential. A mechanism to trade LULUCF credits across Member States and across sectors is a way to ensure this.

In this respect, **Option 1** only allows for intra-LULUCF flexibility and therefore only slightly contributes to this objective; under this option, Option 1.2 is better fit than Option 1.1 to create a flexible framework for LULUCF action, because its higher ambition is more likely to result in active trade of LULUCF credits among Member States (albeit at low prices) and in a cost-effective allocation of LULUCF action. **Option 2** introduces trading opportunities between the LULUCF and ESR sectors, including the possibility of using LULUCF credits bought from another Member State for ESR compliance; this may create a significant demand for LULUCF credits (depending on the ambition of the ESR targets), and can therefore encourage additional action where it is

most cost-efficient to do so. So does **Option 3**, which features full flexibility between agriculture and LULUCF, and thus expands even further the opportunities to trade any overachievement of the national targets for land-based mitigation; under this option there is no flexibility between the land sector and the other sectors, which can provide reassurances about the decarbonisation of the fossil-fuel based economy.

Integration

An integrated policy approach to climate mitigation in the land sector is relevant to the efficiency criterion, because it can promote synergies between different and connected mitigation actions and provide a clear direction for cost-efficient policy making (e.g. in the context of CAP planning).

In **Option 1**, there is no integration of the LULUCF sector in the overall policy framework, and therefore this option does not perform well in terms of better integrating LULUCF into the wider climate policy framework. **Option 2** adds some incentives to a more integrated policy approach to the land sector, through the flexibility between the LULUCF Regulation and the ESR; however, this integration is only partial, given that Member States can use this flexibility to compensate for excess ESR emissions from either agriculture or other sectors, and it does not by itself drive a holistic strategy for land-based mitigation. **Option 3** clearly addresses this objective by setting out a trajectory to climate neutrality in 2035 and asking Member States to submit integrated plans for climate change mitigation in the land sector. There are strong synergies with the CAP and other land-related policies with a view to develop a truly integrated policy approach to the land sector.

- **Specific objective #3: Simplification**

The simplification objective relates to efficiency, as it aims to minimise regulatory costs.

Option 1.1 performs moderately well against this objective because it replaces the complex FRL benchmark with a more straightforward benchmark based on the recent mitigation performance of the forest sector; however, it carries on an accounting framework whereby targets are based on many different benchmarks, which can create implementation costs and undermine the understanding of the contribution of the sector to the overall climate ambition. **Options 1.2 and 2** set a single target for the LULUCF sectors based on the emissions and removals that are reported in the inventories: this choice corresponds to a great degree of simplification, treats the LULUCF sector like any other sector, and is consistent with the way that the 2030 -55% target is formulated (the net emission target fully incorporates all emissions and removals in the LULUCF sector, without a need for any accounting benchmark). **Option 3** goes a step further and integrates all agricultural and LULUCF emissions and removals, abandoning the artificial separation between the LULUCF and agriculture sectors in EU climate policies.

7.3. Coherence

All options aim at increasing carbon removals from the LULUCF sector, and therefore encourage Member States to put in place national policies that are likely to have co-benefits for climate change adaptation, biodiversity and sustainability of biomass. As such, all options are coherent with the EU adaptation, biodiversity and bio-economy policies (for more details, see Annex 10.6). Furthermore, the new business models around carbon removals – be it through CAP payments or carbon markets – are expected to contribute to the development of a circular and sustainable bio-economy (see Annex 10.7).

In the context of the EU climate mitigation policies, the LULUCF sector has particularly strong links with the **Effort Sharing Regulation**, because the latter currently covers agricultural emissions (among others). The review of the ESR envisages three options:

the first option is to maintain the current sectoral scope of the Regulation (agriculture, waste, transport, buildings, F-gases) and increase current targets; the second is to reduce its scope (transport and buildings are only covered by the ETS) and either increase or keep current targets; and the third is to phase out the ESR. The coherence of each of the LULUCF options with the ESR therefore depends on the piece of legislation which would eventually cover agricultural emissions:

- If the ESR is phased out (third option in the ESR review), then the most coherent option would be **Option 3**, whereby agricultural emissions would be covered by extending the scope of the LULUCF Regulation.
- If instead the ESR continues to cover agricultural emissions (first and second options in the ESR revision), then the 2030 binding targets for the land sector proposed under Option 3 would not be coherent with the overall policy framework. Therefore, the most coherent option would be to select the targets on a range between Option 1.2 and Option 2. In particular:
    - If ESR targets are significantly raised compared to the current targets, there would be strong demand for LULUCF credits; this would ensure that relatively less ambitious LULUCF targets combined with the possibility to use LULUCF credits for ESR compliance would put the LULUCF sector on the trajectory towards land climate neutrality in 2035, while ensuring a flexible policy framework. Therefore, **Option 2** would be the most coherent option.
    - If ESR targets are kept at their current levels, then it is unlikely that incentives for higher LULUCF removals would come from the need to generate LULUCF credits for ESR compliance. In this case, the ambitious LULUCF targets proposed in **Option 1.2** would be the most coherent option.

Table 8 provides a summary overview of how the four options perform against the effectiveness, efficiency and coherence criteria.

	Option 1.1	Option 1.2	Option 2	Option 3
Effectiveness	***1 / 3***	***3 / 3***	***2 / 3***	***3 / 3***
Objective 1: *A climate-neutral land sector by 2035*	✓	✓✓✓	✓✓(✓)	✓✓✓
Efficiency	***2 / 6***	***3 / 6***	***4 / 6***	***6 / 6***
Objective 2: *A fair, flexible and integrated climate policy framework*	✓	✓	✓✓	✓✓✓
Objective 3: *Simplification*	✓	✓✓	✓✓	✓✓✓

Coherence with options in ESR Impact Assessment		ESR Opt 1.2 or 2.2, ESR targets kept at current level	ESR Opt 1.1 or 2.1, ESR targets increased	ESR Option 3

Table 8 – Comparison of options based on their Effectiveness, Efficiency and Coherence (✓✓✓ Very positive; ✓✓ Positive; ✓ Mildly positive; 0 No or negligible impact; ✗ Negative)

8. PREFERRED OPTION

When proposing its updated 2030 greenhouse gas emissions reduction target of at least 55%[81], the European Commission also described the actions across all sectors of the economy that would complement national efforts to achieve the increased ambition. A number of impact assessments have been prepared to support the envisaged revisions of key legislative instruments.

Against this background, this impact assessment has analysed the various options through which a revision of the LULUCF Regulation could effectively and efficiently contribute to the delivery of the updated target as part of a wider "Fit for 55" policy package.

8.1. Methodological approach

Drawing conclusions about preferred options from this analysis requires tackling two methodological issues.

First, as often the case in impact assessment analysis, ranking options may not be straightforward as it may not be possible to compare options through a single metric and no option may clearly dominate the others across relevant criteria. Ranking then requires an implicit weighting of the different criteria that can only be justifiably established at the political level. In such cases, an impact assessment should wean out as many inferior options as possible while transparently provide the information required for political decision- making.

Secondly, the "Fit for 55" package involves a high number of interlinked initiatives underpinned by individual impact assessments. Therefore, there is a need to ensure coherence between the preferred options of various impact assessments.

8.2. Policy interactions

Given the complex interdependence across policy tools and the interplay with the methodological issue outlines above, no simultaneous determination of a preferred policy package is thus possible. A sequential approach was therefore necessary.

First, the common economic assessment[82, 83] underpinning the "Communication on Stepping up Europe's 2030 climate ambition" looked at the feasibility of achieving a higher climate target and provided insights into the efforts that individual sectors would have to make. It could not, however, discuss precise sectoral ambitions or detailed policy tools. Rather, it looked at a range of possible pathways/scenarios to explore the delivery

[81] Communication on Stepping up Europe's 2030 climate ambition - Com(2020)562

[82] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176

[83] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331

of the increased climate ambition. It noted particular benefits in deploying a broad mix of policy instruments, including strengthened carbon pricing, increased regulatory policy ambition and the identification of the investments to step up the climate ambition.

An update of the pathway/scenario focusing on a combination of extended use of carbon pricing and medium intensification of regulatory measures in the economy, while also reflecting the COVID-19 pandemic and the National Energy and Climate Plans, confirmed these findings.

Taking this pathway and the Communication on Stepping up Europe's 2030 climate ambition as central reference, individual impact assessments for all "Fit for 55" initiatives were then developed with a view to provide the required evidence base for the final step of detailing an effective, efficient and coherent "Fit for 55" package.

At the aggregate level, these impact assessments provide considerable reassurances about the policy indications adopted by the Commission in the Communication on Stepping up Europe's 2030 climate ambition. This concerns notably a stronger and more comprehensive role of carbon pricing, energy efficiency and renewable energy policies, the land sector, and the instruments supporting sustainable mobility and transport. These would be complemented by a carbon border adjustment mechanism and phasing out free allowances. This would allow to continue to address the risk of carbon leakage in an efficient manner. It would also preserve the full scope of the Effort Sharing Regulation for achieving the increased climate target.

Various elements of the analyses also suggest that parts of the revenues of a strengthened and extended ETS should be used to counter any undesirable distributional impacts such a package would entail (between and within Member States). While the best way to do this is still to be determined, this would seem a superior alternative to foregoing the relevant measures altogether or simply disregarding the uneven nature of their distributional impacts. Under both these alternatives, the eventual success of any package proposed would be at risk.

8.3. Preferred policy option

Preliminarily assuming this fact and the analysis above as the framework for the aggregate "Fit for 55" package, the specific analysis carried out in this impact assessment comes to the main following conclusions and would suggest as the preferred policy option for the revision of the LULUCF Regulation a package consisting of the following elements:

1. Set simplified and more ambitious national LULUCF targets for Member States in 2030 in order to achieve net LULUCF removals above -300 MtCO2eq in 2030 and to put the LULUCF sector on the right trajectory to achieve the objective of land-based climate neutrality in 2035. This can be done via a single removal target (Option 1.2), via increased incentives to create LULUCF credits for ESR compliance (Option 2), or by taking elements of both options (i.e. more ambitious targets combined with flexibility with ESR). Which of these is the most effective choice for the design of the LULUCF targets will depend on the ambition of the ESR targets.

2. Set a new obligation for Member States to submit integrated mitigation plans for the land sector (Option 3), in order to promote a more integrated policy approach to the land sector.

3. Set an EU-wide climate neutrality target for the land sector in 2035; based on the integrated mitigation plans, propose at a later stage binding national land targets for 2035 and, if needed, other EU-wide measures (Option 3).

8.4. Coherence with other elements of the package

If the ESR targets are significantly increased for 2030, the expected large demand for LULUCF credits from the ESR could guarantee that LULUCF targets equal to the recent mitigation performance in combination with wider flexibility opportunities (**Option 2**) will be effective to put the LULUCF sector on a trajectory compatible with land-based climate neutrality in 2035. On the other hand, if the ESR targets are not increased by the necessary magnitude, it will be more effective to set more ambitious LULUCF targets without enhanced flexibility with the ESR (**Option 1.2**), because it is expected that Member States would have less need for and hence make less use of this flexibility.

Setting nationally binding targets for the land sector in 2030 (**Option 3**) would not be coherent with an aggregate "Fit for 55" package in which, for the sake of the stability of the regulatory framework, the Effort Sharing Regulation continues to cover agriculture emissions; these targets are therefore discarded. Nevertheless, the parallel contribution of the agricultural sector to the trajectory towards land-based climate neutrality in 2035 would be ensured by the increased ambition of the ESR targets, as well as by the new planning process for the land sector (second element of the package) and the EU-wide climate neutrality target for the land sector in 2035 (third element of the package).

Increasing planning certainty beyond 2030 is important to incentivise the timely uptake of actions in the LULUCF sector which often deliver mitigation outcomes only after several years, such as afforestation. A 2035 objective for land-based climate neutrality will also strengthen Member States' incentives under the ESR to take more mitigation actions in the agricultural sector (non-CO2 emissions from livestock and use of fertilizers). As the implementing measures for the 2035 objective of climate neutrality for the land sector (e.g. binding Member State targets or other regulatory measures at EU level) will only be set at a later stage (such as after the next cycle of NECPs in 2024), this staged approach leaves enough flexibility to define the interaction with the other post-2030 climate policy instruments.

Generally, more ambitious mitigation targets under LULUCF can bring co-benefits for other land-related policy objectives, such as biodiversity and climate change adaptation, and are coherent and mutually reinforcing with the parallel targeted revision of the EU sustainability and GHG saving criteria for biomass for energy use under the Renewable Energy Directive (see Annex 10.6).

8.5. REFIT (simplification and improve efficiency)

Compared to the current Regulation, the abovementioned preferred policy option is expected to significantly simplify the legal framework. In particular, moving away from a no debit commitment based on a complex set of accounting rules for different land categories to a single removal target for all land categories taken together should simplify compliance. In addition, widening the use of the flexibility opportunities between the LULUCF Regulation and the ESR, as proposed under Option 2, can enhance a cost-efficient achievement of the national targets by Member States.

The provision to start a planning process for enhanced mitigation in a single land sector bringing together agriculture and other land-use under the LULUCF Regulation, as proposed under the preferred option, may add some administrative costs for national

authorities. However, these costs can be minimised by integrating this planning exercise into the already existing governance framework for National Energy and Climate Plans.

The proposed improvement to the monitoring and reporting systems is not expected to significantly increase administrative costs for national authorities as it would rely on using existing datasets and remote sensing technologies.

9. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

9.1. Operational objective of the monitoring

The objective is to assess the annual progress towards – and compliance with – the LULUCF 2030 target assigned to each Member State. Coherence with other EU policies that also rely on land monitoring – such as the CAP, biodiversity, and the Renewable Energy Directive – is also of strong significance, providing moreover important administrative and cost synergies.

As explained in Section 2.1.3, under the Kyoto Protocol (2013-2020), requirements for monitoring were technologically rather weak and met only the relatively low standard required for all UNFCCC parties[84]. Even though the regulatory framework under the current LULUCF regulation will improve this, new policy synergies and new tools have become operational that enhance the opportunities for improved monitoring, at very limited cost. For example, Copernicus sensors and services are today operational, which at the time of the previous proposal (2016) were still emerging.

The definition of individual Member State targets for the LULUCF sector with compliance based upon reported GHG inventories (as proposed in Options 1.2, 2 and 3), places a higher emphasis on the accuracy, completeness and reliability of the reported estimates of emissions and removals. Upgrading the monitoring approach in the Regulation, thereby introducing a level playing field for all Member States with respect to using comparable and standardized approaches, in line with available tools and technologies, is therefore of major importance and will ensure adoption of best practices for monitoring.

The views of stakeholders

For a majority (66%) of the stakeholders who participated in the Open Public Consultation on the Review of the LULUCF Regulation, an improved EU framework for monitoring, reporting and verifying LULUCF emissions and removals is an important or very important policy approach to promote climate change mitigation in land-related sector (this was the most selected policy approach among many; see Annex 10.2.3 for more details).

9.2. Monitoring data and technology

Removal and emission estimates, reported at national level, are aggregates of individual actions that take place over land units (usually called "activity data") which are assessed according to their management and use (so-called "emission factors") (see Annex 10.8 for more details). The individual geographically explicit estimates for each land unit are

[84] for example, according to a JRC analysis (2021), even today most Member States use default IPCC reporting assumptions of "no stock change" to report carbon emissions or removals in agricultural soils.

then statistically aggregated and included in national greenhouse gas inventories, to provide the core monitoring indicators, namely reported estimates at national level per land use and land use change category.

Activity data shows the area of land use and change between uses, within a Member State, year-to-year. The accuracy of this information depends on the quality of the geographical data collected. Improvements in accuracy in these estimates are therefore obtained by first improving the quality and disaggregation of the activity data – for example, the knowledge of where arable fields have been ploughed, what soils they cover and what crop is grown on them. Activity data can be directly measured through a variety of information systems, already available at national level for policies such as the CAP, biodiversity monitoring, forest fire monitoring.

The second step to improvement is through the use of more realistic emission factors, such as those determined by the Member State or region concerned through direct measurement on experimental sites. The estimates of emissions/removals within each land category relies on the accurate application of emission factors to each of these activity data land units. The upgrading of these estimates relies on the application of correct emission factors (broadly described as Tiers by the IPCC).

Improvements to both the activity data collection and the emission factors applied in the EU have been fostered through the trials associated with the LULUCF Decision[85], and the preparation of the implementation of the LULUCF Regulation. The LULUCF Decision 529/2013 already familiarised Member States with the need to develop data collection and provision of emission and removal estimates for cropland and grassland[86]. The LULUCF regulation built on this step-wise process by including agricultural land cover in its mandatory framework, and by also requiring that the collection of activity data should be "geographically explicit", in particular for land use change. This implies that Member States are required to establish operational monitoring systems with a resolution capable of detecting and tracking accurate changes in land use as small as the minimum area defined for forest in the Member State[87].

While the past years have seen tests and improvements achieved by Member States[88], the upgrading of the target to a reporting-based compliance framework could benefit directly from technology and tools applied already in other EU policy areas. Common Agricultural Policy data, based since 2005 upon the regulatory requirement to apply geographic information systems for data management, clearly provides a strong synergy with objectives of climate action. The high degree of monitoring and auditing of farmers' claims, motivated by the high financial level of the policy transactions, also provides a very strong base quality for the data collected. Substantial and well-proven systems are already in place and are systematically improved. Alignment with this operational system largely removes the risk of uncertainty with respect to the activity data collected. A majority of Member States have already started exploring the combined use of these data for the purpose of climate activity data reporting, although some time is still needed to achieve the necessary reporting upscaling.

A further monitoring enhancement with respect to land of high carbon stock would also deliver strong climate and biodiversity synergies. Close monitoring (and appropriate

[85] Decision No 529/2013/EU, https://europa.eu/!fT34JH

[86] Accounting for cropland and grassland management activities is not obliged by the Kyoto Protocol and is therefore not covered in GHG accounting by three-quarters of the Member States.

[87] This minimum area is laid out in Reg (EU) 2018/841 Annex II, and varies between 1ha and 0.05ha.

[88] EU Climate Action Progress report, Nov 2020, https://europa.eu/!By94Yn

management action) would deliver better permanence of these stocks – which if released would have strong detrimental effects on the GHG emissions in a Member State. High carbon stocks also typically correlate with areas of high natural value, such as biodiversity reserves, old-growth forests and wetlands.

It is also apparent that remote sensing data – in combination with the rich data source of traditional national forest inventories – helps address monitoring accuracy and timeliness issues. The Commission has reported [89] on recommendations to better leverage the potential of earth observation tools for forests, by integrating the traditional national forest inventory approaches to create mutually beneficial synergies. The report notes that remote sensing is a powerful tool able to plug information gaps, because of its synoptic view and the possibility to monitor large areas. In Europe, the report concludes that the Copernicus programme provides already many of the necessary tools to produce the required information on forest disturbances such as fires, or to help assess and address vulnerability to climate change and assist with adaptation strategy development[90], with many more tailored products to emerge. The programme services cover all Member States, including the Outermost Regions of France, Portugal and Spain, future coverage of these regions will of course remain very pertinent.

Such tools are moreover already used for land monitoring applications in different parts of the world by agriculture and forest services such as Brazil, Canada and the US to deliver operational applications, especially in the fields of agricultural production, fire monitoring and deforestation. A majority (56%) of the respondents to the Open Public Consultation on the LULUCF Review supported the use of high resolution and wall-to-wall satellite imagery, which was the most frequently selected approach to reinforce LULUCF monitoring, reporting and verification systems.

9.3. Use of monitoring results

Results of the monitoring will be used to evaluate the accuracy of the EU land emissions and removals reporting, and thus determine if action is on track to meet policy objectives in each Member State. The exercise would be made on a yearly basis and provide global assurance of the progress towards meeting the EU's target transparently – a key consideration with respect to the international nature of the commitment. A trial already this year (2021) will help further improve and develop procedures by the European Environment Agency, in line with other GHG emission sectors. However, the continuous improvement of the monitoring will be dependent on tools and resources made available for the specific needs identified in accordance with the target option selected and proposed, with a view to also reducing administrative burden in Member States.

Annex 10.8 provides an overview of the available data and technologies that could be used to upgrade the quality of the monitoring but also to benefit from economies of scale and scope by using the latest available digital technologies.

[89] European Commission, 2020, Monitoring of Forests through Remote Sensing, https://op.europa.eu/s/oKot

[90] Forzieri et al. Emergent vulnerability to climate-driven disturbances in European forests, Nature Communications 2021 (in print). 10.1038/s41467-021-21399-7

10. ANNEXES

10.1. Procedural information

10.1.1. Lead DG, Decide Planning / CWP reference

The Directorate-General (DG) for Climate Action was leading the preparation of this initiative and the work on the Impact Assessment in the European Commission. The planning entry was approved in Decide Planning under the reference PLAN/2020/8682.[91] It is included in the 2021 Commission Work Programme "A Union of vitality in a world of fragility" (COM(2020) 690 final), under the policy objective "Fit for 55 Package".[92]

10.1.2. Organisation and timing

- The planned adoption date (Q2 2021) was included in the Commission Work Programme adopted on 19 October 2020.
- The Inception Impact Assessment was open for feedback between 29 October 2020 and 26 November 2020
- The Open Public Consultation was online between 13 November 2020 and 05 February 2021
- An inter-service steering group (ISG), was established for preparing the climate-related "Fit for 55 Package" initiatives. Its members were: SG, LS, AGRI, BUDG, COMM, COMP, CNECT, DEVCO, DGT, DIGIT, EAC, ECFIN, ECHO, EMPL, ENER, ENV, ESTAT, FISMA, FPI, GROW, HOME, HR, IAS, JRC, JUST, MARE, MOVE, NEAR, OLAF, REGIO, RTD, SANTE, TAXUD, TRADE.
- The ISG met three times in the period from September until adoption in July 2021.

10.1.3. Consultation of the RSB

A draft Impact Assessment was submitted to the Regulatory Scrutiny Board on 10 March 2021. Following the meeting on 14 April 2021, the Board issued a positive opinion with reservations on 19 April 2021. The recommended improvements suggested by the Board were addressed as follows:

(1) The report should strengthen the explanation of the preferred option. It should explain why the seemingly optimal option is not the preferred one given the arguments in the report in favour of better integrating LULUCF into the wider policy framework. The report should explain how the preferred option will address this issue.

Section 8 has been redrafted to stress that the preferred option is a package of several elements. One of these elements is the binding targets for 2030: these targets only cover the LULUCF sector, and not the integrated land sector, for the sake of regulatory stability. Nevertheless, other elements are taken from Option 3 and aim to better integrate the LULUCF sector into the wider policy framework.

[91] Internal reference: https://europa.eu/!hknMk6

[92] https://ec.europa.eu/info/sites/info/files/2021_commission_work_programme_en.pdf

(2) The report should better justify why an EU-wide climate neutrality target for the land sector in 2035 needs to be set at this point in time, in addition to binding national LULUCF targets for 2030. The report should clarify the evidence on the basis of which the 2035 target has been defined, and the reason for its inclusion in the preferred option, including its value added and likely impacts. It should analyse the coherence of the 2035 target with the other initiatives of the 'Fit for 55' package, whose analysis ends in 2030. It should clarify to what extent the introduction of the 2035 target predetermines changes in the other initiatives after 2030. The report should clarify how a binding EU target would evolve after 2035 to ensure sufficient ambition in the land sectors.

The arguments supporting the introduction of an EU-wide target for the land sector in 2035 have been clarified in section 4.2.1, where this objective is presented for the first time. The coherence of this target with other initiatives of the "fit for 55" package has been addressed in section 8.4.

(3) The report should better reflect this two-pronged approach (2030 vs. 2035 targets) in the intervention logic, i.e. in the problem definition, objectives, impact analysis and comparison of options.

This distinction and the arguments behind this approach have been clarified in the description of the first problem (section 2.1.1), of the first objective (4.2.1) and of Option 3 (5.2.3).

(4) The report should be more explicit when analysing the distributional and economic impacts. It should include an analysis of how economic actors in the LULUCF sector will be affected. Stakeholder views should be more prominently included in the analysis, with an explanation on where they converge or diverge on the options considered. As far as possible, the report should quantify the administrative impacts.

The description of impacts has been improved and a box summarizing the economic impacts of each option has been added to section 6.5. Stakeholder views have been highlighted throughout the report in dedicated boxes titled "The views of stakeholders".

(5) The methodological section (in the annex), including methods, key assumptions, and baseline, should be harmonised as much as possible across all 'Fit for 55' initiatives. Key methodological elements and assumptions should be included concisely in the main report under the baseline section and the introduction to the options. The report should refer explicitly to uncertainties linked to the modelling. Where relevant, the methodological presentation should be adapted to this specific initiative.

All modelling tools are presented in section 10.4 of this report. Four main models were used in the LULUCF Impact Assessment: GLOBIOM, G4M, CAPRI and GAINS. GLOBIOM and G4M are unique to the LULUCF sector and require a more thorough presentation; for CAPRI and GAINS this Impact Assessment only introduces elements that are specific and relevant to the LULUCF sector and limited to the modelled policies. GLOBIOM and G4M were used for LULUCF scenario development; all models were used for modelling emission reductions or enhanced removals with marginal abatement cost curves (see Annex 10.4 of this report). All methodological analysis, namely the analysis of policy measures, is specific to the LULUCF sector and is therefore presented in detail in Annex 10.4. A box commenting specifically on the uncertainty levels related to LULUCF estimates has been added to section 10.4.2.

Annex 3 should be reinforced to better explain the costs (including administrative costs), benefits and the impacts on different economic actors

A summary of costs of all options has been added in section 6.5, and annex 3 has been reinforced.

10.1.4. Evidence, sources and quality

- The quantitative assessment of the economic, social and environmental impacts is based on integrated economic land use modelling by IIASA with GLOBIOM and G4M. The policy scenario takes into account likely biomass demands from other sectors and follows assumptions of the 1.5TECH scenario of the EU long-term strategy. This scenario projects that the net LULUCF sink by 2030 will be at similar levels as in the period 2016-2018. The impact of specific measures for emission reduction or enhanced removals was modelled with marginal abatement cost curves. This analysis demonstrated that significant increases in the land sink can be achieved at relatively low costs (5-10 EUR/tonne of CO2). It also showed cost-efficient emission reductions require action on all land uses, such as improved forest management, afforestation, avoided deforestation for forest lands and set aside of land use on organic soils and improved cropland management strategies on agricultural land.

- Specific Contract N° 340201/2020/832904/ETU/CLIMA.C.3 "Reviewing the contribution of the Land Use, Land Use Change and Forestry sector to the Green Deal". Under this contract, a consortium made up of COWI A/S, Technopolis, Exergia and individual experts carried out three tasks: (1) conceptual work on problems, objectives and options for the revision of the LULUCF Regulation (output: 7 research notes and an executive summary); (2) stakeholder consultation (output: four workshops, analysis of the feedback to the Inception Impact Assessment, analysis of the replies to the Open Public Consultation); (3) analysis of "LULUCF action" reports submitted by Member States under art. 10 of the LU

- LUCF Decision (529/2013) (output: a short report).[93]

[93] COWI, Technopolis Group, Exergia, Silvestrum (2021): Reviewing the Contribution of the Land Use, Land-use change and Forestry Sector to the Green Deal; European Commission, Luxembourg: Publications Office of the European Union (https://data.europa.eu/doi/10.2834/201100).

10.2. Stakeholder consultation

10.2.1. Introduction

The Commission carried out consultation activities on the plan to increase the EU 2030 Greenhouse Gas (GHG) emissions reduction target. This plan includes the review of the LULUCF regulation. The review of the LULUCF Regulation started with an Inception Impact Assessment (IIA) and was followed by an Open Public Consultation (OPC). The IIA was conducted from the 29th of October 2020 to the 26th of November 2020. The OPC was conducted through an online survey between the 13th of November 2020 and the 5th of February 2021. A workshop with stakeholders was also conducted. A summary of this feedback is provided in the next sections.

10.2.2. Feedback to the Inception Impact Assessment

The Inception Impact Assessment was published for feedback between 29 October 2020 and 26 November 2020, and received a total of **93 responses**, mainly from the private sector (39%), including the Harvested Wood Products (HWPs) value chain and biofuels, the agricultural sector and the energy sector. A majority of respondents (87%) explicitly supported the need to amend the LULUCF regulation to **align with the higher climate target** set in the European Green Deal, and a large share of them (55%) agreed with the **objective of enhancing land-based sinks**. However, while respondents from the bio-based sector favour an approach that rewards active forest management and views Harvested Wood Products (HWPs) as part of the sink, environmental NGOs strongly disagree with this approach and would rather see a preservation of the existing land carbon sink.

69 respondents provided feedback on the option to strengthen the LULUCF regulation in line with the new climate targets (**Option 1**). Of these, 57% agreed to increase its ambition; all of those disagreeing (19%) expressed a concern that a strengthened regulation would lead to further obligations on the part of the bio-based sector.

56 respondents provided feedback on the option to strengthen the flexibility between the LULUCF Regulation and the Effort Sharing Regulation (**Option 2**). A majority of those respondents (65%), made up mainly of environmental NGOs and respondents from the bio-based industry, disagreed with increasing this flexibility, due to a concern that this could lead to a decrease in the ambition to reduce emissions in other sectors.

53 responses provided feedback on the option to combine the agriculture and LULUCF sectors into a single climate policy pillar with a separate target (**Option 3**). 43% of these respondents disagreed with this option, expressing concerns such as an expectation for the forestry sector to offset emissions from the agricultural sector or to reduce wood harvest rates.

Respondents also expressed their views on the **expected impacts** of a revision of the LULUCF regulation. The economic impact mentioned most frequently was the growth of the bio-based sector through increased use of HWPs in substitution of fossil-based materials. The likely social impacts include: the creation of new business opportunities, the promotion of territorial cohesion, and repopulation in rural areas. The following expected environmental impacts were mentioned most frequently: increased carbon sequestration; preservation of landscapes and ecosystems, including water systems and peatlands; preservation of forests as carbon sinks and biodiverse systems; afforestation and reforestation where there has been intense logging; improved soil fertility and carbon content; reduction of emissions and substitution of fossil-based materials.

10.2.3. Feedback to the Open Public Consultation

- **Overview of respondents**

The OPC on the review of the EU rules on LULUCF received a total of 235 replies from different stakeholders/user groups. Private sector organisations had a combined share of the responses of 28%. This includes business associations with a total of 18% (43 responses) and companies/business organisations with a total share of 10% (24 responses) of all submitted responses. 26% (60 responses) of all responses came from EU-Citizens. 17% of respondents represent a non-governmental organisation (NGO) (41 responses) and 12% came from academia (29 responses). There are also a number of responses from public authorities (8% /18 responses), trade unions (2% /4 responses), environmental organisations (1% / 3 responses), and a non-EU citizen (1 response). 5% (12 responses) were from a stakeholder group which was not predefined.

- **Methodology for data processing**

As questions in the online survey were optional, the percentages presented below refer to the total respondents that answered the concerned question.

Some questions allowed respondents to 'rate' options (from -2 to +2 / not important at all to very important). This synopsis report provides percentage figures for options which were rated by a majority as important or very important. These are indicative of the most relevant positions. If there were less than three options selected by at least 50% of stakeholders the percentages for the three overall highest rated options are presented.

Finally, respondents often selected 'Other' options and provided open text answers. The overview of these answers can be found in a more detailed report[94].

Questionnaire

The questionnaire was composed of four sections. The first collected feedback on the mitigation and business potential of the land sector and the bioeconomy to the overall climate ambition for 2030. The second addressed the overall policy approach for revising the LULUCF Regulation in view of the increased 2030 climate ambition. The third collected feedback on more ambitious rules and targets for the LULUCF sector. The fourth focussed on the links between land use and agriculture.

- **Part I: Mobilising the mitigation and business potential of the land sector and the bioeconomy**

Stakeholders were asked for **the most important drivers behind the decline of the land-based net carbon sink**. The three most important drivers behind the decline were listed by stakeholders as:

1. Conversion of carbon-rich land (deforestation, draining of wetland or peatland), land take and soil sealing (expansion of built-up and artificial areas (63%/127);
2. Unsustainable land management practices impacting carbon stocks and sinks (58%/120);
3. Natural disturbances (weather events, fires, pest outbreaks…) that are caused or accelerated by climate change (56% / 117).

[94] COWI, Technopolis Group, Exergia, Silvestrum (2021): Reviewing the Contribution of the Land Use, Land-use change and Forestry Sector to the Green Deal; European Commission, Luxembourg: Publications Office of the European Union (https://data.europa.eu/doi/10.2834/201100).

The majority of stakeholders believed that an important **EU policy approach** to promote climate change mitigation in land-related sectors was to create an **improved EU framework on monitoring, reporting and verifying emissions and removals (MRV)** (66%/137). Many also found it important that the EU sets national targets which Member States (MS) can achieve in different ways (e.g., Common Agricultural Policy, national forest policies, other national policies) (59%/121), the use of EU taxes or subsidies (56%/107) and having EU policies to promote more sustainable and healthier diets (54%/101).

The next question asked about the best policy approach to harness the **substitution effect** and carbon storage potential of long-lasting wood products and bio-based and renewable materials. More than half of respondents selected support for **research and innovation** into more sustainable production of woody biomass and more sustainable use of wood-based materials, products and by-products (72%/153), and **training** (e.g., for land managers, engineers, architects) and awareness raising (58%/122). Other effective policy options to incentivise use of wood products are a **carbon farming approach** (according to 46% of respondents) or **tax incentives** (45%).

Stakeholders were also asked in which areas the EU should **focus efforts** to enhance carbon sinks and protect carbon stocks. The most selected answers were:

1. Afforestation, reforestation and forest restoration (77%/162 respondents);
2. Protection and restoration of wetland and peatland ecosystems (69%/131);
3. Soil carbon increase in agricultural land (69%/124);
4. Carbon storage in long-lasting wood-based materials and products (66%/131);
5. Agro-ecology and agro-forestry, as well as grassland management (55%/96).

A majority of stakeholders believed that important approaches **to finance more ambitious climate action in land-related sectors** were subsidies (e.g., Common Agricultural Policy or national policies) (72%/136) or a dedicated EU or national fund (61%/111). Using revenues from selling land-based carbon credits was the third most frequently selected option (49%/89).

- **Part II: Overall policy approach**

Stakeholders were asked on their **preferred policy approach** to revise the LULUCF Regulation in view of the increased 2030 climate ambition. The most frequently selected options were:

1. Strengthening the current LULUCF Regulation and increase its ambition (**Option 1**) was selected by 45% of respondents (95).

   This was the most frequently selected policy option among Academic/research institutions, Environmental organisations, EU citizens, and NGOs. This policy option was also the second most frequently selected option for the private sector and shares the second most frequent selection with Policy Option 3 for Public authorities.

2. Combining the emissions from agriculture and LULUCF sectors into a single climate policy pillar with a separate target (**Option 3**) was selected by 35% of respondents (75).

   This was the most frequently selected option by the private sector. It was the second most frequently selected option by Academic/research institutions, EU citizens, NGOs, Others, and Public authorities.

3. Strengthening the flexibility with the Effort Sharing Regulation (**Option 2**) was selected by 20% of respondents (42).

This was the most frequently selected option by Public authorities, the Other group, as well as for the small sample of trade unions in which all policy options were selected once. It was the least frequently selected option for Academic/research institutions, the Private sector, Environmental organisations, EU citizens, Non-EU citizens, and NGOs.

- **Part III: Setting more ambitious rules for the Land Use, Land Use Change and Forestry sector**

A majority (52%) of stakeholders agreed that there should be **more stringent targets** than the current "no-debit" rule for the LULUCF sector (mostly, Academic/research institutions, Environmental organisations, EU citizens, and NGOs), whereas 23% of them opposed more stringent targets and would like to continue with the current no-debit rule. 25% would prefer a totally different option.

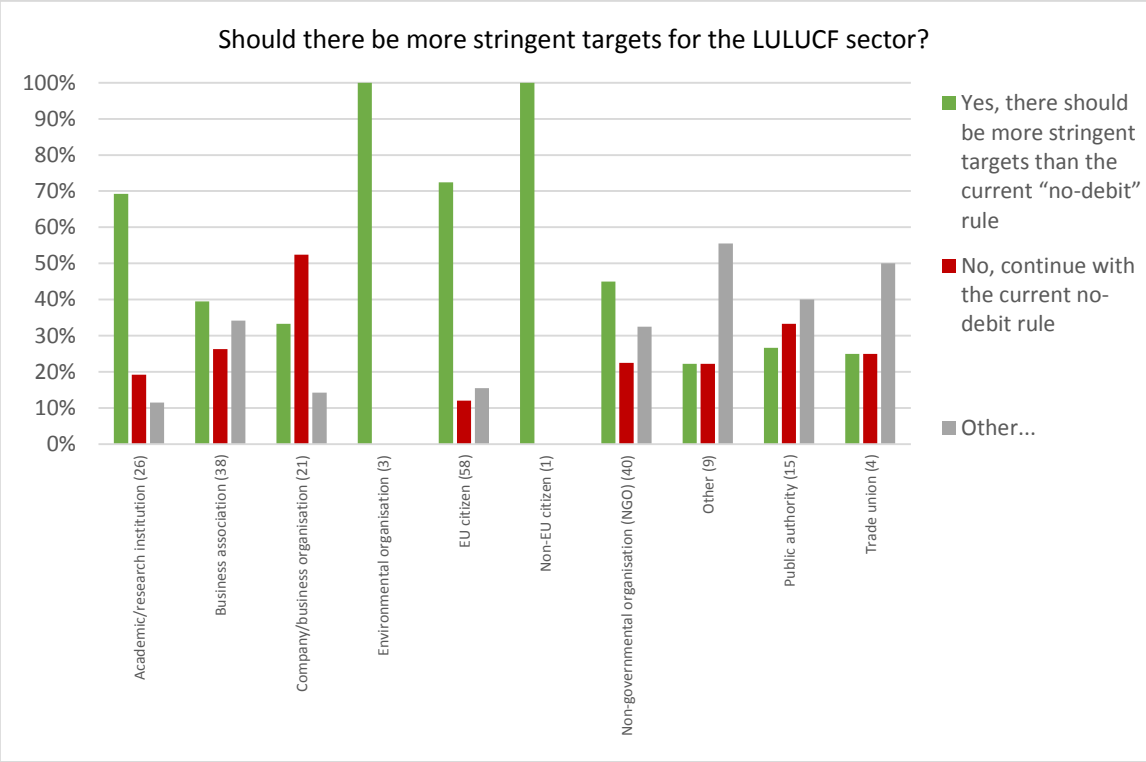


Figure 9 – Stakeholders's replies to the question "Should there be more stringent targets for the LULUCF sector?", by type of stakeholder.

Many stakeholders indicated that **national targets for the LULUCF sector** should be based on the Member State's potential to increase the net sink in a cost-efficient way (28%/55) or a percentage increase compared to the Member State's net sink in a baseline that is specific to each land use category (22% / 43 respondents). This was followed by a criterion based on the Member State's share of agricultural land, forest land and wetland (13% / 25 respondents). A third of respondents (30% / 60) selected the option "Other".

A majority of stakeholders agreed that the EU should **discontinue the Forest Reference Level (FRL) concept** and instead use as a benchmark based on the historic performance of forests (14%/25, plus a large share of the 28%/50 respondents who selected Other and gave more details) or look at all removals in existing forests, without comparing them to any baseline (22%/39). For other stakeholders, the EU should continue with the current FRL approach (16%/28) or harmonise the FRL methodology across Member States (21%/37).

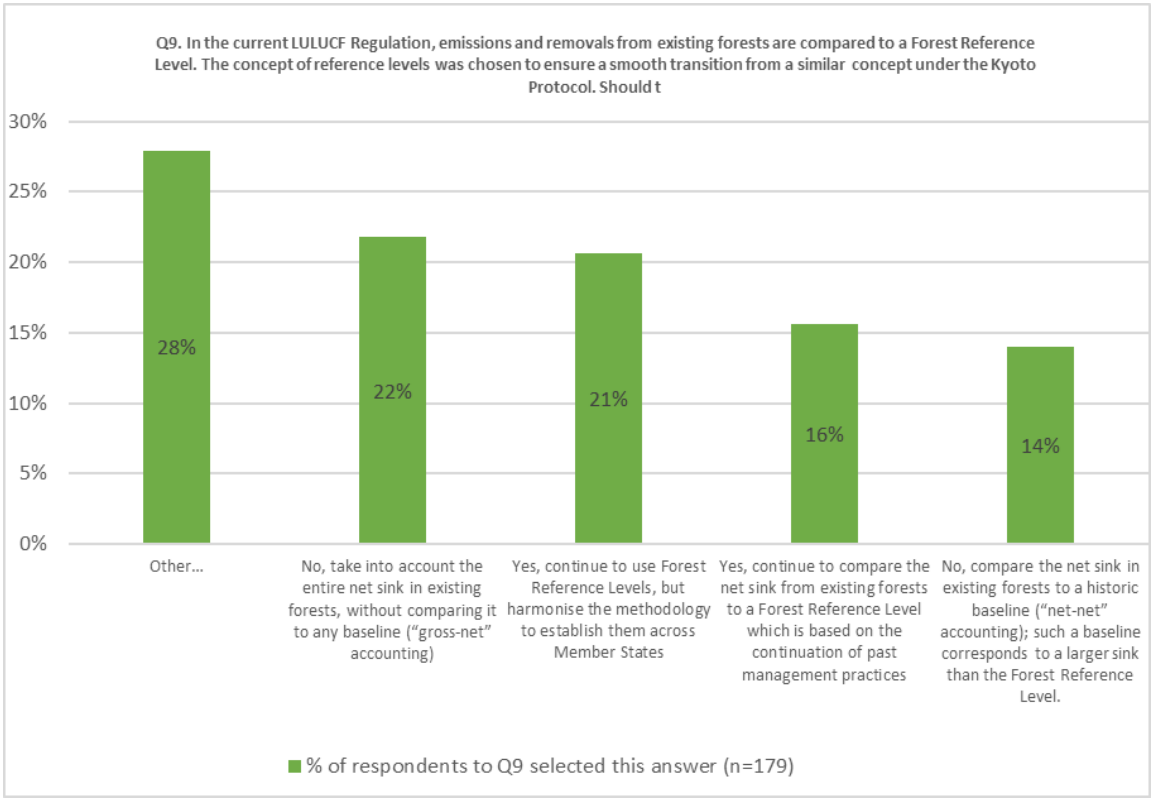


Figure 10 – Stakeholders replies to the question "Should the EU continue with the Forest Reference Level concept"

On reinforcing the LULUCF monitoring, reporting and verification (MRV) systems, a majority of respondents (56%/113) supports the **use of high resolution and wall-to-wall satellite imagery** to identify where land use change happens. Many also selected the options to reinforce biodiversity, ecosystem and adaptation considerations into the reporting requirements (45%/91 respondents), and to use more precise emission factors or emission modelling (34%/68 respondents).

- **Part IV: Links between land use and agriculture**

Stakeholders were asked **how EU climate policy for agriculture and land use should be designed**. About a third of respondents (33%/61 respondents) believe the EU should create a new policy strand which covers agricultural non-CO2 emissions and land use emissions together. Another third of respondents (35%/66) selected options which continue with including agricultural non-CO2 emissions under the ESR. A large number of the 59 stakeholders who selected 'Other' and provided additional comments disagreed with any additional flexibility between the LULUCF sector and other sectors, saying they do not want offsetting of emissions from other sectors using the LULUCF sector; a disagreement with the creation of a land pillar was mentioned explicitly by 13 of these respondents.

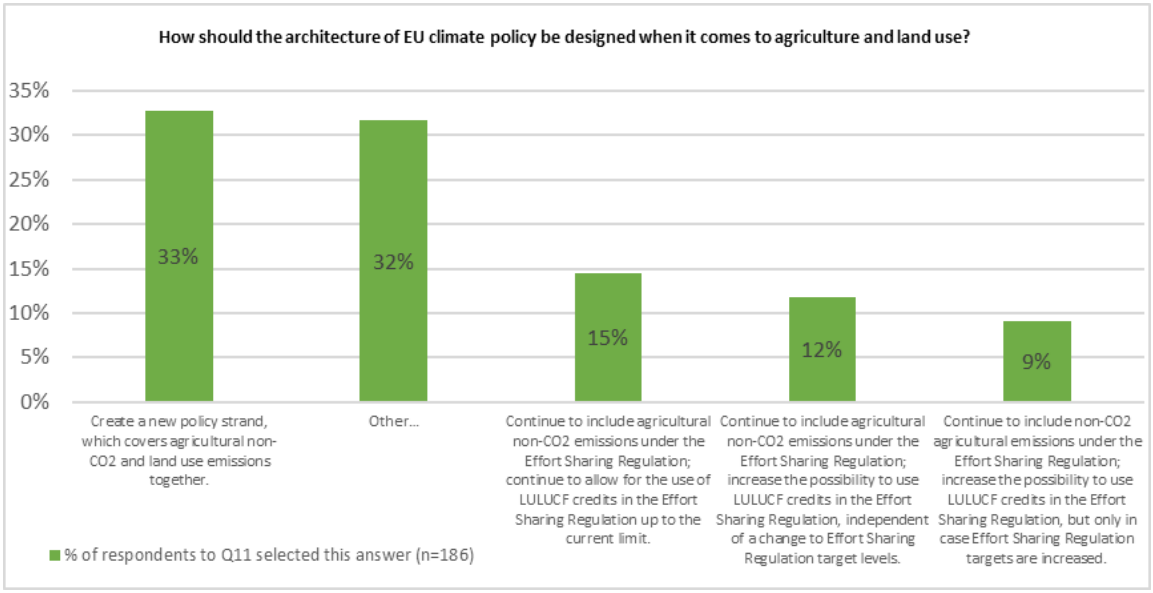


Figure 11 – Stakeholders replies to the question "How should the architecture of EU climate policy be designed when it comes to agriculture and land use?"

If such a single policy strand was created, 34% of respondents would be in favour of legally binding national targets and 28% opted for an EU-wide target to which Member States should be required to pledge their contributions. Only 17% disagreed with having a specific target for a potential combined sector.

If such targets were established, more than a third of respondents (34%/60) believe that they should be based on the Member State's potential to achieve climate neutrality in the EU land sector in a cost-efficient way. The second most popular criterion (of the ones outlined in the OPC) was the Member State's share of agricultural land, forest land and wetland (17 %/29 respondents). This was followed by a percentage increase compared to the MS' past emissions and removals from the land sector (15%/26 respondents). 22% (39) respondents selected the option "other" and provided a different view or agreed with one the options outlined but added comments.

10.2.4. Feedback from expert workshop on reporting and accounting rules

The workshop "LULUCF Reporting and Accounting approaches" was held on 18th November 2020; participation was limited to 70 experts from different stakeholders groups (national authorities, research and academia, NGOs, business associations). Many of the participants were members of the LULUCF Expert Group and therefore had been personally involved in the FRL review process. The workshop aimed to gather insights from experts on how to strengthen greenhouse gas reporting and how to adjust accounting methodologies to ensure that the LULUCF sector can effectively, efficiently and reliably deliver to the new target setting. The workshop was structured around three main discussions: the first one challenged some of the basic ideas on LULUCF accounting and the changes that can be made; the second focused on LULUCF reporting needs, completeness and accuracy as well as on wall-to-wall data as a cost-beneficial means for land monitoring; the third focused on policy options.

Participants broadly agreed that future work should focus on more ambitious LULUCF targets with significantly reduced accounting complexity. The majority of participants were of the view that, in case there would be national targets for the LULUCF sector, these should be proportional to the Member State's potential to increase the net sink in a cost-efficient way. Most of them stated that the EU should not continue with the use of the Forest Reference Level (FRL) concept. The FRL review process was in fact considered as not stringent and too burdensome. As regards LULUCF reporting

improvements, activity data availability was identified as the most pressing need. In addition, remote sensing data and products, and statistical and geostatistical modelling were identified as potential ways to improve and verify the accuracy and uncertainty of LULUCF estimates. All emissions and removals should be reported. Wall-to-wall/seamless geospatial data should play an important role in LULUCF reporting by 2030, while ensuring time series consistency with historic data.

10.3. Who is affected and how

10.3.1. Practical implications of the initiative

The current legislative framework addresses Member States and thus mainly affects authorities in the public administration sector. This situation would predominantly remain in the preferred option. Potentially affected public institutions include agricultural, climate, energy and environmental authorities, agencies dealing with zoning and territorial planning, statistical offices, as well as universities and research institutes.

Under the preferred option, the practical implications for these institutions involve:

1. a simplification of the current LULUCF implementation through the elimination of most of the current accounting layer, and the deployment of targets and compliance based upon reported aggregate values in the greenhouse gas inventory;
2. a higher potential for cost-efficiency through increased trading options at the level of Member States (if the target in the preferred option is based on the design of Option 2, which includes flexibility from the LULUCF sector to the ESR);
3. a requirement to further improve monitoring and reporting systems, in particular by further strengthening the use of geographic information systems (GIS), and by enhancing synergies with datasets that underpin agricultural and environmental policies;
4. an increased focus on integrating land-related policies for climate change mitigation, adaptation, biodiversity, agriculture policy, and bio-economy,
5. enhanced planning specific to the land sector, to ensure better protection of existing carbon stocks and the enhancement in the medium term of carbon removals.

This initiative will not affect the bioeconomy actors in a direct way: in particular, it will not establish any direct reporting requirements at the level of the individual actors, and therefore there will be no associated direct compliance costs. However, the higher national targets will drive national mitigation policies in the agriculture, land use and forestry sector, and these national policies will in turn affect actors of the bioeconomy, both in the primary sectors (e.g. farmers, forest owners, land managers in general) and in the relevant value chains (e.g. food processors, bioenergy producers); indirect effects can also reach final consumers through prices and more sustainable products. The direct costs for the actors of the bioeconomy will therefore stem from the cost of implementing action on the ground; according to Commission's modelling, these costs are found to be relatively low. The net economic impact on these actors will very much depend on the type of incentives established in national policies. For instance, the costs incurred or income foregone due to changes in land management practices to enhance carbon removals can be covered by CAP support. Member States can also facilitate access to voluntary carbon markets or other funds, which would help these actors benefit from additional income stemming from climate action.

10.3.2. Summary of costs and benefits

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
Direct benefits		
Reduced GHG emissions, increased removals	High: additional removals around -75 MtCO2eq in 2030	Co-benefits for climate change adaptation,

		biodiversity, bio-economy
Increased trading of carbon removals at MS-level (only if target is designed according to Option 2)	Medium, unquantifiable	Reduced costs of achieving the targets (cost-efficiency) through better geographic spread of LULUCF action (where it is nearer optimal cost/benefit)
Reduced regulatory costs	Medium/High (avoided cost of establishing new FRLs estimated around EUR 4.5 Mio)	Reduced administrative burden due to simplification of compliance rules
Reduced monitoring costs through re-use of EU programmes (e.g. Copernicus) and other policy data sources	Medium/High, unquantifiable	Improved re-use and synergies with other policy datasets will enhance monitoring, and provide a better platform for decision making and selection of actions
Indirect benefits		
Policy synergies	High, unquantifiable	The planning exercise for the land sector will result in policy synergies thanks to a more integrated approach.
Potential for new business models	Medium/High, unquantifiable	The more ambitious targets can be implemented by Member States through incentive payments to farmers and foresters or through fostering private carbon markets (see Annex 10.7 on carbon farming).
Facilitating EU GHG inventory robustness	High, unquantifiable	The simplified target system and improved monitoring would lead to better incentives for action in the sector.

Table 9 – Overview of Benefits

II. Overview of costs – Preferred option							
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
Costs of action on the ground	Direct costs	n/a	n/a	n/a	Low (approx. EUR 2,2 billion over the ten-year period)	n/a	n/a

	Indirect costs	n/a	Low, unquantifiable	n/a	n/a	n/a	n/a
Simplified targets	Direct costs	n/a	n/a	n/a	n/a	Low	Reduced (by EUR 4.5 Mio)
	Indirect costs	n/a	n/a	n/a	n/a	n/a	n/a
Improved use of GIS and related policy data	Direct costs	n/a	n/a	n/a	n/a	Medium	Reduced
	Indirect costs	n/a	n/a	n/a	Low	Low	Neutral
Integrating land-related policies	Direct costs	n/a	n/a	n/a	n/a	Medium	Reduced
	Indirect costs	n/a	n/a	n/a	n/a	Low	Neutral
Enhanced planning	Direct costs	n/a	n/a	n/a	n/a	Low	Low
	Indirect costs	n/a	n/a	n/a	n/a	n/a	n/a

Table 10 – Overview of costs

10.4. Analytical methods

10.4.1. Overview of the modelling framework applied in this impact assessment

Four main models were used in the LULUCF Impact Assessment: GLOBIOM, G4M, CAPRI and GAINS[95]. GLOBIOM and G4M are unique to the LULUCF sector and require a more thorough presentation; for CAPRI and GAINS this Impact Assessment only introduces elements that are specific and relevant to the LULUCF sector and limited to the modelled policies. GLOBIOM and G4M were used for LULUCF scenario development; all models were used for modelling emission reductions or enhanced removals with marginal abatement cost curves. All methodological analysis, namely the analysis of policy measures, is specific to the LULUCF sector and is therefore presented in detail in this section.

Model description for the LULUCF sector used in this impact assessment

The land-use simulation model GLOBIOM and the forest sector model G4M are commonly applied in an iterative manner for the estimation of LULUCF emission pathways for each EU Member State. GLOBIOM and G4M models cover together all UNFCCC land use categories of relevance for CO_2 emissions, only wetlands and settlements are added exogenously based on the 2020 GHG inventory. Also, non-CO2 emissions from LULUCF are added by an offset-calibration procedure. G4M covers the forestry sector and delivers emissions from biomass, dead organic matter and soil from afforestation and deforestation activities and biomass emissions from forest management. GLOBIOM provides emissions from cropland and grassland management.

GLOBIOM[96] is a global, recursive dynamic, bottom-up, partial equilibrium model integrating the agricultural and forestry sectors. The model computes a market equilibrium for agricultural and forest products by allocating land use among production activities to maximize the sum of producer and consumer surplus, subject to resource, technological, demand and policy constraints. The supply side of the model is built-up from the bottom (spatially explicit land cover, land use, management systems information) to the top (regional markets). For the EU (except Croatia, Cyprus, and Malta) the basis are spatial units of 1x1 km pixels, which are re-aggregated to the NUTS2 level. Demand and international trade occur at regional level (58 regions), covering all 27 EU Member States and 31 regions in the rest of the world. Besides primary products for the different sectors, several processing activities for final and by-products are covered by the models.

The level of production in each area is determined by the agricultural or forestry productivity in that area (dependent on land suitability and farm management), by market prices (reflecting the level of demand), and by the conditions and cost associated to conversion of the land, to expansion of the production and, when relevant, to international market access. Trade flows are balanced between different specific geographical regions based on cost competitiveness. This allows tracing of bilateral trade flows between individual regions.

G4M[97] estimates the impact of forestry activities (afforestation, deforestation, residue harvest and forest management) on biomass and other carbon pools. By comparing the

[95] GAINS is a key model for the ESR Impact Assessment and therefore will not be described in detail here, see also https://iiasa.ac.at/GAINS

[96] See also https://iiasa.github.io/GLOBIOM/.

[97] See also: www.iiasa.ac.at/G4M

net present value of managed forest (difference of wood price and harvesting costs, income from storing carbon in forests) with potential income from alternative land use on the same place, a decision on afforestation or deforestation is made. The model incorporates empirical forest growth functions for major tree species groups. G4M is spatially explicit and runs on a 0.5° x 0.5° resolution. Since the model neither represents forest markets nor other economic sectors, it relies on information from other sources (i.e. GLOBIOM or other databases) for wood prices, land rents, urban sprawl etc. Similarly, information about natural disturbances comes as input to the model. As outputs, G4M produces estimates of forest area change, carbon sequestration and emissions in forests, impacts of carbon incentives (e.g. avoided deforestation) and supply of biomass for bio-energy and timber.

The Common Agricultural Policy Regional Impact Analysis (CAPRI)[98] modelling system is a global, economic, comparative-static, partial equilibrium model for the agricultural sector. The core of CAPRI is based on the linkage of highly detailed and disaggregated models of EU regional agricultural supply and a global market model for agricultural commodities. The regional supply models simulate the profit maximizing behavior of representative farms for all EU regions under constraints related to land availability, nutrient balances for cropping and animal activities, and policy restrictions. The supply module consists of about 280 independent optimization models representing regional agricultural production activities (28 crop and 13 animal activities) at NUTS 2 level within the EU. Producer prices are exogenous to the supply module and provided by the market module. The global market module consists of a spatial, global multi-commodity model for about 60 primary and processed agricultural products, covering about 80 countries in 40 trading blocks. International trade covers bilateral trade flows and price transmission between agricultural commodity markets.

The regional CAPRI supply models capture links between agricultural production activities in detail. Based on the inputs and outputs of these activities, EU agricultural nitrous oxide and methane emissions are calculated following mostly the 2006 IPCC guidelines, tier 2 approach. CAPRI also includes a carbon cycle model for EU agriculture to account for CO_2 emissions and removals linked to EU agricultural production and effects related to the continued use of land and land use change. Moreover, the CAPRI model covers a set of specific technological (i.e., technical and management-based) GHG mitigation options for EU farmers in the livestock and crop sectors. Implementation costs, cost savings, and mitigation potential of these options are mainly based on data from the GAINS database and information collected within the AnimalChange project. A detailed description of each mitigation option and the underlying assumptions is provided in Pérez Domínguez et al. (2016, 2020).[99,100]

Scenarios used in the impact assessment

Scenarios model the likely development under current land use policies or make assumptions about future policies. This concept is different from the baseline, which

[98] See also: www.capri-model.org

[99] Pérez Domínguez et al. (2016): An economic assessment of GHG mitigation policy options for EU agriculture (EcAMPA 2). JRC Science for Policy Report, European Commission, Luxembourg: Publications Office of the European Union. doi:10.2791/843461

[100] Pérez Domínguez et al. (2020): Economic assessment of GHG mitigation policy options for EU agriculture: A closer look at mitigation options and regional mitigation costs (EcAMPA 3). JRC Science for Policy Report, European Commission, Luxembourg: Publications Office of the European Union. doi:10.2760/4668

applies to the current policy framework (the LULUCF Regulation) and is based on data from the 2020 GHG inventory.

In the Reference scenario (hereafter, REF) the LULUCF development is following a business-as-usual development, taking into account foreseeable actions, e.g. harvest and reforestation when forest reach the end of their rotation length. In exceptional cases the REF scenario also takes into account major disturbances of the LULUCF sink.

The REF scenario is based on most recent datasets and model projections available[101]. While input data are mainly based on FAOSTAT and FAO-FRA data, important scenario drivers for the projections of the LULUCF emissions/removals are PRIMES bioenergy demand projections (biofuels and solid biomass use) – which are fully integrated with the other parts of the Fit for 55 proposal – and the GEM-E3 macro-economic projections (population and GDP growth) taken up by GLOBIOM. The afforestation and deforestation rates in G4M have been calibrated to the data based on the 2020 GHG inventory.

The LULUCF Policy scenario (hereafter, MIX) considers changes in the biomass demand from the energy sector, which is the main difference to the REF scenario. Biomass demand assumptions generally follow the 1.5TECH scenario of the EU long-term strategy[102,103]. A higher demand for biomass results in different land-use change and emission trajectories, including an increased production of lignocellulosic crops or higher wood removals from the forest.

Modelling emission reductions or enhanced removals with marginal abatement cost curves

In GLOBIOM, the following technical options have been considered explicitly when estimating the cost curves for agricultural land:

- Alternative tillage and residue management systems (conventional, reduced, and minimum tillage, dynamic representation) with different impacts on soil carbon
- Change in crop rotations (NUTS2-specific based on EUROSTAT crop shares and agronomic constraints)
- Set-aside (incorporated in crop rotations, calibrated to historic EUROSTAT data)
- Reallocation of production to more productive areas and areas with higher potential for carbon sequestration
- Protection of areas with high carbon stocks in biomass and soil (except forests).

For the European agricultural sector, GLOBIOM relies on input datasets from the biophysical process-based crop growth model EPIC. Crop rotations and different tillage systems have been incorporated for Europe. Crop rotations have been derived for each NUTS2 region from crop shares calculated from EUROSTAT regional statistics on crop areas taking into account data on relative NUTS2 crop shares, assumptions about crop planting decisions and other agronomic constraints such as frequency limits for self-intolerant crops (e.g. sugar beet) or intolerant pairs of crops (e.g. sugar beet and rapeseed). The derived crop rotations represent the current crop mix. They include e.g. set-aside, other green fodder on arable land and different legumes (based on shares from EUROSTAT data). In addition, perennial crops such as switch grass, miscanthus and

[101] EU Reference Scenario 2020 publication

[102] COM(2018) 773 final: A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy.

[103] In-Depth Analysis in Support of the Commission Communication COM(2018) 773.

short rotation tree plantations are represented which usually tend to sequester carbon in the soil due to high biomass growth and litter inputs.

Dynamic sequestration/emission rates over time are explicitly taken into account in the modelling framework switching from conventional to no-tillage systems. switching from conventional to no-tillage systems.

The following mitigation options have been explicitly considered in G4M:

- Reduction of deforestation area
- Increase of afforestation area
- Change of rotation length of existing managed forests in different locations
- Change of the ratio of thinning versus final felling
- Change of harvest intensity (amount of biomass extracted in thinning and final felling activity)
- Change of harvest locations.

These activities are not adopted independently since the model manages forest land dynamically and activities affect each other. The model is calculating the economic optimal combination of measures and the introduction of a carbon price gives an additional value to the forest through the carbon stored and accumulated in it which tends to decrease deforestation and increase afforestation. However, this may not happen at the same intensity because less deforestation increases land scarcity and might therefore decrease afforestation. The existing forest under a carbon price is managed with longer rotations and expanding harvest to less productive forest. Where possible, the model increases the area of forests used for wood production, meaning a relatively larger area is managed relatively less intensively which affects the carbon balance. Forest management activities can also have a feedback on emissions from deforestation because they might increase or decrease the average biomass in forests being deforested and influence biomass accumulation in newly planted forests, depending on whether these forests are used for production or not.

Market feedbacks and effects of these mitigation options in the forestry sector, e.g. prolonging rotation, are explicitly accounted for as the production of wood to satisfy wood demand has higher priority than the carbon accumulation. In fact, much of the mitigation effects are achieved by structural and geographic relocation of harvesting schedules to increase sequestration while at the same time satisfy market demands.

CAPRI modelled the mitigation potential and related costs of fallowing of histosols (i.e., ceasing agricultural production on organic soils). This management option focuses on the restoration of organic soils and, hence, prevents peatlands from releasing large quantities of carbon into the atmosphere. Organic soils need to be drained to be used for crop production, and this drainage leads to aeration and subsequent decomposition of the peat, which results in a substantial release of CO_2 and N_2O emissions. In CAPRI, the mitigation option of fallowing histosols is considered by setting aside a certain proportion of the agricultural area (arable and grassland) in each MS. The adoption of this mitigation option is constrained by the shares of cultivated organic soils. The direct costs of this measure considered at present are the opportunity cost of land use (i.e. foregone income). Other direct costs (e.g. rewetting) and indirect costs (e.g. transaction costs linked to regional land regulation) faced by the farmers are not considered.

GAINS has been used to model non-CO2 emission reductions in the agriculture sector. The following mitigation options have been considered in GAINS (they will not be further described in this Impact Assessment):

- Ban on burning agriculture waste (CH4)
- Breeding through selection: enhance productivity, fertility and longevity to minimize kg CH4/kg milk (CH4)
- Farm-scale anaerobic digestion with biogas recovery (CH4)
- Feed additives and/or changed feed management practices (CH4)
- Intermittent aeration and alternative hybrids (CH4)
- Intermittent aeration, alternative hybrids and sulphate amendments (CH4)
- Abandoning agricultural use of org soils (N2O)
- Nitrification inhibitors (N2O)
- Precision farming(N2O)
- Variable rate technology (N2O)

Mitigation measures include technological and opportunity costs[104]:

- GLOBIOM and G4M explicitly take into account land competition and the mutual interaction between mitigation measures. All measures focus on CO2 mitigation options.
- CAPRI estimates the CO2 mitigation potentials from organic soils[105]. The specific mitigation action "fallowing of histosols" is an addition to LULUCF mitigation measures modelled under GLOBIOM and G4M.
- GAINS models the mitigation of agricultural non-CO2 emissions (CH4 and N2O). All N2O and most CH4 mitigation measures introduce technologies and are not related to land management practices as modelled from LULUCF with GLOBIOM, G4M and CAPRI.

Mitigation costs, here in Mio EUR are estimated by the formulas

$$Cost_{MC} = MC * Mitigation_{MC}$$

$Total\ cost = \sum_{MC=0} Cost_{MC}$ Where:

- MC is the marginal cost in EUR per tonne CO2
- $Mitigation$ is the additional mitigation for marginal cost MC in t CO2eq
- $Total\ cost$ is the sum of incremental costs, $Cost_{MC}$ in EUR per year

Mitigation and costs for additional action in 2030 for LULUCF

The MIX scenario projects an EU LULUCF sink of 256 MtCO2eq in 2030 (see Figure 12Figure 12)[106] without an application of a carbon price on the LULUCF sector. The scenario reproduces the historic LULUCF sink development (2000-2015) and projects a relatively stable sink for the years 2020-2035. The forest sink is projected to be relatively stable between 2020 and 2030 but declines towards 2035. This decrease is compensated by significant emission reductions in Cropland, namely due to planting of lignocellulosic energy crops.

[104] Technological costs describe all investments for installation and operation of a certain land management practice or technology. Opportunity costs include all estimates against the current land management as counterfactual, namely the foregone income.

[105] GAINS models the N2O emission reductions by measure "Abandoning agricultural use of organic soils".

[106] For coherence with demands by other policy pillars this section of the impact assessment uses the MIX scenario. For the period relevant the difference to the LULUCF total in the REF scenario is very small.

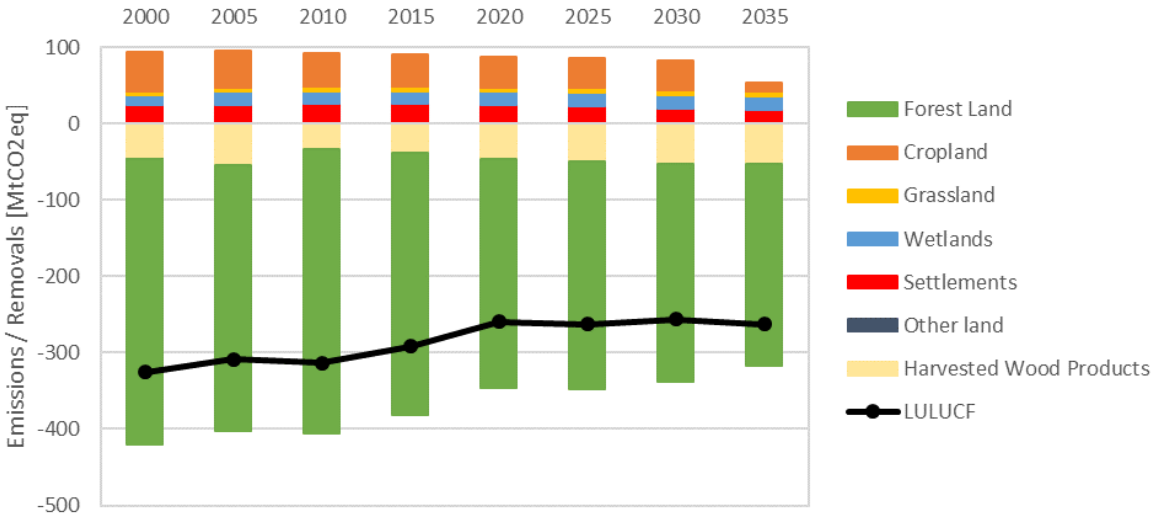


Figure 12 – EU LULUCF MIX scenario modelled in GLOBIOM and G4M for all UNFCCC Land use categories.

Based on this scenario, Figure 13 shows marginal abatement costs curves (MACC) for the main land uses in LULUCF for 2030[107]. According to this modelling, the EU LULUCF sink of -310 MtCO2eq, as proposed in Option 1.2, could be achieved at a carbon price between 5 EUR/tCO2 and 10 EUR/tCO2[108]. A carbon price of 5 EUR/tCO2 could deliver an additional 58.3 MtCO2eq for a cost of EUR 291 Mio per year; 10 EUR/tCO2 could deliver another 10 MtCO2eq for an incremental cost of EUR 100 Mio.

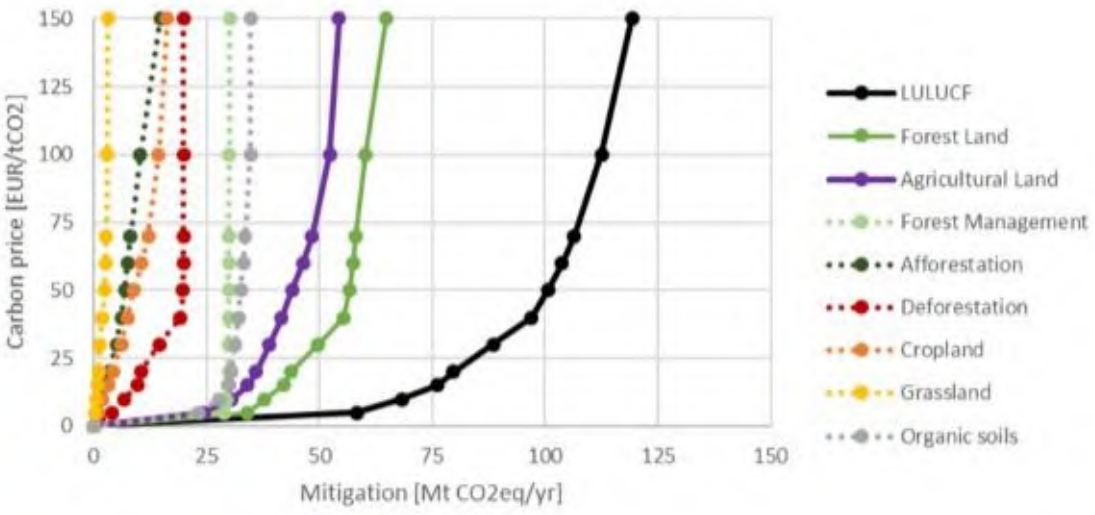


Figure 13 – Marginal abatement costs curve for the MIX scenario in 2030 for actions modelled in GLOBIOM and G4M for main LULUCF land use categories and CAPRI for organic soils on agricultural land. Mitigations were estimated for carbon prices [y-axis] shown in dots. LULUCF is the aggregate of Forest 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.

[107] GLOBIOM G4M and CAPRI used marginal costs in intervals of 5, 10, 15, 20, 30, 40, 50, 70, 100 and 150 EUR/tCO2.

[108] The carbon price of 10 EUR/tCO2 also considers the generation of LULUCF credits for possible use in the ESR, as discussed in the ESR Impact Assessment.

Mitigation on forest land and agricultural land[109] show similar potentials for measures included in the modelled carbon price scenarios, and none can reach the target of -310 MtCO2eq at low costs alone. This underlines the importance of mitigation action and their significant potential on all major land uses. The model setup is a conservative estimate and focusses on simpler and cheaper mitigation measures, because not all land uses and mitigation actions were explicitly modelled. Also, possibly significant abatements by increasing Harvested Wood Products or by rewetting forest organic soils were not included in this modelling.

Measures on Forest Management, such as change of rotation length, thinning and harvest intensity, have the highest mitigation impact for Forest Land; yet, maximum potentials around 30 MtCO2eq are reached with carbon prices as low as 10 EUR/tCO2. This is mainly because the carbon price only needs to compensate for the opportunity costs, e.g. foregone income due to a longer rotation length[110]. Avoided deforestation holds notable potentials for moderate carbon prices (10 Mt CO2eq for 15 to 20 EUR/tCO2) but reaches saturation at 20MtCO2eq due to no further loss of forest at 40 EUR/tCO2.

Afforestation shows a steady increase in the mitigation potential with higher carbon prices. A time span of only 10 years is too short for noting significant effects of fostered afforestation on the carbon sink; the impact becomes significantly more notable in subsequent decades[111]. Investment costs for afforestation are also significantly higher and 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) have been based on existing studies[112,113,114] and scaled to today's expenses. Depending on Member State's 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

[109] Agricultural land is the aggregate of measures for Cropland and Grassland on mineral soils and fallowing of organic soils in cropland and grassland combined.

[110] An additional reason is that Forest Management zero additional cost is based on the 2000-2010 average wood production map (Verkerk et al. 2015) without further optimization. At 5 EUR/tCO2 the carbon sink in forest biomass is optimized for this carbon price. A further increase of carbon price has limited effect on mitigation because the model seeks to satisfy wood demand and hence increased carbon prices are in competition with local wood prices. Overall, the possibility of harvesting approximately the same amount of wood and at the same time increasing the carbon sink in the forest biomass is limited. Verkerk PJ, Levers C, Kuemmerle T, Lindner M, Valbuena R, Verburg PH, Zudin S (2015) Mapping wood production in European forests. Forest Ecology and Management 357: 228-238.

[111] Following IPCC 2006 Guidelines, Afforestation, that is "Land converted to Forest Land" under the UNFCCC, remains in this land transition category until an equilibrium of soil carbon stocks has been reached. By default, this period is 20 years. Thereafter, carbon sequestration (and losses) are reported under "Forest Land remaining Forest Land". This modelling framework applies the same methodology and therefore presents the mitigation by Afforestation under Forest Management for areas 20 years after Afforestation.

[112] Di Fulvio, F., Forsell, N., Lindroos, O., Korosuo, A., Gusti, M. (2016) Spatially explicit assessment of roundwood and logging residues availability and costs for the EU28, Scandinavian Journal of Forest Research, 31 (7), pp. 691-707.

[113] https://bur.regione.emilia-romagna.it/bur/area-bollettini/bollettini-in-lavorazione/n-100-del-05-05-2015-parte-seconda.2015-05-04.8251650544/aggiornamento-elenco-prezzi-degli-interventi-di-forestazione/allegato-c

[114] https://www.skogforsk.se/kunskap/kunskapsbanken/2014/Skogsbrukets-kostnader-och-intakter-20131/

EUR 1,177 and EUR 3,285 [115]. This is still lower than average payments of 4,000 EUR/ha under the CAP[116].

Fallowing of histosols, currently used for agriculture or as grasslands, holds the same mitigation potential as measures for improved Forest Management. Very high mitigations at low carbon prices (e.g. 23 MtCO2eq for 5 EUR/tCO2) soon reach a limit of 35 MtCO2eq because all land has been set aside. Fallowing histosols is intended as permanent non-use of economic land, as the intention is to maintain accumulated carbon stocks in this land and each economic use has the loss of part of this carbon as a consequence. This impact assessment limits the mitigation measure to fallowing, hence only the compensation for foregone income (opportunity costs). In reality, fallowing of histosols should be accompanied by renaturation and rewetting of the land to stop mineralization of the organic matter[117]. The area affected by fallowing of histosols is very small: emission reporting for grassland and cropland in the EU[118] notes less than 1.5 Mio ha of Cropland and less than 3 Mio ha of Grassland on organic soils which corresponds to 1.18% and 3.33% of the respective total land use category area. The current annual emissions from these areas are reported with 30 MtCO2eq for Cropland and 41 MtCO2eq for Grassland. Therefore fallowing histosols is a powerful mitigation strategy that only affects a very small part of agricultural land and holds further potential of emission reductions with additional technologies such as renaturation and rewetting.

In comparison, other measures on agricultural land have a comparatively low impact on climate mitigation. Yet, improvements on cropland management e.g., change in tillage systems, crop rotations and reallocations show a steadily increasing mitigation potential with higher carbon prices and could therefore gain relative importance in future decades when other mitigation measures reach saturation levels.

Mitigation and costs in 2035 for an integrated Agriculture and LULUCF target

Figure 14 shows the mitigation by carbon price for 2035. LULUCF mitigation categories show similar patterns as for 2030 with the exception of afforestation; the additional five years result in notably higher mitigation for high carbon prices. The agriculture sector (which is additionally presented in Figure 14) shows a non-CO2 mitigation potential of nearly 20 MtCO2eq at no economic cost by introducing animal breeding and a ban on burning agricultural waste. Feed additives for dairy cows may reduce emissions by 7 MtCO2eq for a carbon price between 20 and 40 EUR/tCO2. Nitrification inhibitors show a significant effect for carbon prices above 50 EUR/tCO2. The total emission reduction for a carbon price of 150 EUR/tCO2 is 60 MtCO2eq. The combined mitigation on agricultural land and agriculture non-CO2 holds a significantly higher potential than the forest sector.

[115] The actual cost might be substantially different considering site circumstances (soil quality, water potential, access and terrain) and the selected species. Calculations assumed no costs for natural disturbances. The literature reports cases of costs above 10,000 EUR/ha.

[116] SWD(2019) 389 final. Evaluation of the Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005 concerning the forestry measures under Rural Development. P11, Table 3: planned Afforestation under M8.1: Area afforested: 569,234ha, public expenditure: EUR 2,263 Mio.

[117] Rewetting could result in additional carbon sequestration, yet at substantially higher carbon prices.

[118] EU GHGI inventory 2020: Table 4.B (Cropland) and Table 4.C (Grassland) for areas with organic soils.

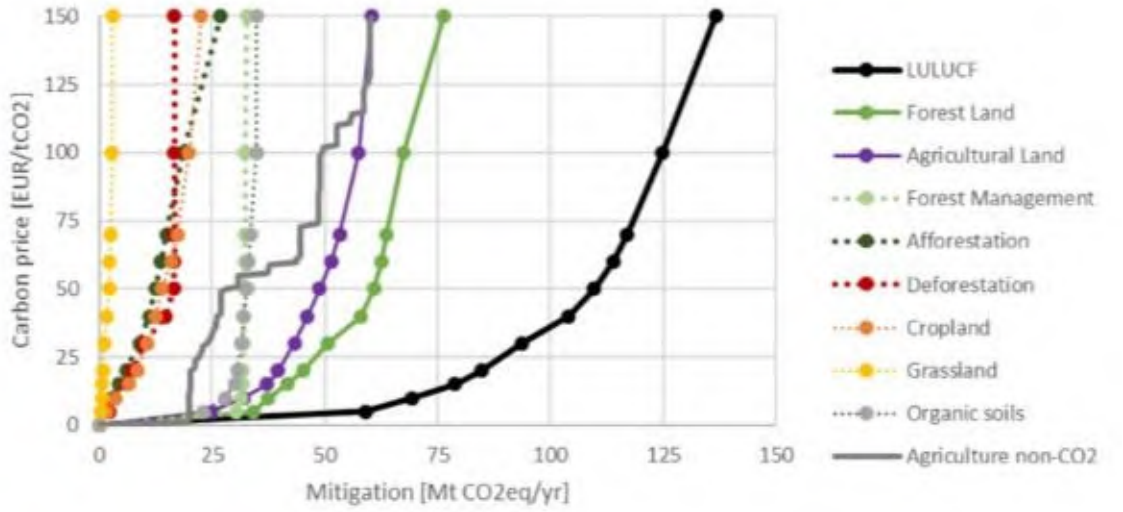


Figure 14 – Marginal abatement costs curve for the MIX scenario in 2035 for actions modelled in GLOBIOM and G4M for main LULUCF land use categories, CAPRI for organic soils on agricultural land and GAINS for mitigation of CH4 and N2O in the agriculture sector. For LULUCF, mitigations were estimated for 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, HWP) were not explicitly modelled. For agriculture non-CO2 marginal mitigations were extracted at steps of 1 EUR/tCO2 for all technologies listed in the method description.

Option 3 of the Impact Assessment seeks to achieve a climate neutral land sector (agriculture non-CO2 and LULUCF sectors combined) by 2035. To that end, the MIX policy scenario at zero additional cost predicts a mitigation gap of 106 MtCO2eq in 2035. Figure 15 shows the range of carbon price and total costs needed to achieve EU land neutrality. The EU may achieve this goal on any point on this curve that combines the marginal abatement cost curves for LULUCF and agriculture non-CO2. As action in the agriculture non-CO2 sector can only mitigate 60 Mt of non-CO2 for an assumed maximum carbon price of 150 EUR/tCO2, a minimum set of actions in the LULUCF sector is required for a carbon price of at least 4 EUR/tCO2[119]. Carbon prices for economic cost-efficient solutions (in orange) range from 16 to 23 EUR/tCO2 for LULUCF that correspond to 41 to 1 EUR/tCO2 for emission reductions in the agriculture non-CO2 sector. The total costs in 2035 in both sectors combined range between EUR 531 Mio and EUR 605 Mio. Given the generally higher mitigation potential of action in the LULUCF sector, total costs in LULUCF will exceed investments in non-CO2 emission reductions in agriculture. However, the overall mitigation action and costs on agricultural land (Grassland Cropland in LULUCF, including fallowing of histosoils) and the agriculture non-CO2 sector combined will exceed actions in the forest sector.

[119] For this analysis carbon prices for LULUCF were interpolated to intervals of 1 EUR/tCO2.

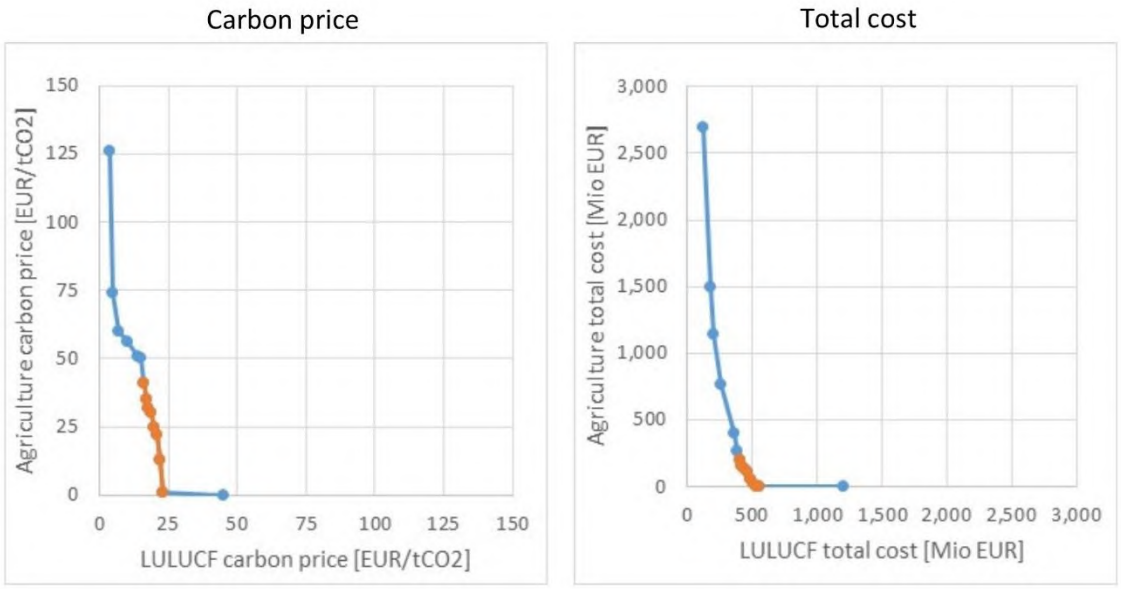


Figure 15 – Carbon price (left) and Total cost (right) ranges for the LULUCF and Agriculture sector to achieve land neutrality by 2035. Orange shows economic cost-efficient solutions.

10.4.2. Approach to compute the targets

Table 11 gives an overview of LULUCF targets under the baseline and the various options:

	Targets				
Option	**Baseline**	**Option 1.1**	**Option 1.2**	**Option 2**	**Option 3**
Scope	*LULUCF*	*LULUCF*	*LULUCF*	*LULUCF*	*Agriculture + LULUCF*
MtCO2eq	-224.9	-259.7	-310	-267.7	+39.9

Table 11 – Overview of LULUCF targets in the various options for 2030.

All benchmarks and targets calculated and set out in this impact assessment, partly also the scenarios modelling, are linked to the emission and removals as reported in the 2020 GHG inventory by Member States and submitted to the UNFCCC.

Box 5 – Uncertainty in LULUCF estimates

The LULUCF sector estimates in the EU GHG inventory have an uncertainty of 22.4% for the level and 15.0% for the trend[120]. Level uncertainty estimates for all other sectors but fuel combustion are at a similar level or even higher (e.g. Agriculture non-CO2: 45.1%). Uncertainty estimates for the trend are lower for all other sectors but Waste (19.1%). There are no specific uncertainty estimates for model runs in this impact assessment. However, scientific studies analysed the model sensitivity for scenario modelling[121] and marginal abatement cost curve (MACC) analysis[122].

[120] EU National Inventory report for 2020. Table 1.15, page 53.

[121] Böttcher, H. Verkerk, P.J., Gusti, M., Havlik, P., Grassi, G. (2012), Projection of the future EU forest CO2 sink as affected by recent bioenergy policies using two advanced forest management models. GCB Bioenergy, 4, p. 773–783.

Figure 16 – Total LULUCF emissions and removals from annual GHG inventory submissions 2008 to 2020 for the EU-27. Left: Total LULUCF greenhouse gas profile from all inventories from 1990 to the respective last reporting year (inventory year – 2). Right: Total LULUCF emissions and removals from all GHG inventories for reporting year 2006 (last common reporting year) and the last reporting year or each GHG inventory submission.

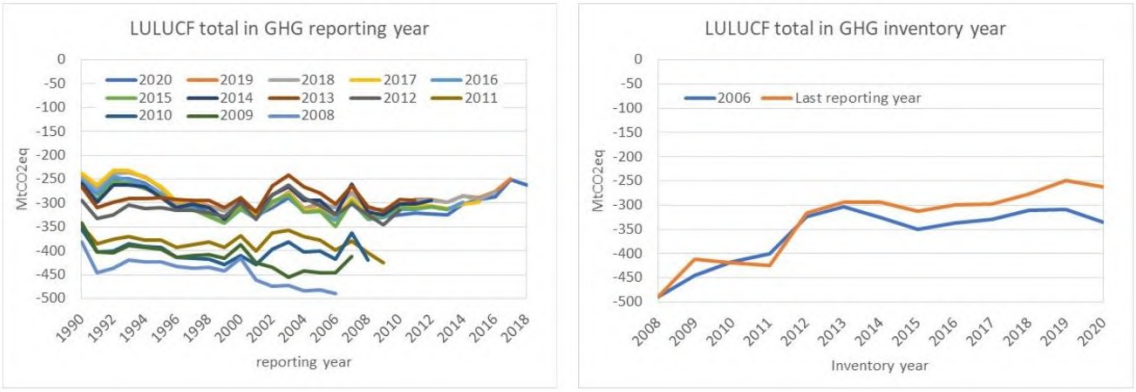


Figure 16 – Total LULUCF emissions and removals from annual GHG inventory submissions 2008 to 2020 for the EU-27. Left: Total LULUCF greenhouse gas profile from all inventories from 1990 to the respective last reporting year (inventory year – 2). Right: Total LULUCF emissions and removals from all GHG inventories for reporting year 2006 (last common reporting year) and the last reporting year or each GHG inventory submission.

In the first years of GHG reporting (GHG inventory submissions of 2008-2011), LULUCF totals changed a lot from one GHG inventory submission to the next, with a significant jump in the 2012 GHG inventory submission (Figure 16). Since 2014, the GHG inventory submissions are relatively stable at EU level[123]. Usually, a new GHG inventory submission shifts the level of the entire time series due to improvements in data and methodologies, e.g., reflecting new carbon pools or a change in emission factors, but rarely changes only specific years. The changes in emission level between GHG inventory submissions may be more significant in relative terms at the level of individual Member States. To ensure the same level of ambition at the point of compliance, it is important to update targets with the GHG inventory used for compliance against the initial calculations set out with the 2020 GHG inventory in this impact assessment.

The benchmarks and targets for each Member State are calculated as follows:

- **Baseline**

The estimate of **-224.9 MtCO2eq** represents the no debit benchmark, or baseline, by applying the accounting framework of the current LULUCF Regulation to the reported emissions and removals in the GHG inventory submission of 2020. This estimate can therefore be quantitatively compared to other benchmarks or targets as proposed in this Impact Assessment. Despite some caveats, this approach for estimating the baseline is the best-possible solution while also taking into account envisioned changes in the scope.

[122] Gusti, M., Forsell, N., Havlik, P., Khabarov, N., Kraxner, F., Obersteiner, M. (2019), The sensitivity of the costs of reducing emissions from deforestation and degradation (REDD) to future socioeconomic drivers and its implications for mitigation policy design. Mitig Adapt Strateg Glob Change, 24, p. 1123 1141.

[123] The GHG inventory submission of 2014 corresponds with the last year of reporting under the first commitment period of the Kyoto Protocol.

The baseline of each Member State is calculated from the average reported emissions and removals of greenhouse gases (CO2, CH4 and N2O) of the period 2005-2009 using the following equation:

$$BL = LULUCF - MFL - AFL - DFL + FRL$$

where[124]:

- *BL*: the baseline for 2030
- *LULUCF* from "Total LULUCF" for emissions and removals in Table 4
- *MFL*: Managed Forest Land, which consists of:
    - "Forest Land remaining Forest Land" for net carbon stock changes in Table 4.A, direct N2O emissions from N inputs to managed soils in Table 4(I), direct N2O emissions from N mineralization/immobilization in Table 4(III) and greenhouse gas emissions from biomass burning in Table 4(V)
    - "Harvested wood products" for net change of CO2 in Table 4.Gs1
    - "Total Forest Land" for emissions and removals from drainage and rewetting and other management of organic and mineral soils in Table 4(II)[125]
- *AFL*: Afforested Land from "Land converted to Forest Land" for net carbon stock changes in Table 4.A, direct N2O emissions from N inputs to managed soils in Table 4(I), direct N2O emissions from N mineralization/immobilization in Table 4(III) and greenhouse gas emissions from biomass burning in Table 4(V)
- *DFL*: Deforested, Land which consists of[126]:
    - "Forest land converted to Cropland" for net carbon stock changes in Table 4.B and direct N2O emissions from N mineralization/immobilization in Table 4(III)
    - "Forest land converted to Grassland" for net carbon stock changes in Table 4.C and direct N2O emissions from N mineralization/immobilization in Table 4(III)
    - "Forest land converted to Settlements" for net carbon stock changes in Table 4.E and direct N2O emissions from N mineralization/immobilization in Table 4(III)
    - "Forest land converted to Other Land" for net carbon stock changes in Table 4.F
- *FRL*: Forest Reference Level as laid down in the Commission Delegated Regulation (EU) 2021/268.[127,128]

[124] Table notations for the descriptors refer to specific LULUCF tables in the GHG inventory submitted to the UNFCCC.

[125] In the context of laying down Forest Reference Levels it was recommended to include emissions from drainage and rewetting into the FRL (LULUCF Expert Group, slide 10). As Table 4(II) does not provide a disaggregation between remaining and converted forest land uses, it was deemed appropriate to assume that all emissions correspond to "Forest Land remaining Forest Land".

[126] The land category conversion "Forest land converted to Wetland" is currently only reported by very few Member States and was therefore not included in the baseline calculation. Including this conversion from the currently reported estimates has an impact of 2.5Mt yr^{-1}.

[127] Commission Delegated Regulation (EU) 2021/268 of 28 October 2020 amending Annex IV to Regulation (EU) 2018/841 of the European Parliament and of the Council as regards the forest reference levels to be applied by the Member States for the period 2021-2025.

[128] Forest Reference Levels are based on the continuation of sustainable forest management practices as documented in the period from 20002-2009 (Art 8 of the LULUCF Regulation). Accounting of managed cropland, managed grassland and managed wetland, which are not subtracted from the LULUCF total in the baseline equation, result from the base period 2005-2009 (Art 7 of the LULUCF Regulation).

The current reporting to the UNFCCC does not provide a sufficient disaggregation for estimating all carbon stock changes and GHG emissions and removals in an additive way as required in Art 2 of the current LULUCF Regulation. Applying a "backward calculation" or subtraction approach, as shown in the equation above, ensures covering all reported emissions and removals. At the same time it extends the scope of the current LULUCF Regulation to all emissions and removals as reported in the LULUCF sector[129].

The calculation makes three assumptions:

- Global Warming Potentials: All calculations use Global Warming Potentials of AR5, only the FRLs are based on AR4[130]. FRLs are not disaggregated by gases, hence the impact cannot be directly quantified, yet it is safe to assume a negligible impact[131].
- Age dynamics: The calculation assumes the FRLs laid down for the period 2021-2025 to be the same in the period 2026-2030. Forest Reference Levels for the period 2026-2030 will be proposed by June 2023, hence a quantitative estimate cannot be made at this moment. However, the only variable compared to the existing FRLs are the age-class dynamics that evolved by 5 years. Therefore it is reasonable to assume no significant differences compared to the FRLs laid down today.
- Background level for natural disturbances: This baseline cannot take into account possible exclusions of emission due to applying the provision for natural disturbances, except for those Member States that included a preliminary estimate in the FRL. This parameter cannot be inferred indirectly, and there are not yet experiences with the provision's application. Therefore, it is impossible to predict both, the occurrence of natural disturbances and the application of the provision.

- **Option 1.1**

The average reported emissions and removals from Managed Forest Land in the period 2016-2018 was -351.0 MtCO2eq, which corresponds to 34.8 MtCO2eq of additional removals with respect to the Forest Reference Levels (-316.2 MtCO2eq). This simplification of accounting rules, therefore, raises the ambition of the LULUCF Regulation from the current -224.9 MtCO2eq to **-259.7 MtCO2eq**.

- **Option 1.2**

The allocation criterion is a mix between:

1. A Member State's recent LULUCF emissions and removals (the average between 2016-2018): this ensures that the target reflects the current mitigation performance of the LULUCF sector in each Member State, which include the recent impacts of natural disturbances;

[129] The current LULUCF Regulation (Regulation 2018/841) does not include net carbon stock changes and GHG emissions from "Settlements remaining Settlements", "Settlements converted to Other Land", "Other Land converted to Settlements" and "Other". The Regulation is unclear on the inclusion of Emission from indirect N2O emissions from managed soils by atmospheric deposition or Nitrogen leaching and run-off. The Baseline at the scope of the current LULUCF Regulation is -229 MtCO2eq.

[130] In the 4th Assessment Report Global Warming Potentials (GWP) for 100 years are 25 for CH4 and 298 for N2O; in the 5th Assessment Report GWPs for 100 years are 28 for CH4 and 265 for N2O.

[131] The differences between GWPs for both gases combined for Forests at the level of the EU is below 300kt yr^{-1}.

2. The area of managed land: this criterion reflects the capacity of a Member State to improve its LULUCF performance, as it strongly correlates with the area available for action, either via positive land use change or by improved land management practices.

The proposed target allocation for each Member State (T_{MS}) is the result of the following sum:

$$T_{MS} = LULUCF_{MS} + \frac{Area_{MS}}{Area_{EU}} \left(Target_{EU} - LULUCF_{EU}\right)$$

Where:

- $LULUCF_{MS}$ is the Member State's 2016-2018 average LULUCF net emissions or removals as reported the 2020 GHG inventory;
- $\frac{Area_{MS}}{Area_{EU}}$ is the percentage of a Member State's area of managed land over the total EU area of managed land[132];
- $Target_{EU}$ is the overall target of LULUCF net emissions or removals set for 2030. In Option 1.2 this target is set to **-310 MtCO2eq**
- $LULUCF_{EU}$ is the sum of all Member State's average (2016-2018) LULUCF net emissions or removals and corresponds to -267.7 MtCO2eq as reported the 2020 GHG inventory.

- **Option 2**

This option calculates an EU target of **-267.7 MtCO2eq** equal to the sum of all Member State's average (2016-2018) LULUCF net emissions or removals. Like in Option 1.2, the target is set in terms of the overall amount of emissions and removals reported in the 2020 GHG inventory. In addition, flexibilities as set out in Annex III of Regulation (EU) 2018/842 may be added (26.2MtCO2eq per year on average).

- **Option 3**

Under this option the EU achieves land neutrality by combining agriculture emissions with LULUCF net removals. However, individual Member States may have land net emissions or net removals targets, depending on their capacity to reduce Agriculture emissions and reduce emission or enhance removals in the LULUCF sector. Target setting considers the Agriculture emission reduction potential per Member state, and based on this collective EU achievement the remaining emissions are balanced by LULUCF removals. Based on the 2020 GHG inventory, the calculations use the average Agriculture emissions and LULUCF net emissions or removals of 2016-2018 as a starting level and 2018 as starting year for the trajectory.

Two approaches are considered for emission reductions in agriculture:

- **Flat reduction**: a reduction of agriculture emission by 20% in each Member State. At the EU level, this corresponds to a decrease of agricultural emissions from 403.4 MtCO2eq in 2016-2018 to 322.7 MtCO2eq in 2035.

[132] Managed land areas are the average of 2016 to 2018 reported in the greenhouse gas inventory, Table 4.1. Areas are assumed not to change significantly over time.

The assumption of an EU 20% reduction by 2035 in Agriculture non-CO2 emissions is justified on the grounds of three elements:

i. In the Climate Target Plan analysis[133], potential emission reductions of non-CO2 greenhouse gases by the sector in 2030 in the EU27 compared to baseline (AR5) are computed as 30.6 MtCO2. Including the modelling baseline reduction, this leads to an overall reduction of the sector of around 15% by 2030.

ii. A further modelling exercise conducted by the European Commission's Joint Research Centre provides a narrowly focused assessment of the effects of achieving the targets stemming from the Biodiversity and Farm to Fork Strategies, in combination with the implementation of the 2018 Legal Proposal of the Common Agricultural Policy (CAP) and associated Strategic Plan implementation. This work confirms the significant role the CAP would play, in particular the boosted uptake of mitigation technologies and upgrading of farming practices, resulting in 17.4% reduction of non-CO2 GHG emissions in the agricultural sector by 2030, going up to 19.0% with additional budget potentially made available under the "Next Generation EU".[134]

iii. The 2016 LULUCF impact assessment[135] also worked on the guiding assumption of a 20% reduction compared to 2005 in this sector's emissions, in the discussion on needs for flexibility with the ESR.

- **GDP-based reduction**: a reduction modulated by GDP/capita adapted from the fairness distribution key of the Effort Sharing Regulation. In this option we applied the reduced ESR scope and an overall -27% emission reduction (following Option 2.2 of the ESR Impact Assessment) only to the agriculture sector, extended the period for reductions to 2035 and removed the LULUCF flexibility from each MS target[136]. For the EU, this reduction corresponds to 21% or a decrease of agricultural emissions from 403.4 MtCO2eq in 2016-2018 to 318.0 MtCO2eq in 2035.

Balancing of the remaining removals follows the same principle as outlined under option 1.2.

The national contributions to the 2035 objective (L_{MS}) are composed of two additive parts in brackets corresponding to Agriculture and LULUCF and are computed as follows:

$$L_{MS} = [AGRI_{MS} - AGRI_{MS} * Reduction_{MS}] +$$

$$\left[LULUCF_{MS} + \frac{Area_{MS}}{Area_{EU}} \left(Target_{EU} - LULUCF_{EU}\right)\right]$$

Where:

- $AGRI_{MS}$ is the Member State's 2016-2018 average Agriculture emissions as reported the 2020 GHG inventory

- $Reduction_{MS}$ is the percent reduction for agriculture as explained above.

[133] SWD(2020) 176 final part 2/2, p88 and Table 44.
[134] SWD(2020) 176 final part 2/2, p90
[135] SWD/2016/0249 final.
[136] Annex III of Regulation (EU) 2018/842, annualized.

- $LULUCF_{MS}$ is the Member State's 2016-2018 average LULUCF net emissions or removals as reported the 2020 GHG inventory;

- $\frac{Area_{MS}}{Area_{EU}}$ is the percentage of a Member State's area of managed land over the total EU area of managed land[137];

- $Target_{EU}$ is the overall target of LULUCF net removals and equals the remaining emissions in the agriculture sector after applying the emission reductions (the result of the first bracketed term). Depending on the chosen emission reduction approach this equals -322.7 MtCO2eq or -318.0 MtCO2eq.

- $LULUCF_{EU}$ is the sum of all Member State's average (2016-2018) LULUCF net emissions or removals and corresponds to -267.7 MtCO2eq as reported in the 2020 GHG inventory.

The national targets for 2030 are then found by drawing, for each Member State, a linear trajectory between the 2016-2018 average performance of the land sector (starting in year 2018) and their 2035 contribution as computed above. Summing up all national targets, the EU-wide 2030 target corresponds to total net emissions from the land sector equal to **39.9 MtCO2eq**, implying reductions in agricultural emissions and reduced emission or enhanced removals in LULUCF. It is important to stress that this trajectory is only indicative, and the proportion between the reduction of agricultural emissions and the efforts in LULUCF can vary depending on national circumstances, as long as the net national targets for the land sector are achieved.

The emission reductions and enhanced removals may be reached by various strategies or combinations of those. The strategies may include planting of perennial crops, increases of the forest biomass, significant action on organic soils, implementation of practices and technologies in the agriculture sector, dietary changes, or the general application of a carbon price.

Planting of perennial crops for bioenergy hold significant potential of increasing the LULUCF sink, albeit with a short-term effect. Once the rotation length of the energy crops is reached, the sink will begin to decline and in the longer run even fall below previous levels (this measure is favoured under the 1.5TECH scenario of the long-term strategy). Increases of the forest biomass may be reached through reduced deforestation, increased afforestation and limited harvest, even though the latter may lead to overaging of forests with reduced carbon sequestration potential (this measure is favoured under the 1.5LIFE scenario). Organic soils hold a particular potential for LULUCF mitigation, ranging from passive interventions like fallowing to active restoration actions such as rewetting.

While action in the agriculture sector hold a wide variety of choices, a significant impact is reached via dietary changes in the food consumption with significant domestic and international implications on the food production sector. Dietary changes have double benefit as the land freed from food production, with consequently less emissions, becomes available for perennial cropping of biomass feedstock with an increase in the LULUCF removals and related material or energy substitution effects.

[137] Managed land areas are the average of 2016 to 2018 reported in the greenhouse gas inventory, Table 4.1. Areas are assumed not to change significantly over time.

Modelling (see also Annex 10.4.1) is largely based on economic criteria and will trigger certain mitigation actions at specific carbon prices while taking into account constraints like the general applicability or saturation effects. However, active land management also considers environmental, socio-cultural or political criteria. This can result in not applying a mitigation measure even if it is economically beneficial or applying a more expensive mitigation action instead.

10.5. Results of target computations

The modelling presented in this impact assessment shows that, with no additional actions, the EU net removals in 2030 will be similar to the levels today (-256 MtCO2eq), and that a net removal target above -300 MtCO2eq can be achieved at relatively low cost. This shows clearly the potential for EU mitigation supporting a net removal target of -310MtCO2eq in 2030. Nevertheless, the linking of mitigation potential (shown by the modelling framework) for each Member State to the direct allocation of Member State targets should be done with caution and take into account:

First, some of the GLOBIOM output appears to generally make rather conservative estimates for removals, especially in forest management, where modelled harvest demand is driven with limited recognition of some boundary assumptions (for example, local governance or national commitments to ensure no depletion of removals) or economic considerations intrinsic to the model (higher price mostly results in higher biomass supply, irrespective of e.g. biodiversity policies). This may result in disproportional market-driven demand in certain Member States, and correspondingly lower removal potential.

Second, under the existing LULUCF Regulation, a Member State may make use of flexibility to compensate debits in managed forest land. Under certain conditions, Member States that find themselves at non-compliance with emissions accounted against the FRL, are entitled to benefit from a certain amount of the surplus of the other Member States. This flexibility mechanism can only enter into force in the case, *inter alia*, that the "no-debit" rule is fulfilled at EU level. Furthermore, Member States may engage in trade with another Member State. Both the flexibility and the trading routes can be used by Member States, since the EU level modelling projects a reasonable level of net removals above the EU targets of every option evaluated.

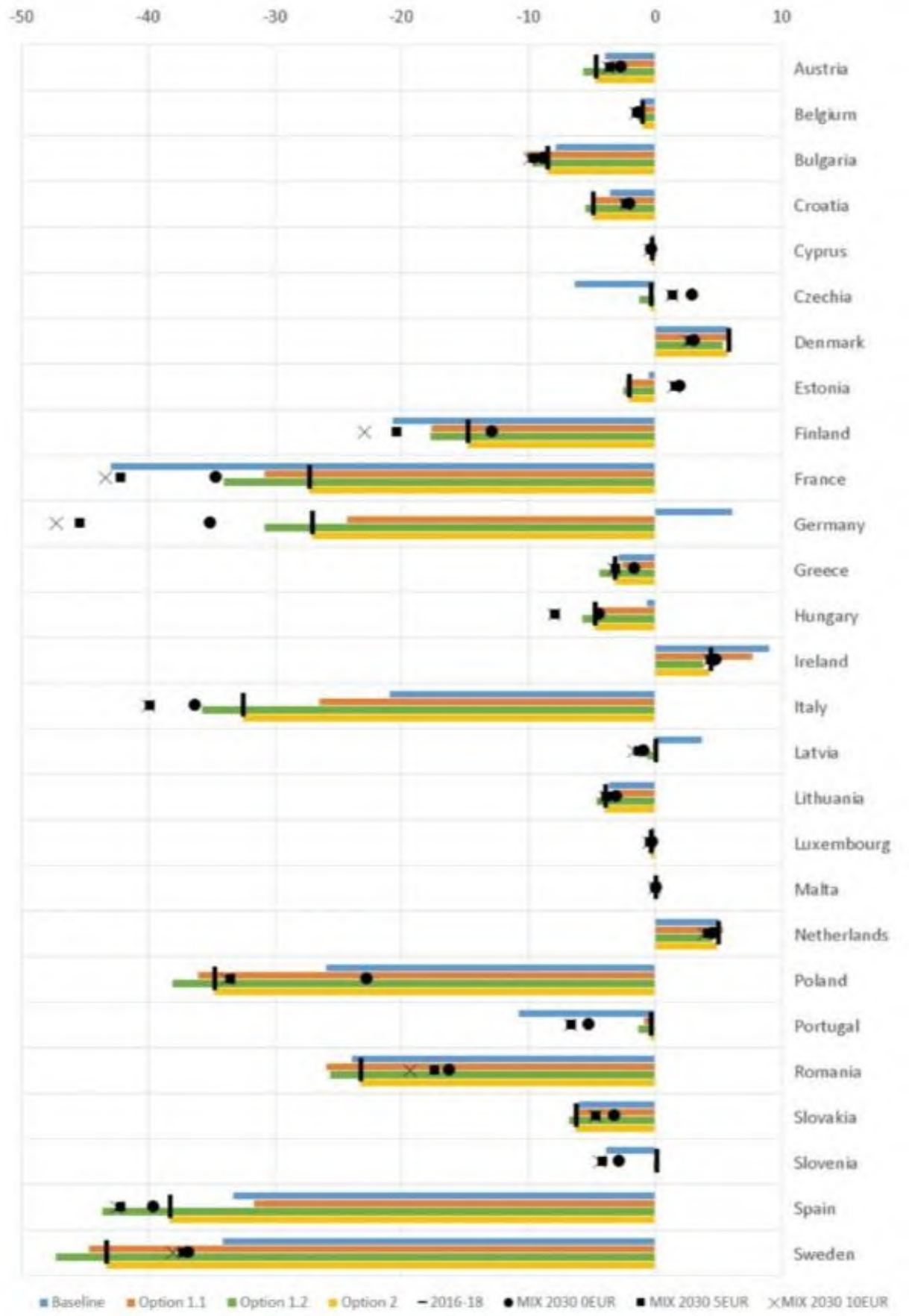


Figure 17 – LULUCF targets under the baseline, Option 1.1, Option 1.2 and Option 2. For comparison, the graph also shows the recent performance of the LULUCF sector (2016-2018) and the 2030 projections from the Commission's policy scenario (MIX 2030 with carbon price equal to 0, 5 or 10 EUR/tCO2eq). Unit of measure: MtCO2eq.

	Baseline	Opt. 1.1	Opt. 1.2	Option 2	2016 - 18	MIX 0	MIX 5	MIX 10
Austria	-4,0	-3,7	-5,6	-4,8	-4,8	-2,8	-3,6	-3,7
Belgium	-1,2	-1,3	-1,4	-1,0	-1,0	-1,5	-1,5	-1,5
Bulgaria	-7,9	-10,2	-9,7	-8,6	-8,6	-8,9	-9,7	-9,9
Croatia	-3,6	-5,0	-5,5	-4,9	-4,9	-2,1	-2,3	-2,4
Cyprus	-0,4	-0,3	-0,4	-0,3	-0,3	-0,4	-0,4	-0,4
Czechia	-6,4	-0,1	-1,2	-0,4	-0,4	2,8	1,4	1,4
Denmark	5,8	5,8	5,3	5,8	5,8	3,0	2,7	2,6
Estonia	-0,5	-2,4	-2,5	-2,1	-2,1	1,8	1,5	1,4
Finland	-20,8	-17,7	-17,8	-14,9	-14,9	-13,0	-20,4	-23,0
France	-43,0	-30,9	-34,0	-27,4	-27,4	-34,7	-42,3	-43,3
Germany	6,1	-24,3	-30,8	-27,1	-27,1	-35,2	-45,4	-47,2
Greece	-2,9	-2,6	-4,4	-3,2	-3,2	-1,7	-3,1	-3,3
Hungary	-0,7	-4,3	-5,7	-4,8	-4,8	-4,5	-8,0	-8,0
Ireland	9,1	7,7	3,7	4,4	4,4	4,7	4,3	4,3
Italy	-21,0	-26,5	-35,8	-32,6	-32,6	-36,4	-39,9	-40,0
Latvia	3,7	-0,3	-0,6	0,0	0,0	-1,0	-1,4	-1,6
Lithuania	-3,7	-3,2	-4,6	-4,0	-4,0	-3,2	-3,9	-3,9
Luxembourg	-0,4	-0,3	-0,4	-0,4	-0,4	-0,3	-0,5	-0,5
Malta	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Netherlands	5,1	5,3	4,5	5,0	5,0	4,5	4,1	3,9
Poland	-26,0	-36,1	-38,1	-34,8	-34,8	-22,8	-33,5	-33,8
Portugal	-10,8	-0,9	-1,4	-0,4	-0,4	-5,3	-6,7	-6,7
Romania	-24,0	-26,0	-25,7	-23,3	-23,3	-16,3	-17,5	-19,3
Slovakia	-6,1	-6,1	-6,8	-6,3	-6,3	-3,3	-4,7	-4,7
Slovenia	-3,9	0,1	-0,1	0,1	0,1	-2,9	-4,2	-4,3
Spain	-33,3	-31,7	-43,6	-38,3	-38,3	-39,7	-42,2	-42,5
Sweden	-34,1	-44,7	-47,3	-43,4	-43,4	-36,9	-37,3	-38,1
EU-27	**-224,9**	**-259,7**	**-310,0**	**-267,7**	**-267,7**	**-256,3**	**-314,6**	**-324,6**

Table 12 – LULUCF targets under the baseline, Option 1.1, Option 1.2 and Option 2. For comparison, the table also shows the recent performance of the LULUCF sector (2016-2018) and the 2030 projections from the Commission's policy scenario (MIX 2030) with carbon price equal to 0 or 5 EUR/tCO2eq. Unit of measure: MtCO2eq.

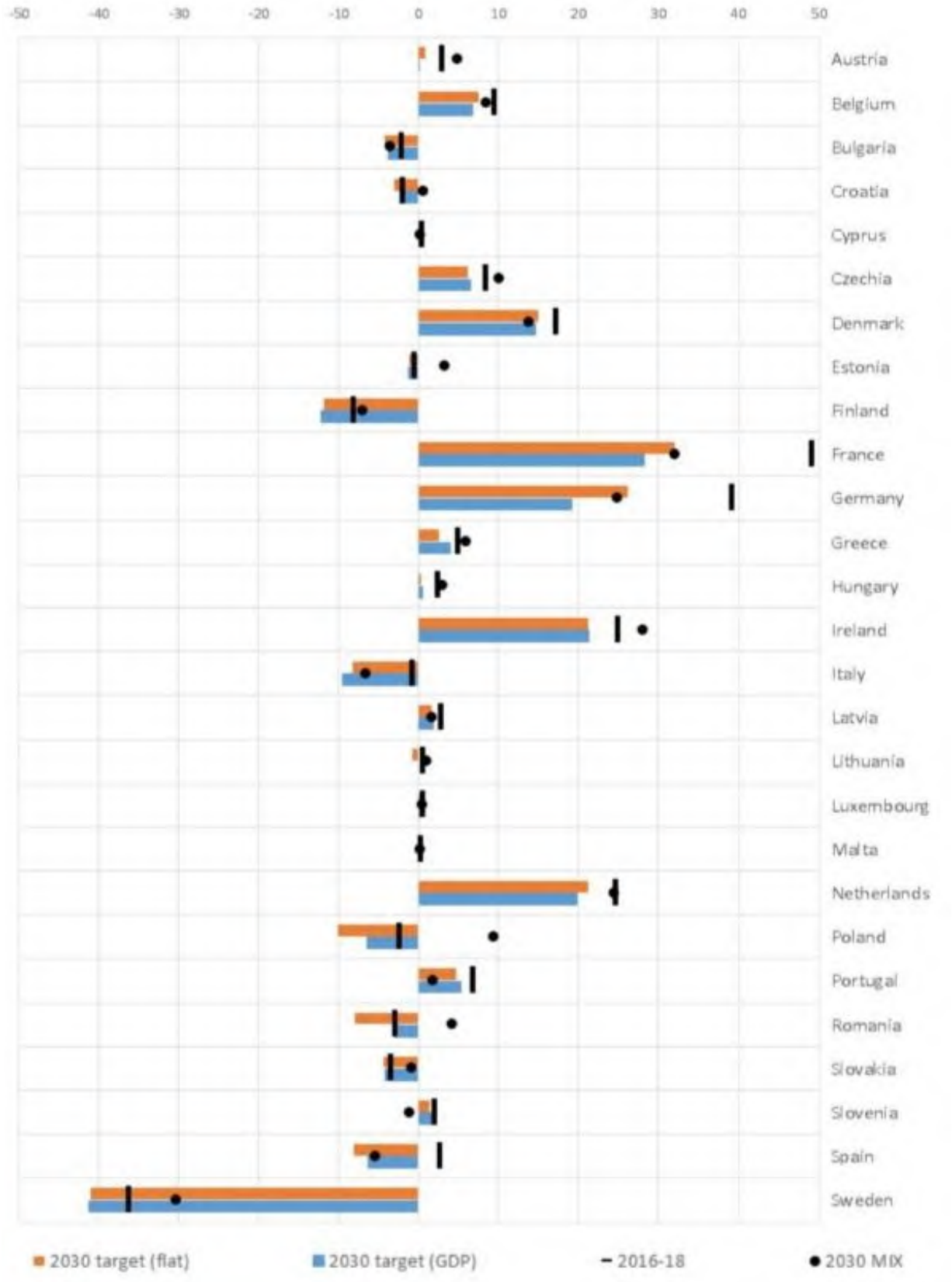


Figure 18 – Option 3 land targets in 2030 under two approaches for emission reductions in agriculture (flat reduction or GDP-based reduction). For comparison, the graph also shows the recent performance of the land sector (2016-2018) and the 2030 projections from the Commission's policy scenario (MIX 2030) with zero additional carbon price per tonne CO2. Unit of measure: MtCO2eq.

	2030 targets (flat)	2030 targets (GDP)	2016 to 2018	2030 MIX
Austria	0,9	0,2	2,8	4,8
Belgium	7,5	6,8	9,2	8,3
Bulgaria	-4,3	-3,8	-2,3	-3,6
Croatia	-3,1	-2,4	-2,2	0,5
Cyprus	0,1	0,1	0,2	0,1
Czechia	6,2	6,6	8,2	9,9
Denmark	15,0	14,7	17,0	13,6
Estonia	-1,3	-1,3	-0,7	3,2
Finland	-11,9	-12,3	-8,4	-7,1
France	32,0	28,3	49,0	31,9
Germany	26,2	19,2	39,0	24,7
Greece	2,6	4,0	4,8	5,9
Hungary	0,3	0,6	2,2	2,9
Ireland	21,3	21,4	24,8	27,9
Italy	-8,3	-9,5	-0,9	-6,8
Latvia	1,6	1,9	2,6	1,5
Lithuania	-0,9	-0,1	0,3	0,9
Luxembourg	0,2	0,1	0,3	0,4
Malta	0,1	0,1	0,1	0,1
Netherlands	21,3	19,8	24,4	24,3
Poland	-10,2	-6,5	-2,6	9,3
Portugal	4,7	5,3	6,6	1,6
Romania	-8,1	-3,1	-3,1	4,0
Slovakia	-4,5	-4,2	-3,6	-1,0
Slovenia	1,4	1,6	1,9	-1,2
Spain	-8,1	-6,4	2,5	-5,5
Sweden	-41,1	-41,3	-36,5	-30,4
EU-27	**39,9**	**39,9**	**135,7**	**120,5**

Table 13 - Option 3 land targets in 2030 under two approaches for emission reductions in agriculture (flat reduction or GDP-based reduction). For comparison, the table also shows the recent performance of the land sector (2016-2018) and the 2030 projections from the Commission's policy scenario (MIX 2030) with zero additional carbon price per tonne CO2. Unit of measure: MtCO2eq.

10.6. Win-win solutions for climate, biodiversity, and bioeconomy

This annex provides more details on the synergies between enhancing carbon removals in the LULUCF sector and other land-related policy objectives, in particular:

- biodiversity and climate change adaptation (section 10.6.1),
- a sustainable bioeconomy (section 10.6.2),
- a sustainable agricultural sector (section 10.6.3), and
- a sustainable food system (section 10.6.4)

For each section, the text clarifies why such synergies are important, describes the EU policy framework to enhance them, and elaborates on the most relevant win-win actions.

10.6.1. Biodiversity and climate change adaptation

- **Why are these synergies important?**

Climate change and biodiversity loss are interdependent and mutually reinforcing emergencies and closely interconnected threats, and therefore they need to be addressed together: climate change is one of the main drivers of biodiversity loss, while biodiversity loss and ecosystem degradation have implications for climate change through feedbacks, and for the capacities and limits of nature-based adaptation and mitigation efforts.

Ambitious global mitigation measures are necessary to avoid the most dangerous impacts of climate change, because there are many limits and barriers to adaptation. At the same time, climate change is already occurring, and it will continue for many decades to come (or even centuries, in the case of sea level rise), even under the most stringent mitigation policies. Short term adaptation solutions can risk being antagonistic to climate change – for example desalinating water using energy intensive processes. However, strong synergies can be found by combining actions, such as ecosystem-based adaptation which can also contribute to climate change mitigation by reducing emissions caused by ecosystem degradation and/or by enhancing carbon stocks[138].

Box 6 – Climate change threats to the land sector

Forest growth is generally projected to increase in northern Europe and to decrease in southern Europe, but with substantial regional variation. As acknowledged in the new EU Adaptation Strategy[139], the increasing frequency and severity of climate and weather extremes has caused a surge in the number of, and damages from, disasters over the last two decades, particularly on the land sector. These extremes – which result in high level of localised impacts – include forest fires, heatwaves, droughts, hurricanes, and pest outbreaks. Slow onset processes, such as desertification, loss of biodiversity, land and ecosystem degradation, ocean acidification or sea level rise are equally destructive over the long term. These combined impacts considerably affect

[138] European Environment Agency. (2019). The European environment state and outlook 2020: Knowledge for transition to a sustainable Europe. Retrieved from https://doi.org/10.2800/96749

[139] COM (2021) 82 final

forest structure and the functioning of forest ecosystems and their services, a finding that also applies to other sensitive ecosystems, including wetlands[140]. Climate change may therefore also locally impact ecosystems, reducing land carbon stocks and undermining their ecosystem function of carbon removal, thus working against mitigation objectives.

Climate change has already negatively affected the agricultural sector in many locations across Europe, and this trend will continue in the future. Future climate change might in contrast have some positive effects on the sector in some locations due to longer, more favourable growing seasons and more suitable cropping conditions. However, the number of extreme climate events that will negatively affect agriculture at varying locations in Europe is projected to increase, affecting the price, quantity and quality of products, trade patterns and therefore agricultural incomes in rural areas where the sector is dominant.

Other complications and dangers arise from 'tipping points' or thresholds such as temperature increase[141] or massive forest dieback[142]. In the longer run, reduced CO2 uptake under average growing conditions or falling soil moisture levels[143] could also be a major risk. Feedback loops resulting in continued global warming could occur beyond these thresholds even if anthropogenic emissions were reduced to almost zero. Several of these tipping points would occur at temperature increases between 2 and 3°C[144]. The uncertainty as to whether under future climate change the current EU forest sink will be maintained or turn it into a carbon source is large[145], although it is unlikely these thresholds will be breached in the near term. The longer that mitigation efforts are delayed, however, the greater the inevitable impact of climate change will be and the more effort will needed to scale up and enhance land carbon sinks in response.

- **What is the EU policy framework?**

Following the large scientific evidence highlighting the importance of linking biodiversity protection and restoration, carbon sequestration and adaptation to climate change[146], the Biodiversity Strategy for 2030[147] and the new Adaptation Strategy[148] put a

[140] Salimi, S., Almuktar, S. A. A. A. N., & Scholz, M. (2021). Impact of climate change on wetland ecosystems: A critical review of experimental wetlands. Journal of Environmental Management, 286, 112160. https://doi.org/10.1016/j.jenvman.2021.112160

[141] Duffy, K. A., Schwalm, C. R., Arcus, V. L., Koch, G. W., Liang, L. L., & Schipper, L. A. (2021). How close are we to the temperature tipping point of the terrestrial biosphere? Science Advances, 7(3), eaay1052. https://doi.org/10.1126/sciadv.aay1052

[142] Neumann, M., Mues, V., Moreno, A., Hasenauer, H., & Seidl, R. (2017). Climate variability drives recent tree mortality in Europe. Global Change Biology, 23(11), 4788–4797. https://doi.org/10.1111/gcb.13724

[143] Green, J. K., Seneviratne, S. I., Berg, A. M., Findell, K. L., Hagemann, S., Lawrence, D. M., & Gentine, P. (2019). Large influence of soil moisture on long-term terrestrial carbon uptake. Nature, 565(7740), 476–479. https://doi.org/10.1038/s41586-018-0848-x

[144] Steffen, W., et al., 2018, 'Trajectories of the Earth system in the Anthropocene', Proceedings of the National Academy of Sciences 115(33), pp. 8252-8259 https://doi.org/10.1073/pnas.1810141115.

[145] Valade, A., Bellassen, V., Magand, C., & Luyssaert, S. (2017). Sustaining the sequestration efficiency of the European forest sector. Forest Ecology and Management, 405(Supplement C), 44–55. https://doi.org/10.1016/j.foreco.2017.09.009

[146] Including the following: Shukla, P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H. O., Roberts, D. C., … Van Diemen, R. (2019). IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. http://www.ipcc.ch/srccl; IPBES thematic assessment on land degradation and restoration (https://ipbes.net/assessment-reports/ldr); Strassburg, et al. (2020) Global

strong emphasis on carbon-rich ecosystems, areas most vulnerable to climate change, and the need to enhance resilience.

Both strategies highlight the implementation of nature-based solutions on a larger scale as a way to increase climate resilience and contribute to multiple Green Deal objectives, including mitigation and carbon sequestration. For example, protecting and restoring carbon-rich ecosystems such as forest, grasslands, wetlands and peatlands; promoting sustainable management of land, including agroecology, agroforestry and sustainable forest management; and improving soil health, will help to mitigate and adapt to climate change while reversing biodiversity loss in a cost-effective way.

The **Biodiversity Strategy** contains, among other provisions, nature protection commitments (protect 30% of EU land and strictly protect a third of these areas) and an EU Nature Restoration Plan, whose main element is an EU legally binding instrument for nature restoration to be proposed in 2021. Other actions target agricultural area (10% under high-diversity landscape features; 25% under organic farming management, and a significant increase of the uptake of agro-ecological practices, 50% reduction of use and risk of pesticides, reduction of pollution from fertilisers by 50% which will lead to a reduction of 20% their use); the planting of at least three billion additional trees in the EU by 2030, in full respect of ecological principles, development of close-to-nature forest management, and the protection of all primary and old growth forest; and significant progress in the remediation of contaminated soil sites.

The restoration priority makes a significant contribution to climate action and this implies to identify ecosystems which have the highest potential for both biodiversity, climate adaptation, and carbon sequestration and storage. At the same time, successful ecosystem restoration will also require information on climate risks and vulnerabilities of ecosystems, and on projected shifts and vegetation zones in order to 'restore forward' to future in bioclimatic conditions. Because of this climate prism, the EU Nature Restoration Plan needs to be articulated in coherence with the review of the LULUCF regulation and with the implementation of the new EU adaptation strategy.

The 2030 goals of this legally binding instrument are to restore significant areas of degraded and carbon-rich ecosystems; to prevent any deterioration in conservation trends and status of habitats and species; to ensure that at least 30% of them reach favourable conservation status or at least show a positive trend; and to increase the EU's resilience, and contribute to climate change mitigation and adaptation and disaster risk reduction as a key nature-based solution. Target would be legally-binding at EU level, based on pledges made by Member States. For these pledges, there would be a pool of targets, some in expressed in hectares, other in biodiversity metrics (e.g. status of conservation, land degradation neutrality, river continuity or indicators related to pressures and conditions of ecosystems and their services).

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priority areas for ecosystem restoration. *Nature* 586, 724–729. https://doi.org/10.1038/s41586-020-2784-9. Goldstein, A., et al. (2020). Protecting irrecoverable carbon in Earth's ecosystems. *Nature Climate Change* 10, 287–295. https://doi.org/10.1038/s41558-020-0738-8. Stanturf, J. A., et al. (2015) *Forest landscape restoration as a key component of climate change mitigation and adaptation*. Vienna: International Union of Forest Research Organizations (IUFRO). Bonn, A., et al. (2016) *Peatland restoration and ecosystem services: science, policy and practice*. Cambridge University Press. Cole, A. J., et al. (2019) "Grassland biodiversity restoration increases resistance of carbon fluxes to drought." *Journal of Applied Ecology* 56.7 (2019): 1806-1816. https://doi.org/10.1111/1365-2664.13402

[147] COM/2020/380 final, https://europa.eu/!PJ43Qg

[148] COM/2021/82 final, https://europa.eu/!pq73pH

A number of these targets address climate mitigation, adaptation as well as disaster risk reduction, and should therefore be linked with climate legislation including the LULUCF Regulation. In this prospect, there are at least two possibilities to reflect the restoration objectives:

1. Mapping and monitoring provisions could be introduced in order to require Member States to have geographically explicit information to identify priority areas to be or being restored. This information could reinforce field and remote sensing monitoring of biodiversity and ecosystem services and would contribute to the Green Deal data space foreseen in the European Data Strategy. As part of a general improvement of monitoring, reporting and verification, the work could also focus on refining databases of activity and emissions factors to improve greenhouse gas inventories; and on how to embed indicators of pressures and condition for biodiversity and ecosystem services.
2. Reporting provisions could consist of either sub-categories of additional land dedicated to the priority areas at stake for restoration - this would allow annual monitoring of emissions and removals from these areas and include this information in the national inventory reports - or specific additional sections in any reporting scheduled between Member States and the Commission (sections in climate reporting and in biodiversity reporting could be dedicated to synergies between climate action and biodiversity action on land, for example).

The precise articulation between biodiversity protection and restoration and climate action could rely on existing and upcoming reporting, mapping, modelling and research works, including:

- The Mapping and Assessment of Ecosystems and their Services (MAES) whose final report [149], just published, presents an analysis of the pressures and condition of terrestrial, freshwater and marine ecosystems using a single, comparable methodology based on European data on trends of pressures and condition relative to the policy baseline 2010.
- EU Natural Capital Accounting (NCA) [150] and proposed EU ecosystem accounting legislation, based on the System of Environmental-Economic Accounting (SEEA)[151], which is a UN framework that integrates economic and environmental data to provide a more comprehensive and multipurpose view of the interrelationships between the economy and the environment and the stocks and changes in stocks of environmental assets.
- The newly created Knowledge Centre for Biodiversity[152] that needs to organise, store and provide easy access to a wide variety of information sources that produces regular updates on pressures, biodiversity, ecosystem condition and ecosystem services.
- The upcoming Biodiversity Partnership under Horizon Europe which will provide an overarching platform connecting national, local and European Research & Innovation programs
- The Taxonomy Regulation and its delegated acts, which would allow for connecting green investment from stakeholder's initiatives (e.g. carbon farming

[149] Maes, J., et al. (2020), Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment, EUR 30161 EN, Publications Office of the European Union, Ispra, doi:10.2760/757183, JRC120383

[150] https://ec.europa.eu/environment/nature/capital_accounting/index_en.htm

[151] System of Environmental-Economic Accounting (SEEA) https://seea.un.org/

[152] https://ec.europa.eu/knowledge4policy/biodiversity_en

removal certificates, wetland and peatland restoration activities) to restoration for biodiversity and climate.

- The new EU Adaptation Strategy, which announces action to propose nature-based solutions for carbon removals and to continue to incentivize and assist Member States to rollout nature-based solutions through assessments, guidance, capacity building and EU funding.
- Resilience and Restoration Plans, the revision of the civil protection mechanism (EUCPM) and setting up EU disaster resilience goals to stimulate investment in building resilience and preventing natural disasters and the JRC/SG Resilience Dashboard[153]

Highlighting biodiversity issues in the review of the LULUCF Regulation would constitute a concrete signal for Member States to seize the opportunity for synergies between EU climate and biodiversity policies. These synergies can be reflected in land mapping, field monitoring, remote sensing and monitoring, reporting and verification systems. This would benefit to other policies, including agriculture and would improve policy coherence as committed in the European Green Deal.

The **new EU Adaptation Strategy** paves the way for a higher ambition on climate resilience: in 2050, the EU will be a climate-resilient society, fully adapted to the unavoidable impacts of climate change. For this reason, climate change adaptation is an integral part of the European Green Deal and its external dimension, and firmly anchored in the European Climate Law. The Adaptation Strategy seeks to step up action across the economy and society to bring us towards the 2050 vision for climate resilience, while increasing synergies with other policy areas such as biodiversity. The implementation will be conducted in close concert with the other elements of the European Green Deal.

The new EU adaptation strategy and the new proposed common agricultural policy for 2021- 2027, which has adaptation as a clear objective, will continue to enable adaptation action on agriculture. Solutions are urgently needed to help farmers and land managers tackle climate risks. Member States have defined the agriculture sector as a priority in their national adaptation strategies or national adaptation plans. Measures at national or regional levels include awareness raising, practical measures to decrease the impacts and risks of extreme weather events and implementing infrastructure for irrigation and flood protection. There are opportunities for implementing a wide variety of existing and proven measures at farm level that aim to improve the management of soils and water, which can provide benefits for adaptation, mitigation, the environment and the economy. The objectives of these potential measures are therefore to sustain resilient production, conserve soil and water resources, reduce pests, droughts and other weather and climate threats, as well as to reduce emissions or sequester carbon[154].

- **What are the win-win actions?**

Meeting higher carbon removal targets and higher resilience of land while addressing biodiversity challenges will require strong action to change land management practices, in combination with adequate spatial planning, including the expansion of protected areas, the restoration of degraded areas and the sustainable management of land and forests, and targeting a balance between CO2 removals and higher carbon stocks in all carbon pools.

[153] https://ec.europa.eu/info/strategy/priorities-2019-2024/new-push-european-democracy/strategic-foresight/2020-strategic-foresight-report_en

[154] European Environment Agency. (2019). Climate change adaptation in the agriculture sector in Europe. Retrieved from https://doi.org/10.2800/86966

Synergies and trade-offs between mitigation, adaptation and biodiversity have led strong research efforts and policy interest to put forward nature-based solutions, with a particular focus on land. **Nature-based solutions** are an umbrella concept standardised by the International Union for the Conservation of Nature (IUCN)[155]. As highlighted in the 2019 IPCC Special Report on Climate Change and Land (SRCCL)[156] and the 2019 IPBES Global assessment report on biodiversity and ecosystem services[157], nature-based solutions have a large potential to contribute to the climate change mitigation efforts needed to meet the long-term goals of the Paris Agreement, as well as reversing biodiversity loss. Land-use actions are indispensable, in addition to strong actions to reduce greenhouse gas emissions from fossil fuel use and other industrial and agricultural activities.

A wide range of land-based mitigation options, such as protection and restoring natural ecosystems, sustainable land management practices (including agroecology), agroforestry, crop rotation with leguminous crops, fire management, soil management, sustainable forest management, reduced erosion and increasing soil organic matter, do not increase competition for land. Such options, based on a smart use of natural ecological processes and improved technologies, reducing the use of synthetic pesticides and fertilisers and promoting integrated pest management, such as biocontrol, contribute to improving the quality, diversity and resilience of ecosystems, all of which have substantial benefits for biodiversity.

In contrast, if applied at large scale, some land-based mitigation measures such as afforestation, reforestation and intensive bioenergy production, including monocultures replacing natural forests and subsistence farmlands, could increase the demand for land conversion, with adverse side-effects for adaptation and biodiversity. Such measures could also threaten food and water security as well as local livelihoods, including by intensifying social conflict. The choice of species and management practices, the implementation of these measures at appropriate scales and on relevant locations, and their integration into sustainable managed landscapes can attenuate these adverse impacts, and even deliver co-benefits when established on degraded lands or as part of ecological connectivity. A recent JRC report[158] on the use of woody biomass for energy production in the EU highlights synergies and trade-offs between bioenergy production, climate change mitigation and biodiversity (see section 10.6.2 below for more details).

The SRCCL also highlights the mitigation and adaptation potential of various options throughout the food system, from production to consumption, including food loss and waste. These options include sustainable intensification, in a land sparing logic, or the expansion of extensive food systems, in a land sharing logic. In both cases, dietary

[155] IUCN. (2020). IUCN Global Standard for Nature-based Solutions: First edition. https://doi.org/10.2305/IUCN.CH.2020.08.en

[156] Shukla, P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H. O., Roberts, D. C., … Van Diemen, R. (2019). IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. http://www.ipcc.ch/srccl

[157] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. https://ipbes.net/global-assessment

[158] Camia et al. (2021), "The use of woody biomass for energy production in the EU" (https://europa.eu/!Bn46df)

changes (see 10.6.4) favouring plant-based food[159] could improve nutrition and food safety, while also freeing large amounts of land that can be devoted to other uses, more in favour of mitigation, adaptation and biodiversity.

These results at the global level also apply at the European level, where a growing body of evidence underlines the potential for mitigation, adaptation and biodiversity of land-based options, following in particular the impulse of the European Commission[160]. A recent analysis of EU-funded projects of nature-based solutions for climate mitigation identifies opportunity to scale-up such options for land and forest management, wetland restoration and urban greening[161]. To be robust and resilient, the design of nature-based solutions has to address jointly the challenges of climate change and biodiversity loss while also considering other sustainable goals[162].

Regarding forests, the apparent trade-offs between maximising carbon stocks and maximising carbon removals are at the origin of ongoing debates about optimum management strategies to achieve climate change mitigation in forests. Some studies stress the need to increase forest carbon sequestration, e.g. up to 1200 MtCO2e/yr[163], highlighting not just above ground biomass carbon stocks but also the increased carbon stock in soils, improved resilience of natural forests to climatic hazards and high biodiversity benefits. Other studies[164] highlight the saturation of the removal capacity, the issues of adaptation in the face of increased risks of natural disturbance, and bio-economy issues, and promote other models, based on a balanced combination of increased carbon storage in forests and wood products, adaptive forest management and wood-based substitution. Such improvements in EU forest management could double the forest management climate mitigation potential by 2050[165], up to -440 MtCO2e/yr. Although forest restoration aims to achieve multiple benefits other than climate mitigation[166], recent analysis suggests that under current climate conditions, restoring

[159] Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., … Murray, C. J. L. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet, 393(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

[160] Faivre, N., Fritz, M., Freitas, T., de Boissezon, B., & Vandewoestijne, S. (2017). Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges. Environmental Research, 159, 509–518. https://doi.org/10.1016/j.envres.2017.08.032

[161] Wild, T., Freitas, T., Vandewoestijne, S., Bulkeley, H., Naumann, S., Vojinovic, Z., … Whiteoak, K. (2020). Nature-based solutions for climate mitigation: Analysis of EU-funded projects. https://doi.org/10.2777/236007

[162] Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., … Turner, B. (2021). Getting the message right on nature-based solutions to climate change. Global Change Biology, n/a(n/a). https://doi.org/10.1111/gcb.15513

[163] Roe, S., Streck, C., Obersteiner, M., Frank, S., Griscom, B., Drouet, L., … Lawrence, D. (2019). Contribution of the land sector to a 1.5 °C world. Nature Climate Change, 9(11), 817–828. https://doi.org/10.1038/s41558-019-0591-9

Based on Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., … Fargione, J. (2017). Natural climate solutions. Proceedings of the National Academy of Sciences, 201710465. https://doi.org/10.1073/pnas.1710465114

[164] Verkerk, P. J., Costanza, R., Hetemäki, L., Kubiszewski, I., Leskinen, P., Nabuurs, G. J., … Palahí, M. (2020). Climate-Smart Forestry: The missing link. Forest Policy and Economics, 115, 102164. https://doi.org/10.1016/j.forpol.2020.102164

[165] Nabuurs, G.-J., Delacote, P., Ellison, D., Hanewinkel, M., Hetemäki, L., & Lindner, M. (2017). By 2050 the Mitigation Effects of EU Forests Could Nearly Double through Climate Smart Forestry. Forests, 8(12), 484. https://doi.org/10.3390/f8120484

[166] Borrelli, P., Panagos, P., & Wuepper, D. (2020). Positive cascading effect of restoring forests. International Soil and Water Conservation Research, 8(1), 102. https://doi.org/10.1016/j.iswcr.2019.12.002

global tree cover to 900 Mha could store some 200 Gt of carbon at full maturity[167]. Concerns have nevertheless also been raised that such potential relies on plantation forests, generating monocultures with little biodiversity value and degradation of good conservation status of habitats and species, while evidence that such systems can contribute to the long-term storage of carbon is still limited[168].

Regarding peatlands, a large mitigation potential lies in stopping new drainage and rewetting the lands that have been artificially drained, and which are estimated to emit around 220 MtCO2e/yr in the EU[169]. Rewetting peatlands can potentially protect existing and remaining carbon stocks in organic soils, sequester carbon as the degraded land recovers, and help to improve water quality, protect against flooding, provide habitats for biodiversity restoration, and can still be used for production of biomass (or 'paludiculture'),

A large body of research has also explored options for improving the sustainability of European agriculture, highlighting three-fold solutions in terms of climate action, biodiversity and food security (see also section 10.6.3 below). Some of this research, including those based on EcAMPA 3 and CAPRI modelling[170], focuses on a sustainable intensification of agriculture production, in a land sparing logic. On the crop sector, various options can reduce the use of fertilisers, through legume cultivation or precision agriculture. By reducing the consumption and the loss of fertilisers, such measures can contribute to reduce both GHG emissions and nitrogen pollution, with significant benefits for biodiversity, particularly in soil and aquatic environments. Other measures such as the use of cover crops, the fallowing of organic soils, are practices increasing carbon sequestration while helping reducing soil erosion, and delivering biodiversity benefits. Other works, such as the Ten Years for Agroecology scenario[171], are based on a more extensive food system, in a land sharing logic, relying on the generalisation of organic farming, the extension of agroecological infrastructures, including agroforestry and high diversity landscape features[172], and the adoption of healthy diet. In terms of biodiversity, these options can contribute significantly to the recovery of biodiversity through the redeployment of food webs at all scales, from soil to landscape. Continuous soil cover through the development of intermediate crops can also ensure healthier soils and water body status to be achieved simultaneously. The diversification of plant systems, the reconnection of crop and livestock systems and the improvement of soil health are also key aspects to increase the adaptation capacity of the agricultural sector to

[167] Bastin, J.-F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., … Crowther, T. W. (2019). The global tree restoration potential. Science, 365(6448), 76–79. https://doi.org/10.1126/science.aax0848

[168] Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

[169] Tanneberger, F., Appulo, L., Ewert, S., Lakner, S., Ó Brolcháin, N., Peters, J., & Wichtmann, W. (2021). The Power of Nature-Based Solutions: How Peatlands Can Help Us to Achieve Key EU Sustainability Objectives. Advanced Sustainable Systems, 5(1), 2000146. https://doi.org/10.1002/adsu.202000146

[170] Pérez Domínguez I., Fellmann T., Witzke P., Weiss F., Hristov J., Himics M., Barreiro-Hurle J., Gómez Barbero M., Leip A., Economic assessment of GHG mitigation policy options for EU agriculture: A closer look at mitigation options and regional mitigation costs (EcAMPA 3), EUR 30164 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-17854-5, doi:10.2760/4668, JRC120355

[171] Poux, X., & Aubert, P.-M. (2018). Ten Years for Agroecology in Europe: A multifunctional agriculture for healthy eating. Findings from the Ten Years For Agroecology (TYFA) modelling exercise. Paris, Iddri, 73, 789–815. Retrieved from https://www.iddri.org/en/publications-and-events/study/agroecological-europe-2050-multifunctional-agriculture-healthy-eating

[172] These include, inter alia, buffer strips, rotational or non-rotational fallow land, hedges, non-productive trees, terrace walls, and ponds

climate change impacts: increased water stress, emergence of new parasites/diseases, irregular rainfall.

10.6.2. A sustainable bioeconomy

- **Why are these synergies important?**

The bioeconomy sector is key for stepping up Europe's 2030 climate ambition[173]. In particular, the land sector will have to provide food, feed and materials in a climate-neutral economy, increasing the use of sustainably produced biomass and the use of durable harvested wood products. The bioeconomy is one of the seven main strategic building blocks to achieve the EU strategic long-term vision, as described in the "Clean Planet for all" communication[174]. This vision highlights the role of sustainable biomass in a net-zero greenhouse gas emissions economy, as provider of heat, of biofuels and biogas, of bio-based products to substitute for carbon intensive materials, particularly in the building sector and in biochemistry. Regarding the sources of biomass, the vision takes note of the limited potential of EU forests to increase biomass production in a sustainable way and the risks associated to biomass imports, in particular raising emissions due to indirect land use changes. Instead, the increased biomass production need to come from a combination of sources from agriculture, animal farming, aquaculture and forestry production, while ensuring the maintenance and the enhancement of natural sink. The main source of increased biomass would be agriculture, involving agroforestry techniques, the cultivation of abandoned land, and the conversion of land currently used for food-based bio-fuels. The vision highlights the issue of land availability, and the preservation of natural resources as critical factors in ensuring the efficiency and the sustainability of the biomass-based transition. In this perspective, the biomass extracted from aquatic and marine resources is considered as a way to relive the pressure on agricultural lands.

Box 7 - Statistics on EU biomass

Using the latest available data[175] (2017 for agriculture, 2015 for forestry, 2011 for fisheries), the total **supply** of biomass in the EU27+UK amounted to **approximately 1218** Mtdm (tonnes of dry matter), mostly originating in the land-based sectors. **1141 Mtdm were produced domestically**, 76 Mtdm are net imports and 32 Mtdm are net exports of biomass.

The major **sources** of biomass are: (i) **agricultural biomass** (791 Mtdm, or 69% of total biomass production; net imports: 50 Mtdm; net exports: 22 Mtdm); (ii) **woody biomass** (348 Mtdm, or 30% of total biomass production; net imports: 24 Mtdm; net exports 9 Mtdm), including primary (240 Mtdm, 69%) and secondary (91 tdm, 26%) sources of woody biomass, and post-consumer wood (17 tdm, 5%); (iii) **seafood** from capture fisheries and aquaculture (1.6 Mtdm or 0.1% of total biomass production; net imports of fish and seafood products were approximately 1.7 Mtdm).

The total biomass **use** in the EU27+UK **(including exports)** amounted to **1218** Mtdm, of which feed and food was the most important category (**588** Mtdm, **48**% of biomass supply), accounting for **69**% of the total agricultural biomass supply. Biomaterials

[173] COM(2020)562 final, https://europa.eu/!uR93tq

[174] COM/2018/773 final, https://europa.eu/!VU93kN.

[175] Gurría, P., et al., (2020) Biomass flows in the European Union: The EU Biomass Flows tool, version 2020, EUR 30454 EN, Publications Office of the European Union, Luxembourg, , doi:10.2760/14342, JRC122379 https://datam.jrc.ec.europa.eu/datam/mashup/BIOMASS_FLOWS/index.html.

(mostly **solid** wood products, followed by wood pulp) were the second most important category (220 Mtdm, 18% of biomass supply) and accounted for around 60 % of forest biomass. A significant amount of biomass is either lost or its uses are unknown (**256** Mtdm, **21**% of biomass supply).

When it comes in particular to assessing the role of the forest sector in mitigating climate change, it is important to take a "system-perspective" that balances two directly opposed mitigation options: increasing carbon stocks ('net removals') in forest land vs. using wood for substituting other materials or energy sources. A recent brief by the European Commission's Knowledge Centre for Bioeconomy[176] provides some elements to qualify the balance between carbon storage in forest land and material substitution. The brief recognises that decreasing harvests appears as a simple and direct approach to increase the net forest sink in the short-medium term (2030-2050). However, this strategy would have negative socio-economic impacts in the forest sector, would likely lead to a net forest sink saturation in the medium-long term. Whether or not forest harvest and use of biomass is contributing to net reductions of atmospheric carbon depends on carbon losses during and following harvest, rates of forest re-growth, and the use of the harvested wood and the carbon retention in long-lasting or short-lived products as well as the emission reductions achieved through the substitution of emission-intensive products with wood products. Studies that ignore changes in forest carbon stocks, ignore changes in wood product pools or ignore changes in emissions from substitution benefits will arrive at diverging conclusions. The apparent trade-offs between maximising forest carbon stocks and maximising ecosystem carbon sinks are at the origin of ongoing debates about optimum management strategies to achieve negative emissions[177].

Increasing harvest would make more wood available for carbon storage in Harvested Wood Products (HWP) and for material substitution in general. However, in the short to medium term, the potential additional benefits from HWP and material substitution will unlikely fully compensate for the immediate reduction of the net forest sink associated with the increased harvest.

Increasing the forest net annual increment – or net annual forest growth – through forest management and new forest area, is therefore crucial to align the forest sector contribution with the EU goal of climate neutrality by 2050. Economic incentives to trigger this enhancement – through better forest management and efficient use of biomass resources, especially from forests – will be a key driver. This extra increment can be used partly to reverse the current trend and projected decline in net forest sink, and partly to increase HWP and material substitution. A shift to wood products with higher service life and substitution benefits may also play an important role also in function of the circular economy.

- **What is the EU policy framework?**

LULUCF Regulation

Contrary to the past legislative framework under the Kyoto Protocol, woody bioenergy is not automatically assumed "carbon neutral" within the EU climate and energy policy

[176] Grassi, G., et al., (ibid) European Commission, 2021, JRC124374.

[177] Shukla, P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H. O., Roberts, D. C., … Van Diemen, R. (2019). IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. http://www.ipcc.ch/srccl. Chapter 4. Pages 4-65-67.

framework for the period after 2020[178]. Through the LULUCF Regulation, the LULUCF sector now accounts the emissions (or removals) due to changes in forest carbon stocks and removals against Member State accounts and targets, and consequently biomass emissions are not accounted again in the energy sector under the recast Renewable Energy Directive.

Recast Renewable Energy Directive (RED II) [179]

The 2018 Renewable Energy Directive (RED II) extends the scope of the EU sustainability criteria by covering not only biofuels but also biomass and biogas in heat and power.

In addition, RED II includes a new set of risk-based sustainability criteria for forest biomass, in order to ensure that forest biomass is sourced from sustainably management forests and that impacts on forest carbon stock are tracked. More specifically, operators need to demonstrate that the forest biomass used is subject to national or sub-national legislation ensuring the following: i) legal logging; ii) forest regeneration, iii) protection of sensitive areas, iv) minimization of harvesting impacts on soil quality and biodiversity; and v) maintenance or strengthening of long-term forest productivity. If this cannot be shown, economic operators need to provide additional sustainability evidence through management systems at the forest sourcing area level.

Furthermore, the new sustainability criteria require that forest biomass is sourced only from countries that (i) are a Party to the Paris Agreement, and (ii) have Nationally Determined Contributions (NDCs) that account any changes in carbon stock associated with biomass harvest towards the national GHG reduction targets, or have national laws ensuring that the reported LULUCF-sector emissions do not exceed removals. If these conditions are not met, economic operators need to provide additional evidence, through management systems, that forest carbon stocks and sinks are maintained or strengthened.

RED II also contains a set of no-go areas for the sourcing of agriculture biomass. More specifically, to be considered as renewable, agriculture biomass shall not be made from raw material obtained from land with has, in or after January 2008, i) a status of land with high biodiversity value (primary forest or human-undisturbed forests, highly biodiverse forest, nationally and internationally protected areas, highly biodiverse grassland), or ii) a status of land with high-carbon stock (wetlands, continuously forested areas, some other forests), or iii) peatland (except without drainage). RED II includes also a new requirement to minimize soil quality and soil carbon impacts that could be associated to the harvesting of agricultural waste and residues for advanced biofuel production. Besides, the directive calls for Member States to take into consideration the biomass cascading principle and requires large-scale bio-electricity generation to meet minimum efficiency standards or use of highly efficient combined heat and power technology.

RED II is also being reviewed in the context of the Fit for 55% package, and synergies between the various LULUCF approaches and the RED II bioenergy sustainability options can be identified. Indeed, approaches for strengthening the sustainability criteria may be complemented by the biomass emissions reporting and accounting under the

[178] This is explained in details in the JRC report on the use of woody biomass for energy purposes in the EU mentioned above.

[179] Directive 2018/2001, https://europa.eu/!Jk96MM

LULUCF regulation, which are needed to underpin the correct working of the RED II and (therefore) ETS and ESR sector "zero-rating" of biomass emissions. In this respect, all biomass net emissions – whether categorised as sustainable within the scope of RED II or otherwise – should be reported against a target in the LULUCF regulatory scope, as a priority for the Fit for 55% review proposals.

Moreover, considerations for restricting sourcing areas may well align with the LULUCF options for target setting, which may also look to consider highlighting areas of high carbon stock. These could produce synergies of protecting forest stock (i.e. areas where harvest would risk releasing large levels of CO2) as identified in the JRC analysis of forest management pathways (see Figure 19 below).

The ILUC Directive[180]

In 2015 the so-called "ILUC Directive" addressed Indirect Land-Use Change (ILUC) emissions associated with the displacement of agricultural production resulting from increased demand for crop-based biofuels. The directive places a 7% cap on crop-based biofuels that can count towards the RED target. Member States are still able to use (and import) fuels beyond the cap, but they do not count towards the targets for renewables. Average ILUC values are provided by MS for reporting purposes.

RED II maintains the concept of a cap on crop-based feedstocks. The cap is determined by consumption levels in each Member State in 2020 (with 1% flexibility). The maximum share cannot exceed 7%. RED 2 allows MS to set lower limits for crop-based biofuels, bioliquids or biomass fuels reducing downwards the overall compliance target. Moreover, biofuels, bioliquids or biomass fuels considered high-ILUC risk are first frozen at 2019 shares and gradually phased out between 2024 and 2030.

The 2019 Commission Delegated Regulation [181] identifies "high-ILUC risk" based on land expansion of biofuel , bioliquids or biomass fuels feedstocks into high-carbon stock areas. Conversely, biofuels, bioliquids or biomass fuels can be certified as "low-ILUC risk" if feedstocks used to produce them are: grown on abandoned or severely degraded land; cultivated using duly verifiable measures to increase productivity beyond the increases which would be already achieved in a business-as-usual scenario (additionality); grown by independent smallholders on plots of land smaller than two hectares. Upcoming Commission Implementing Regulation on implementing rules for voluntary schemes under RED 2 (to be adopted in 2021) will also cover a module on Low ILUC certification.

ETS

The accounting convention that treats biomass combustion in the LULUCF sector and not in the energy sector, leads to biomass considered as "zero-rated" being an abatement option that can lower the amount of EU allowances that need to be surrendered under the Emission Trade Scheme[182]. However, the ETS Monitoring and Reporting Regulation[183] specifies that only biomass that complies with the requirements of the Renewable Energy Directive can be 'zero-rated'. During ETS phase 3 (2013-2020) and in 2021, this means compliance with the sustainability criteria from RED I, therefore only for biofuels and

[180] Directive (EU) 2015/1513
[181] Commission Delegated Regulation (EU) 2019/807
[182] Directive 2018/410
[183] Regulation 601/2012 during ETS phase 3, Regulation 2018/2066 from 1 January 2021, as amended by Regulation 2020/2085

bioliquids. Indeed, there are no sustainability criteria in RED I for solid biomass, which is therefore always 'zero-rated'. From 1 January 2022, only the biomass that complies with the sustainability criteria and GHG emission savings from RED II will be zero-rated. This will apply to biofuels, bioliquids and solid biomass, as defined in RED II. Biomass that is not compliant with RED I (and, from 2022, with RED II) is regarded as fossil fuel: the emissions have to be reported and allowances have to be surrendered. However, if an installation exclusively uses biomass for combustion, then that installation will be wholly excluded from the ETS and its compliance obligations, regardless of the compliance with RED I or RED II criteria.

State aid

In the EU, bioenergy is promoted as a form of renewable energy. Governmental support for bioenergy may have the form of both a financial measure or a favourable regulatory framework. EU State aid rules allow Member States to support bioenergy under certain conditions. Bioenergy is promoted by other EU support policy tools including the Energy Taxation Directive (ETD) and various EU funding programmes such as research and development funding, and rural development.

Where public support for bioenergy falls under the category of State aid (in accordance with Article 107 TFEU), depending on the type of measure, it can be allowed on the basis of different State aid rules or be exempted from State aid control. The most relevant State aid instrument[184] to cover such support are the Guidelines on State aid for environmental protection and energy (EEAG)[185].

The EEAG, adopted in 2014 and prolonged until end of 2021, lay down conditions, under which aid aimed at increasing the level of environmental protection – notably the GHG emissions reduction – to the level that would not have been achieved in the absence of the aid, may be compatible with the internal market. Under the EEAG, biomass is supported as a renewable energy source used for heating/cooling, electricity and transport, with the rationale to facilitate renewables to compete with less environmentally friendly and less costly forms of energy source. The EEAG attempt to address market failures in the energy sector that prevent an optimal outcome in terms of environmental objectives, including the negative externality of greenhouse-gas emissions for as long as these are not priced in[186].

The revision of the initial Guidelines on State aid for environmental protection[187] of 2009 intended to allow Member States to support renewable energies and meet the EU renewables objective, while encouraging innovation and the decrease of renewable energy production costs (for instance by requiring the organisation of competitive tenders). Stricter rules were introduced under the EEAG, particularly since the operating aid, which is essential to biomass, shifted from 'Feed-in-Tariffs' to 'Feed-in-Premium'. Beneficiaries selling renewable electricity directly in the markets are eligible for a

[184] Support with relation to biomass/bioenergy projects could be covered also under the General Block Exemption Regulation (Commission Regulation (EU) 651/2014, OJ L 187, 26.6.2014, p. 1); the EU Guidelines for State aid in the agricultural and forestry sectors and in rural areas (OJ C 204, 1.7.2014, p. 1); the Agricultural Block Exemption Regulation (Commission Regulation (EU) 702/2014, OJ L 193, 1.7.2014, p. 1); the RD&I Guidelines (OJ C 198 of 27.06.2014, p. 1) and the de general Minimis Regulation (Commission Regulation (EU) 1407/201, OJ L 352, 24.12.2013, p. 1).

[185] OJ C 200, 28.6.2014, p. 1.

[186] Zuidema, L. (2020). State aid for solid biomass: The case for improved scrutiny. Retrieved from European University Institute website: https://cadmus.eui.eu//handle/1814/68737

[187] OJ C 82, 1.4.2008, p.1.

premium in addition to the market price, compensating only for the difference between the market price and the operating costs and being flexible enough to adjust to changes in costs as well as market developments.

Operating aid may be granted after plant depreciation only under certain conditions, if the beneficiary can prove that the operating costs are still higher than the market price of the energy concerned, eventually if the use of fossil fuels as an input is economically more advantageous than the use of biomass in plants, which can operate with both types of input. However, the aid must be strictly limited only to compensate the difference between the market price and the operating costs, eventually the difference in operating costs when using biomass compared to fossil fuels. In addition, a monitoring mechanism must be put in place, which will supervise that these conditions are respected.

Moreover, since 2017 aid to renewables generating electricity is to be granted in a competitive bidding process on the basis of clear, transparent and non-discriminatory criteria, in order to be deemed as proportionate and not distorting competition to the extent contrary to the internal market. Biomass is also reflected among the exceptions to the general principle of technology neutrality, where possible distortions on the raw material markets could occur due to the aid.

The general assumption of EEAG is that renewables will become competitive with other energy sources between 2020 and 2030 and until then the aid will gradually phase out as technologies mature. For instance, no operating aid may be granted to food-based biofuels after 2020 (i.e. after 2021 with the extension of the EEAG). In any case, Member States need to comply with the applicable sustainability criteria to be able to support the production of biofuels and energy from biomass.

The Commission has recently published a fitness check of the 2012 State aid modernisation package [188], an inception impact assessment for the revision of the guidelines and a public targeted consultation[189]. This revision should reflect the policy objectives of the European Green Deal [190], supporting a cost-effective transition to climate neutrality by 2050, and facilitating the phasing out of fossil fuels, in particular those that are most polluting, ensuring a level-playing field in the internal market.

The updated Bioeconomy Strategy[191]

In 2018, the Commission published an update of the bioeconomy strategy, with strengthened links with the renewed Industrial Policy Strategy[192], the Circular Economy Action Plan [193] and the Communication on Accelerating Clean Energy Innovation. Regarding climate action, the updated bioeconomy strategy highlights the role of sustainable and circular bioeconomy to achieve climate neutrality in the EU, and to help fulfil the goals of the Paris Agreement. The strategy aims to increase the potential to reduce emissions by promoting resource efficient, active and sustainable primary production practices on land and sea, as well as the enhancement of the capacity of ecosystems to regulate climate, for instance through the deployment of carbon farming innovations. The updated Bioeconomy Strategy has been supported in the context of the

[188] SWD (2020) 257 final

[189] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12616-Revision-of-the-Energy-and-Environmental-Aid-Guidelines-EEAG-

[190] COM (2019) 640 final

[191] COM (2018) 673 final and SWD (2018) 431 final.

[192] COM (2017) 479 final

[193] COM (2015) 614 final

European Green Deal by the Council[194], while 9 Member-States (AT, DE, ES, FI, FR, IE, IT, NL, LV) have elaborated national bioeconomy strategies.

The European Green Deal communication[195] confirms the cross-cutting nature of the bioeconomy, which will also be relevant for two upcoming strategies: the Forest Strategy and the long term vision for rural areas. Climate-friendly action in the bioeconomy sectors is also promoted in the Horizon Europe Programme, the Circular Economy Action Plan (see below), the Regulatory framework for biodegradable and bio-based plastics, and the blue economy.

The new Circular Economy Action Plan[196]

The new Circular Economy Action Plan enshrines the objective of supporting the sustainable and circular bio-based sector through the implementation of the Bioeconomy Action Plan, including actions aiming to ensure the sustainability of renewable bio-based materials. It sets out the agenda of interrelated initiatives to establish a strong and coherent product policy framework to contribute to GHG emission reduction in key sectors. The Action Plan addresses reduced material use overall and stimulates the use of renewable materials. Dedicated actions are also considered for bio-based plastics. The Action plan includes the development of a regulatory framework for certification of carbon removals, that can be nature-based or based on increased circularity, for instance through long-term storage in wood construction. This framework will be based on robust and transparent carbon accounting to monitor and verify the authenticity of carbon removals.

The Renovation Wave[197] and other building-related policies

The Renovation Wave for Europe recognises the bioeconomy as one of the areas of intervention. Circular solutions, the use and reuse of sustainable materials and the integration of nature-based solutions are presented as a pillar of sustainable renovation, while the use of bio-based products will be part of the 2050 roadmap for reducing whole life-cycle carbon emissions in buildings. A 2050 whole life-cycle performance roadmap will be developed to reduce carbon emissions from buildings and advancing national benchmarking in Member States.

Several initiatives, including the review of the Construction Product Regulation[198], the climate change category of the Product Environmental Footprint (PEF) methodology[199], and the initiative on substantiating green claims[200] have been launched or are expected in order to obtain a comprehensive information of life-cycle environmental performance of buildings. This could include valuing wood products as a natural carbon sink in the construction sector, taking account of the scientific developments. The development of a methodology to quantify the net carbon storage of wood products, building on the existing methodologies for measuring the embodied carbon (such as e.g. EN 15804) and the biogenic carbon (i.e. temporary storage function) could lead to harmonisation of assessment of climate impact of buildings within EU regulatory framework and

[194] ST 14954/19 Council Conclusion, 29/11/2019
[195] COM (2019) 640 final
[196] COM (2020) 98 final
[197] COM (2020) 662 final
[198] https://ec.europa.eu/growth/sectors/construction/product-regulation/review_en
[199] https://eplca.jrc.ec.europa.eu/EnvironmentalFootprint.html
[200] https://ec.europa.eu/environment/eussd/smgp/initiative_on_green_claims.htm

accelerating work with standardisation organisations on climate resilience standards for buildings.

The Biodiversity Strategy for 2030

In order to ensure the land use sink can continue to strengthen and improve biomass for energy use in the EU should to be produced sustainably, and environmental impacts should be minimised. The EU Biodiversity Strategy for 2030 [201] contains several commitments related to biomass, including the following: minimise the use of whole trees and food and feed crops for energy production; avoid any unsustainable intensification of forest harvesting for bioenergy purposes; prioritise renewable energy solutions favourable to biodiversity. Besides, the Biodiversity Strategy proposes several limitations to the production of biomass. At least 30% of the EU's land area will be legally protected. The EU's primary and old-grown forests are to be strictly protected, while also stipulating that the EU's actions should not cause deforestation in regions outside the EU's border. The Biodiversity Strategy also anticipates a dedicated EU Forest Strategy in 2021 in line with the wider biodiversity and climate neutrality ambitions, and stresses the need to link the management of forests for biomass to biodiversity considerations.

Sustainable finance

Regarding sustainable finance policies, the Commission published on 21 April 2021 the text of the delegated act[202] on the climate change mitigation and adaptation objectives of the EU Taxonomy Regulation [203] , which creates a classification system for environmentally sustainable economic activities ('taxonomy'). For multiple activities, including forest activities, restoration of wetlands and electricity generation from bioenergy, the delegated act provides two sets of technical screening criteria for a substantial contribution to climate change mitigation and adaptation, respectively, while doing no significant harm to other environmental objectives.

The EU Taxonomy is part of the EU's overall efforts to reach the objectives of the European Green Deal and make Europe climate-neutral by 2050. There are some mandatory disclosure rules defined in the Taxonomy Regulation in relation with the Non-Financial Reporting Directive [204] and with the sustainable finance disclosure regulation[205]. Companies can also use the EU taxonomy voluntarily. In addition, there are other EU policies that may refer to the Taxonomy Regulation. An important example is the use of the 'do no significant harm' principle of the Taxonomy Regulation in the Recovery and Resilience Facility[206]. Here, the 'do no significant harm principle' is applied within the meaning of Article 17 of the Taxonomy Regulation but without requiring the use of the delegated acts and related technical screening criteria[207]. Similarly, for the period of 2021-2027, budget expenditure as part of those funds will also need to respect the 'do no significant harm' principle within the meaning of Article 17 of the Taxonomy Regulation but without requiring the use of the delegated acts and related technical screening criteria.

[201] COM (2020) 380 final
[202] https://europa.eu/!Fv64fP
[203] Regulation (EU) 2020/852
[204] Directive 2014/95/EU, named after revision as Corporate Sustainability Reporting Directive, see COM/2021/189 final.
[205] Regulation (EU) 2019/2088
[206] https://europa.eu/!jt78Jr
[207] See Commission technical guidance document C(2021) 1054 final.

- **What are the win-win actions?**

Bioenergy

Responding to a need identified in the EU Biodiversity Strategy for 2030[208], the Commission committed to publishing a report[209] on the use of forest biomass for energy production. Bioenergy is the main renewable energy source in the EU and in many Member States, accounting for over 10% of EU final energy consumption and about 60% of renewable energy consumption. An objective was to ascertain if synergies could be identified to inform the EU climate and energy policies governing the sustainable use of forest biomass for energy production and the accounting of associated carbon impacts.

The report notes that EU legislation focuses the definition of environmentally sustainable bioenergy on biodiversity conservation and climate change mitigation (see below for more information on the policy framework), because bioenergy sits at the nexus of two of the main environmental crises of the 21st century: the biodiversity and climate emergencies. Wood-based bioenergy has the potential to provide part of the solution to both crises, but only when biomass is produced sustainably.

The JRC analysis shows an increasing overall use of woody biomass in the EU in the past two decades (around 20% since 2000). Similarly, the subset of woody biomass used for the specific purpose of energy has followed an increasing trend until 2013 (about 87% from 2000-2013), after which the growth has slowed. According to the JRC analysis, wood-based bioenergy production is, to a large extent, based on secondary woody biomass (forest-based industry by-products and recovered post-consumer wood), which makes up almost half of the reported wood use (49%). Nevertheless, primary woody biomass (stemwood, treetops, branches, etc. harvested from forests) makes up at least 37% of the EU input mix of wood for energy production (and the remaining 14% is uncategorised in the reported statistics). Considerable inconsistencies in reported data are identified: it is estimated that in the EU, the amount of woody biomass used exceeds the total amount of reported as sources by more than 20%, with large differences among Member States. This identified gap also highlights a specific need to improve tracking and reporting of a crucial climate policy resource, and the report identifies also Earth observation (remote sensing, and Copernicus services) as a suitable and potent tool to address this.

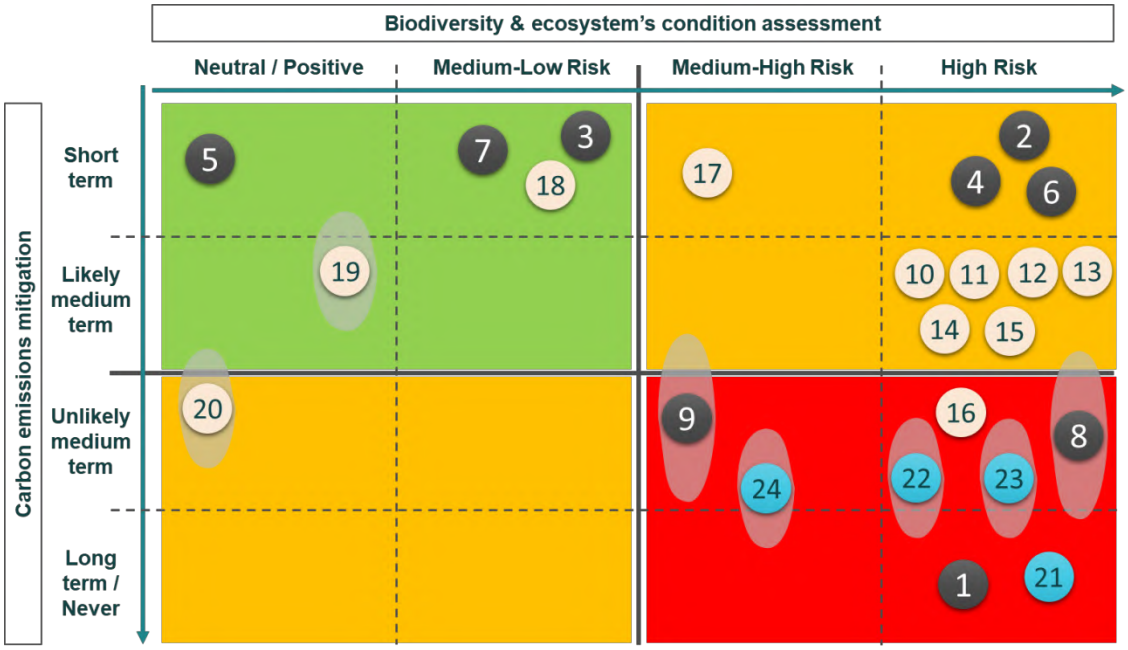
The JRC report provides detailed assessments of a wide variety of pathways for biomass sourcing. Summarised in Figure 19, these show, on the one hand, that it is indeed possible to highlight several pathways that can both reduce greenhouse gas emissions in the short term while not damaging, or even improving, the condition of forest ecosystems. For example, afforestation on former agricultural land with mixed species plantations or with naturally regenerating forests would enhance the terrestrial sink even before producing biomass for energy and thus would contribute to climate change mitigation, while at the same time improving ecosystems' conditions.

On the other hand, several pathways are categorized negatively on both biodiversity and climate counts, and should be discouraged. In this respect, it can be highlighted that the conversion of natural (primary) and old growth forests to plantations aiming to provide

[208] COM/2020/380 final, https://europa.eu/!PJ43Qg

[209] Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621, JRC122719, https://europa.eu/!Bn46df

wood for bioenergy would be extremely negative for local biodiversity, and at the same time it would provide no carbon mitigation in the short-medium term. Similar considerations are valid also for the conversion of naturally regenerating forests to high-intensity management plantations: the impact on local biodiversity is highly negative while, even though wood production might increase, the benefits in terms of carbon mitigation are only accrued in the medium to long term.



	ID	Pathway description
Logging residues removals	1	Coarse Woody Debris removal
	2	Fine Woody Debris (Slash + foliage/needles) removal above landscape threshold
	3	Fine Woody Debris (Slash + foliage/needles) removal below landscape threshold
	4	Fine Woody Debris (Slash - Coniferous) removal above landscape threshold
	5	Fine Woody Debris (Slash - Coniferous) removal below landscape threshold
	6	Fine Woody Debris (Slash - Deciduous) removal above landscape threshold
	7	Fine Woody Debris (Slash - Deciduous) removal below landscape threshold
	8	Low stumps removal above landscape threshold
	9	Low stumps removal below landscape threshold
Afforestation	10	Natural grassland afforestation with monoculture plantation
	11	Natural grassland afforestation with polyculture plantation
	12	Natural grassland afforestation with other planted forest
	13	Anthropogenic heathland afforestation with monoculture plantation
	14	Anthropogenic heathland afforestation with polyculture plantation
	15	Anthropogenic heathland afforestation with other planted forest
	16	Natural forest expansion on anthropogenic heathland
	17	Former agricultural land afforestation with monoculture plantation
	18	Former agricultural land afforestation with polyculture plantation
	19	Former agricultural land afforestation with other planted land managed with low intensity
	20	Natural forest expansion on former agricultural land
Conversion to plantation	21	Conversion of primary, old-growth forest, to plantation
	22	Conversion of native naturally regenerating forest to monoculture plantation
	23	Conversion of native naturally regenerating forest to polyculture plantation
	24	Conversion of native naturally regenerating forest to other planted forest managed with low intensity

Figure 19 – Qualitative assessment of the archetype pathways based on their climate and biodiversity impacts. Black symbols represent pathways referring to 'logging residues removal' intervention, yellow symbols refer to pathways for 'afforestation', and blue symbols refer to 'conversion to plantation' interventions. Uncertainty ranges are placed where payback time for carbon emissions could not be placed within a single one of the already broadly defined levels. The position of the interventions within each sub-section is arbitrary. (Source: Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621, JRC122719, Fig. 42)

Box 8 – Biomass projections in 2030 and 2050

According to the analysis underpinning the communication "Stepping up Europe's climate ambition for 2030" [210] and previously the "a Clean Planet for all" communication[211], bioenergy use is projected to increase in a limited way in the coming years. In the period after 2030, bioenergy demand may increase more significantly in order to stabilise the electricity grid, replace fossil fuels in hard to decarbonise sectors, and deliver negative emissions. The analysis shows this could be achieved without unintended environmental impacts.

All the scenarios analysed rely on a substantial use of biomass for energy with a consumption of bioenergy by 2030 at around 150 Mtoe. By 2030, the use of biomass in the residential sector is expected to decrease slightly but the overall picture will not change dramatically. The combination of feedstock used to supply the demand in bioenergy by 2030 is similar to today's needs with in particular biofuels relying on cereal and oil crops. In all the scenarios, more than 93% of the bioenergy feedstock used in the EU economy is produced domestically in 2030.

By 2050 the use of biomass in the residential sector is expected to significantly decrease in all scenarios. The power sector would absorb most of the additional demand in bioenergy in all scenarios, with more than a doubling of the bioenergy dedicated to the production of electricity. A significant share of the feedstock used to produce this bioenergy is coming from the waste sector that could supply about 100 Mtoe of feedstock to the energy sector. The use of harvested stemwood stays at 2015 level in all scenarios while the sustainable extraction of forest residues increases strongly, in total the forest sector provides 60 to 65 Mtoe of wood for energy. This increase implies an increase in primary production, and thus the residues, or otherwise, it will affect negatively the material sector. Biogas or biofuels produced from food crops will be very marginal in EU by 2050 but more agriculture residues are used for the production of biogas or solid biomass. The optimisation of the sustainable exploitation of all these classical sources of biomass could supply just over 200 Mtoe of feedstock for bioenergy production to the EU economy. Fast growing energy crops will provide for the rest of needs in biomass. Scenarios vary substantially in their demand for these new energy crops. Most of the demand is supplied via lignocellulosic grass such as switchgrass and miscanthus while short rotation coppices, poplar and willow, provide only 20 to 25% of the demand in energy crops.

Long-lived Harvested Wood Products

Buildings are responsible for 40% of EU energy consumption and 36% of greenhouse gas emissions in the EU, which mainly stem from construction, usage, renovation and demolition[212]. They need to become less wasteful, less expensive and more sustainable. Scientific evidence[213] is accumulating to show that the construction sector can even be

[210] COM (2020) 562 final

[211] COM (2018) 773

[212] https://ec.europa.eu/info/news/focus-energy-efficiency-buildings-2020-feb-17_en

[213] Churkina, G., Organschi, A., Reyer, C. P. O., Ruff, A., Vinke, K., Liu, Z., … Schellnhuber, H. J. (2020). Buildings as a global carbon sink. Nature Sustainability, 3(4), 269–276. https://doi.org/10.1038/s41893-019-0462-4. Himes, A., & Busby, G. (2020). Wood buildings as a climate solution. Developments in the Built Environment, 100030. https://doi.org/10.1016/j.dibe.2020.100030. Pomponi, F., Hart, J., Arehart, J. H., & D'Amico, B. (2020). Buildings as a Global Carbon Sink? A Reality Check on Feasibility Limits. One Earth, 3(2), 157–161. https://doi.org/10.1016/j.oneear.2020.07.018

turned from a carbon source into a carbon sink, if organic building materials like wood and smart technologies like artificial intelligence are applied[214].

The potential of EU forests to increase supply of wood for the EU construction sector is limited and raises sustainability issues, particularly with regard to biodiversity aspects. However, several barriers could be lifted to increase the demand of wood construction products and induce changes in the use of wood products in favour of longer-lasting uses. The positive climate mitigation effect of long-lasting wood products could be maximised by re-directing the uses from short-live uses such as energy. The whole value chain could gain in skills, including through the implementation of climate-oriented improvements in forest management, the equipment of sawmills to better handle wood of lower quality grade or from broadleaves; the promotion of wood-based buildings design and engineering; the facilitation of access to wood waste to promote its recovery and reuse.[215] The climate benefits of using wood construction products, compared to using mineral-based materials, are computed with heterogeneous methods, so that the results lack the legitimacy that could convince customers.

10.6.3. A sustainable agricultural sector

- **Why are these synergies important?**

In 2018, the agricultural sector emitted 487 million tonnes of CO2eq in the EU-28, corresponding to 12% of total EU GHG emissions[216]. This figure includes both non-CO2 emissions (e.g. methane from livestock digestion processes, manure management and rice cultivation; nitrous oxide from the use of organic and mineral nitrogen fertilisers and from manure management), and LULUCF CO2 emissions from agricultural soils and biomass, as a result of land management activities, ploughing, or conversion of land uses (e.g. from grassland to cropland) resulting in a mineralisation of the soil organic carbon to CO_2 emitted in the atmosphere. It does not include CO2 emissions from fossil energy consumption (fossil energy is used in the form of fuels for agricultural machinery, as an energy source for heating greenhouses and livestock buildings, or for operating tools and other devices on the farm).

Emissions from agriculture have consistently decreased for two decades between 1990 and 2010, notably due to declines in herds. However, the decline in greenhouse gas emissions from EU agriculture has stagnated in recent years, and even risen in some Member States – whether from livestock or soil management. Due to the parallel decrease in emissions in other sectors of the economy, the share of total EU emissions that can be attributed to the agricultural sector has increased.[217]

In order to ensure that the agricultural sector contributes in an effective way to European Green Deal, it is important to ensure the transition towards a sustainable food system and

[214] State of the Union address 2020. https://ec.europa.eu/info/strategy/strategic-planning/state-union-addresses/state-union-2020_en

[215] A question in the Open Public Consultation on the LULUCF Review (see Annex 10.2.3) asked about the best policy approach to harness the substitution effect and carbon storage potential of long-lived wood products and bio-based and renewable materials. More than half of respondents selected support for research and innovation into more sustainable production of woody biomass and more sustainable use of wood-based materials, products and by-products (72%/153), and training (e.g., for land managers, engineers, architects) and awareness raising (58%/122). Other effective policy options to incentivise the use of wood products are a carbon farming approach (46% of respondents) or tax incentives (45%).

[216] Agridata dashboard, https://europa.eu/!uW84RN

[217] SWD(2021) 115 final – Evaluation of the impact of the Common Agricultural Policy on climate change and greenhouse gas emissions

to strengthen the efforts of European farmers to contribute to the EU's climate objectives. 'Smarter', more precise and more sustainable farming, drawing from knowledge and digital technologies, can produce jointly more private goods and environmental public goods with lower levels of input use and negative externalities; many of these approaches can also translate into economic benefits for farmers, especially if they are directly rewarded for environmental and climate action via carbon farming approaches (see Annex 10.7), creating new business opportunities for rural areas.[218]

- **What is the EU policy framework?**

The Common Agricultural Policy (CAP) will be instrumental in managing this transition. In June 2018 the Commission adopted the legislative proposals of the CAP for the period 2021-2027[219]. The proposal has nine specific objectives, one of which is to increase the contribution of EU agriculture to climate change mitigation and adaptation. To reach these objectives, the future legislation requires each Member State to draw up a single CAP strategic plan. The Commission Staff Working Document 'Analysis of links between CAP Reform and Green Deal' [220] lists the key features related to the environment and climate in the CAP proposal, and concludes that the proposal could be up to the task of delivering the Green Deal objectives, but this also depends on whether the European Parliament and the Council maintain this ambition and strengthen some of its elements in the current co-legislative process[221].

- **What are the win-win actions?**

Agriculture can mitigate climate change not only by reducing GHG emissions but also by increasing removals through the sequestration of carbon in soils, by supplying bio-based materials to replace fossil-based ones, and by producing renewable energy.

In December 2020, the Commission provided each Member State with tailor-made recommendations to assist in the drafting of the national CAP strategic plans[222]. The recommendations identified the key areas on which each EU country should focus to ensure the achievement of the nine CAP specific objectives, which include climate change adaptation and mitigation. To provide an overview of promising climate mitigation actions in the agricultural sector, Table 14 summarises the relevant recommendations per Member State.

[218] COM(2020) 846 final, Recommendations to the Member States as regards their strategic plan for the Common Agricultural Policy, https://europa.eu/!yg49tp
[219] COM(2018) 392 final (https://europa.eu/!cy47Kc)
[220] SWD(2020) 93 final "Analysis of the links between the CAP and the Green Deal", https://europa.eu/!vt78Pp
[221] Factsheet « Working with Parliament and Council to make the CAP reform fit for the European Green Deal", November 2020, https://europa.eu/!ju99cJ
[222] https://europa.eu/!Tp83cR

	Climate mitigation measures in Commission's CAP recommendation
Austria	Improve the health of agricultural soil and its capacity for storing carbon by supporting appropriate management practices Foster climate change mitigation in particular by reducing the impact on the climate from livestock farming Fostering sustainable forest management, enhancing multi-functionality, forest protection and restoration of forest ecosystems Reduce nutrient losses in areas with high nitrate figures Promote the use of woody biomass for long-living materials, namely in the building sector
Belgium	Reducing non-CO2 emissions from the livestock sector and soil fertilisation and maintaining and improving the carbon storage capacity by supporting grassland maintenance and conservation/zero tillage via carbon farming approaches and the shift to a bio-based and circular economy Contributing to the EU Green Deal target to reduce nutrient losses (of both nitrates and phosphorus) Fostering sustainable forest management and afforestation, enhancing multifunctionality, forest protection and restoration of forests ecosystems
Bulgaria	Addressing the increasing trends of non-CO2 greenhouse gas emissions and ammonia from soils, notably brought about by increased fertilisation. Reducing air pollution and non-CO2 greenhouse gas emissions by improving manure management and by using manure for the sustainable production of biogas Fostering a sustainable management of forestry land and afforestation, enhancing multi-functionality, forest protection and restoration of forests ecosystems
Croatia	Support for management practices that increase the carbon uptake of forests and grasslands (carbon farming) and reduce emissions from enteric fermentation, as well as investments in energy efficiency and renewable energy production, and the promotion of carbon assessment tools Contribute to the EU Green Deal target on nutrient losses by improving the application of fertilisers
Cyprus	Increasing the sustainable production of renewable energy from agricultural waste and by-products, solar and wind energy Contribute to the EU Green Deal target to reduce nutrient losses, while increasing soil organic matter and reducing soil erosion Improving feed and manure management and investing in anaerobic digestion, supporting carbon sequestration by the farming and forest sectors; promoting on-farm GHG emissions assessment tools to help lower environmental footprint; supporting investments in afforestation/reforestation and forest protection (from fires, pests and diseases); reducing nitrogen excess Enhancing multifunctional and sustainable forest management, forest protection and restoration of forests ecosystems
Czechia	Supporting practices to improve soil management. Enteric fermentation of livestock should be addressed by adopting low emission feeding strategies. Integrated land use systems such as agroforestry and carbon farming approaches to increase carbon sequestration should be

	promoted. Also, efforts to reduce energy reliance of agricultural sector should be strengthened Promoting the development of agricultural practices that limit substantially NH3 emissions and that improve the management of nitrogen fertilizers and organic manures Contributing to climate change mitigation and adaptation in forests by applying sustainable forest management adapted to current and projected climate change impacts
Denmark	Reducing greenhouse gas emissions, in particular from enteric fermentation and manure. Measures could target improved feed management. Encourage carbon farming and improve management practises for carbon-rich soils and peatlands in order to enhance the current carbon sinks and reduce carbon losses. Consider rewetting of peatlands. Contribute to the EU Green Deal target on reducing nutrient losses and address the impact of intensive farming on water quality and air emissions. Increase sustainability in production and use of energy along the food supply chain. Fostering sustainable forest management and afforestation, enhancing multifunctionality, forest protection and restoration of forest ecosystems.
Estonia	Ensure improvement in nutrient management Reduce GHG emissions from enteric fermentation in farmed livestock Ensure adequate protection of Estonian peatlands – including through effective design of related conditionality elements and support for carbon farming. Rewetting may also be appropriate in some cases. Encourage the timely regeneration of harvested forest, in such a way as to maximise long-term carbon capture Encourage effective management of semi-natural grasslands
Finland	Promoting climate change mitigation: special focus should be on forests and carbon-rich soils (peatland and cropland), in order to enhance the current carbon sinks and reducing greenhouse gas emissions. Further attention is also needed for reducing methane emissions, for example, by promoting biogas production. Increasing nutrient use efficiency Fostering sustainable forest management, enhancing multifunctionality, forest protection and restoration of forests ecosystems
France	Strengthening efforts to reduce GHG emissions, to improve energy efficiency, to foster renewable energy production and to reduce ammonia emissions Halting the decline and degradation of permanent grasslands, and remunerating the protection of these carbon stocks and the enhancement of carbon removals as a key carbon farming action Fostering uptake of farming practices to reduce nutrient pollution from fertiliser use and nitrogen surplus
Germany	Foster climate change mitigation by promoting less intensive management of arable land to increase carbon sequestration and of permanent grassland for carbon storage as well as protection of carbon-rich soils through rewetting and restoration of peatlands and wetlands. Reduction of GHG emissions from agriculture, particularly methane emissions, should be promoted.

	Preservation of tree stocks and increase of carbon sinks in forests should be enhanced, as well as the multifunctional forest management that makes the most of all the ecological services provided by forests.
Greece	Developing the Greek bio-economy by increasing the contribution of agricultural waste and by-products in the production of total renewable energy Contributing to the EU Green Deal target on reducing nutrient losses and improving soil health Contributing to climate change mitigation by encouraging carbon sequestration though carbon farming, the sustainable management of the existing forests as well as the timely replacement of harvested or damaged forest
Hungary	Improve the efficiency of nutrient management by applying reduction measures ranging from low-emission animal housing to manure storage and fertilisation application techniques Promote climate mitigation practices, for instance by designing carbon farming approaches to remunerate carbon sequestration, afforestation, incentivising soil carbon sequestration and the reduction of soil erosion (e.g. catch and cover crops), improving feed and manure management to decrease methane emissions
Ireland	Ensure a widespread improvement in nutrient management through optimised fertilisation (and potentially limited fertilisation in some cases), improved manure management and a wider transition to precision farming. Encourage improvements to the efficiency of enteric fermentation in farmed livestock Halt the deterioration of Irish peatlands and encourage their restoration – including through appropriate design of elements of conditionality, and potentially through funded schemes for carbon farming and more extensive grazing. Step up efforts to encourage tree-planting in various configurations – including agro-forestry systems Improve the conservation status of grasslands and heathlands.
Italy	Increasing the sustainability of production, while mitigating climate change and reducing GHG and air pollutant emissions, through an appropriate blend of voluntary interventions and obligations such as supporting practices leading to more efficient input use (in particular harnessing the potential of carbon farming, precision farming, low input and agro-ecological methods), adopting low emission feeding strategies, improving manure management, increasing the use of energy from renewable sources, improving the management of agricultural residues, grassland and forest areas and their valorisation as a carbon sink
Latvia	To mitigate and adapt to climate change, Latvia should address primarily nutrient management, sustainable crop rotations, the protection and, if appropriate, restoration of peatlands and wetlands as well as improved drainage systems Ensuring improvement in nutrient management through the application of tailored emission reduction measures such as the manure management systems and precision farming Fostering sustainable forest management and promoting the efficient use of biomass, enhancing multi-functionality of forest, promoting forest protection and restoration of forests ecosystems
Lithuania	Reducing agricultural emissions of greenhouse gases by fostering climatefriendly farming methods, with a particular focus on the livestock sector, nutrient management, peatlands and carbon-rich soils, and promoting the production of on-farm renewable energy Reducing pressure from the agricultural sector on natural resources by cutting ammonia emissions, increasing soil organic carbon content,

	better nutrient management and increasing nutrient use efficiency Ensuring resilient and sustainable forest management and promote the efficient use of biomass
Luxembourg	Reducing non-CO2 emissions from the livestock sector and soil fertilisation, and maintaining and improving the carbon storage capacity of forests and permanent grasslands. In this regard, carbon farming approaches could be designed to remunerate carbon sequestration or the protection of existing carbon storage in forests and grassland Enhancing multifunctional and sustainable forest management, protection and restoration of forests ecosystems
Malta	Improving the overall carbon farming capacity and reversing the trend in emissions from cropland, supporting the reintroduction of local breeds and crop varieties that are more resilient in drier conditions, promoting afforestation, improving energy efficiency and fostering renewable energy production
Netherlands	Reducing non-CO2 emissions from the livestock sector and soil fertilisation, and improving the carbon storage capacity by supporting peatland/wetland restoration via carbon farming approaches and the shift to a bio-based and circular economy Foster sustainable forest management and afforestation, enhancing multifunctionality, forest protection and restoration of forests ecosystems
Poland	Reducing emissions related to fertilizer use on soils and avoiding carbon release from organic soils, including peatlands better livestock management (ruminants), especially by adapting feeding strategies so that to reduce emissions from enteric fermentation The role of forest in carbon removal must also be improved through sustainable forest management, enhanced multifunctionality, a greater reliance on agro-forestry, afforestation and improved forest resilience to climate change.
Portugal	Strengthen efforts on climate change mitigation by promoting precision farming and on-farm GHG assessment tools Incentivise governance measures for resilient and sustainable forest management, addressing the atomisation of privately owned forest land. Enhanced governance should promote active forest management more consistently across forested landscapes.
Romania	Improving nutrient management, as well as soil protection and water management, by supporting appropriate farming practices, fertilisation techniques (including precision farming), longer and more diverse crop rotations, agro-ecological practices Fostering sustainable forest management and afforestation, enhancing multifunctionality and the role of forests as carbon sink, protecting forests and restoring forests ecosystems Keeping low levels of greenhouse gas and ammonia emissions from agriculture by supporting appropriate farming practices and systems – e.g. precision farming, as well as investments needed to apply them. Such actions are required particularly on livestock farms to decrease emissions from manure and enteric fermentation
Slovakia	Reducing greenhouse gas emissions from agriculture, in particular by mitigating the emissions from soils through practices leading to more efficient use of inputs; and addressing the intensity of enteric emissions from ruminants by adopting low emission feeding strategies Maintaining and strengthening the carbon sink in existing forests and implementation of afforestation programmes Fostering sustainable forest management and enhancing multifunctionality, forest protection and restoration of forests ecosystems
Slovenia	Fostering sustainable forest management of forestry land, enhancing multifunctionality, forest protection and restoration of forests ecosystems

	Encouraging farming practices aimed at improving nutrient (nitrogen, phosphorous, potassium etc.) management, such as reduced and improved fertilisation (including through precision farming) and adequate livestock manure management Strengthen the long-term capacity of forests to act as carbon sinks, in particular by: investing in adequate forest preservation and harvested wood products, timely replanting of forest, taking into account the projected climate trends for appropriate species selection, and implementing the capacities for wood processing Strengthening the efforts to reduce ammonia and methane emissions, in particular from the livestock sector, including by improving the livestock manure management
Spain	Support improved crop rotations, precision farming, carbon farming and improvement of manure management. Particular attention needs to be paid on reducing GHG emissions from enteric fermentation Fostering sustainable forest management, enhancing multifunctionality, forest protection and restoration of forests
Sweden	Contribute to sustainable energy by increasing renewable energy production and use on farms Promote climate change mitigation and GHG emissions reduction by restoring, preserving, improving the carbon sinks on forest land (e.g. by fostering sustainable forest management) and carbon-rich soils (e.g. peatland and wetland conservation). Reduce methane emissions in line with the Methane Strategy (e.g. with biogas production) Foster sustainable forest management, enhancing multifunctionality, forest protection and restoration of forests ecosystems

Table 14 – Overview of climate-related CAP recommendations

10.6.4. A sustainable food system

- **Why are these synergies important?**

The important role of more sustainable and balanced diets in the fight against climate change was highlighted by many scientific publications, including the IPCC Special Report on Climate Change and Land[223]. In its Communication "A Clean Planet for All"[224], the Commission has presented eight scenarios to decarbonise the economy. One of the scenarios, aiming at a climate-neutral EU by 2050, includes climate-friendly consumers' choices. The modelling exercise showed that even moderate changes in the consumption of food of animal origin in line with the World Health Organization (WHO) recommendations can significantly reduce emissions from agricultural production.

- **What is the EU policy framework?**

The EU Farm to Fork strategy[225], published in May 2020, aims to increase the sustainability of the EU food system. This includes ensuring that our citizens get healthy, affordable and sustainable food, that we tackle climate change, protect the environment and preserve biodiversity. The strategy sets out both regulatory and non-regulatory initiatives, with the common agricultural and fisheries policies as key tools to support a just transition. In particular, a proposal for a legislative framework for sustainable food systems will be put forward to support implementation of the strategy and development of sustainable food policy; the strategy includes many more actions that the Commission will take in the next years, including a Carbon Farming Initiative to promote a new business model for land-based carbon sequestration in rural areas (see Annex 10.7).

- **What are the win-win actions?**

[223] Shukla, P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H. O., Roberts, D. C., … Van Diemen, R. (2019). IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. http://www.ipcc.ch/srccl

[224] COM (2018) 773 and the accompanying in-depth analysis

[225] COM/2020/381 final, https://europa.eu/!rt73kQ

A recent scientific publication[226] concurs with the Climate Target Plan, that a switch towards a plant based diet can have important impacts on our planetary boundaries. In addition to notable reductions in GHGs by the food system, the diet switch also invokes resource trade-offs. More specifically, comparing with a business-as-usual baseline to 2050, increasing blue water and cropland requirements are accompanied by considerable savings in permanent pasture and (in particular) food system GHG emissions (see Figure 20). On the latter, a realistic plant-based diet scenario could generate global food-system GHG reductions of 9% by 2050, whilst European Union food system based emissions actually fall 21% below 2015 levels. In a scenario that combines the diet change with the elimination of all red meat consumption, global GHGs fall by up to 22% (or only 12% above 2015 world GHG emissions).

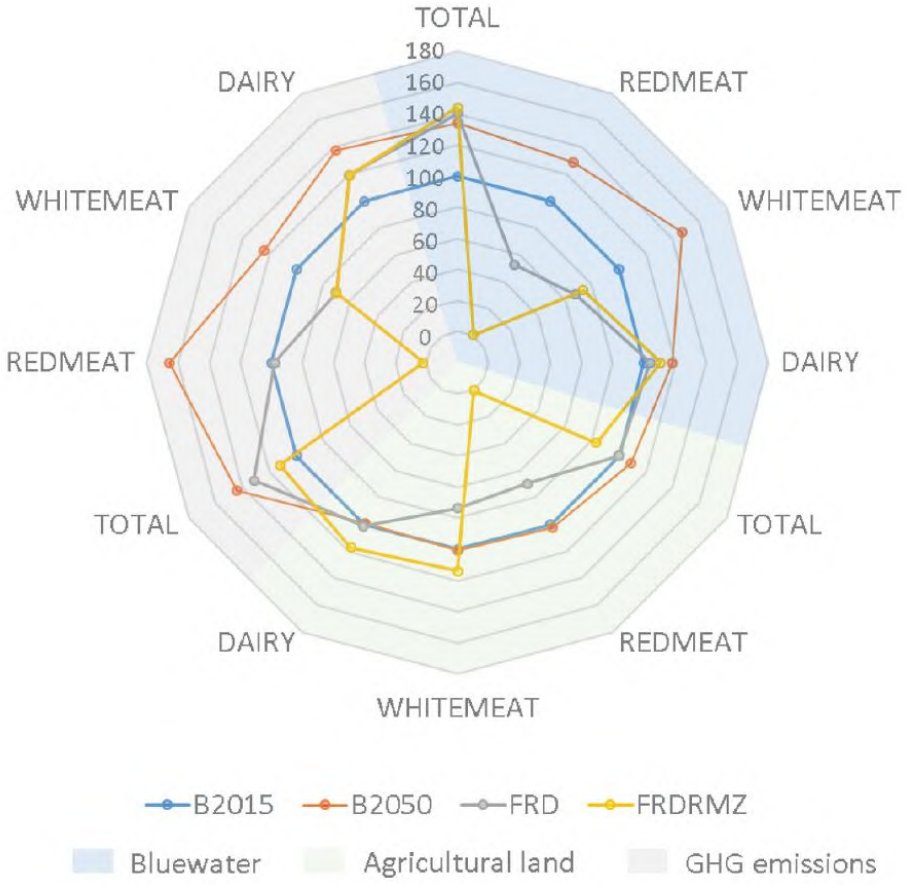


Figure 20 – Global virtual commodity consumption by scenario (2015=100) Notes: B2015 = Baseline in 2015; B2050 = Baseline projection in 2050 (business as usual scenario); FRD = Feasible Reference Diet; FRDRMZ = Feasible Reference Diet, Red Meat Zero. Source: Philippidis et al.,ibid.

The Farm to Fork strategy recognises that alternatives (such as plant, microbial, marine and insect-based proteins and meat substitutes) to protein from livestock, with a potential to lower environmental footprint and a higher sustainability potential, should be come a key area of research. It also stresses that sustainable aquaculture has an important role to play to lower the carbon footprint of our food system, including by providing alternative proteins (e.g. algae) for food and feed. Another possible approach could be to include aquaculture more explicitly in land use and land use change analyses, leading to a wider consideration of options for emission reductions. Other studies have suggested that

[226] George Philippidis, Hugo Ferrer-Pérez, Pilar Gracia-de-Rentería, Robert M'barek, Ana Isabel Sanjuán López, Eating your greens: a global sustainability assessment, Resources, Conservation and Recycling, Volume 168, 2021, 105460, ISSN 0921-3449, https://doi.org/10.1016/j.resconrec.2021.105460

cultured meat in place of that from animals is a promising, innovative solution, with a potentially lower environmental footprint and a higher sustainability potential[227].

10.7. Carbon farming

Currently there is no targeted policy tool to significantly incentivise carbon removals and the protection of carbon stocks at the level of the individual land manager. In this context, the **Farm to Fork Strategy** announced that in 2021 the Commission will launch a carbon farming initiative[228] to promote carbon sequestration as new green business model. This new business model shall reward climate-friendly practices either via the common agricultural policy (CAP) or other public or private initiatives linked to carbon markets, thus providing individual farmers or foresters with a new source of income. These financial incentives can also help to achieve the targets set out in the **Forest Strategy**, the **Biodiversity Strategy** and the **Adaptation Strategy**.

The study "Technical Guidance Handbook – setting up and implementing result-based carbon farming mechanisms in the EU"[229] explored key issues, challenges, trade-offs and design options to develop carbon farming. It reviewed existing schemes that reward climate-related benefits in five promising areas: peatland restoration and rewetting; agroforestry; maintaining and enhancing soil organic carbon (SOC) on mineral soils; managing SOC on grasslands; and livestock farm carbon audit. It also explored how a widespread adoption of carbon farming can be triggered in the EU.

The study stressed that a particularly promising option for Carbon Farming is improved management and restoration, rewetting and conservation of **peatlands**. Due to their role as a permanent carbon stock and ongoing sink, peatlands have a key function in the carbon cycle. Cropping under wet conditions (paludiculture) can also increase the beneficial impact of boosting in-field carbon sequestration by delivering bio-material feedstocks. Climate action in peatland can immediately[230] deliver significant emission reductions in a relatively small area and has great potential in terms of climate benefits and co-benefits. Additionally, the experience based on existing peatland initiatives shows that some essential elements of Carbon Farming schemes such as Monitoring, Reporting and Verification aspects can be simpler and more cost efficient, as emission factors in peatlands are well correlated to water table levels, land use and vegetation type, thus payments can rely on monitoring of proxy indicators, rather than on direct measuring. Such green business model has a great potential in rural areas, particularly in regions hosting extensive peatlands that could also make use of other types of support[231].

The study concluded that result-based carbon farming can contribute significantly to the EU's efforts to tackle climate change, bringing benefits in terms of carbon sequestration and storage and other co-benefits, such as increased bio-diversity and preservation of eco-systems. Pilot initiatives should be developed at local or regional level in order to gather experience to upscale carbon farming. This will enable improving design aspects,

[227] A recent life cycle assessment of cultivated (cell-cultured) meat, conducted by CE Delft, found that cultivated meat could cause up to 92% less greenhouse gas emissions, 93% less pollution, and use up to 95% less land and 78% less water. This is compared to an ambitious scenario for conventional animal agriculture in 2030 – where farmers manage to cut the carbon footprint of meat by 15% (beef), 26% (pork) and 53% (chicken). Compared with current average environmental impacts, the benefits of cultivated meat are even greater (https://www.cedelft.eu/en/publications/2610/lca-of-cultivated-meat-future-projections-for-different-scenarios).

[228] https://ec.europa.eu/clima/content/carbon-farming_en

[229] https://europa.eu/!VW49yw

[230] Once the necessary restoration investment, which can take some years, is completed.

[231] For example the Just Transition Fund, in line with the Territorial Just Transition Plans.

in particular the certification of carbon removals, and expanding stakeholders' knowledge and understanding of the potential benefits for them. The study can serve as a guidance to help private actors and public authorities start up an increasing number of carbon farming initiatives.

Carbon farming can be promoted via EU and national policies and private initiatives. This new type of financial support will create a new source of income for land managers. Member States will be able to accelerate the roll out of carbon farming practices in the context of the Common Agricultural Policy (CAP); in the Recommendations on the CAP Strategic Plans[232], the Commission already highlighted the measures that look more promising to realise the mitigation potential in each Member State (see Table 14 in Section 10.6.3 for a summary). In particular, the relevant GAECs under the conditionality ensure a basic protection of existing carbon stocks, whereas eco-schemes and rural development interventions can encourage the enhancement of carbon removals beyond conditionality. CAP instruments can furthermore support a wide range of measures (for example advisory services, knowledge transfer and training actions, non-productive investments), which are useful to incentivise uptake and promote the early involvement of land managers. Carbon farming schemes could also combine funding through CAP support and carbon removal markets. In such a scenario, CAP support would constitute a fundamental source of financing to cover the upfront costs of setting up a carbon farming scheme, whereas land managers would benefit from revenues produced through the selling of carbon certificates on the markets. Due to the time needed to generate and correctly measure carbon removals, the different forms of CAP support (incentives and/or compensation of income losses and additional costs) will be important in order to support the farmer and foresters in building up their carbon removal business. A further avenue for public funding could be **State aid**, as Member States might consider interesting to support carbon farming initiatives through pure national financing.

Carbon farming incentives should be based on a clear calculation methodology of the CO2 units sequestered or protected and for the baseline; a solid framework for Monitoring, Reporting and Verification (MRV); reward and sanction mechanisms; rules on governance. In this regard, of particular relevance is the ongoing development of a **Carbon Removal Certification** (CRC) mechanism[233], which will establish the regulatory framework for the certification of carbon removals based on robust and transparent carbon accounting to monitor and verify the authenticity of carbon removals. Also in view of the earlier experience with lower-quality carbon credits under the Clean Development Mechanism, it will be essential to establish a credible governance system that can guarantee the additionality and permanence of land-based carbon removals. The Commission plans to publish a Communication setting out an action plan for both initiatives (the carbon farming initiative and the carbon removal certification mechanism) by the end of 2021[234].

[232] Adopted in December 2020, available here: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-strategic-plans_en#cap-strategic-plans-recommendations.

[233] Announced by the Circular Economy Action Plan, the Carbon Removal Certification initiative will deliver a legislative proposal to be adopted by 2023.

[234] https://ec.europa.eu/clima/news/commission-sets-carbon-farming-initiative-motion_en

10.8. Monitoring technologies and data standardisation

The current regulation provides considerable scope and choice to Member States, leading to a high degree of divergence and issues relating to quality assurance. For instance, in 2021 quantitative assessments will be carried out for the first time in a trial with Member States and the EEA. This will lead to definitive guidance on how to best assure high quality estimates for reported emissions and removals in the annual GHG inventories. Much of this improvement process is also related to the collection of enhanced activity data and appropriate application of emission factor methods or tiers (see Box 3 below and Section 9).

Box 9 – Core monitoring indicators

- **Activity data** shows the area land use and change between uses[235], within a Member State, year-to-year.
    - These data are aggregated in the Common Reporting Format (CRF) tables reported to UNFCCC, Table 4.1.
    - The accuracy of these emission estimates relies on quality of the geographical data collected, including the attribute data (such as how the area of land has been managed; used for arable crops, grazing, mowing of grass, fertilizer application, etc.)
    - Depending on the stratification of land use categories applied by Member States, activity data can be directly measured through a variety on information systems, already available at national level for policies such as the CAP, biodiversity monitoring, forest fire monitoring.
- The estimates of emissions/removals within each land category in turn relies of the accurate application of **emission factors** to each of these activity data land units.
    - The upgrading of these estimates relies on the application of correct emission factors (broadly described as *Tiers* by the IPCC), and the full use of the carbon pools (required by the LULUCF Regulation).
    - Work on improving emission factors has been achieved by Member States through experimental work, in some cases[236] supported by the EU's LIFE programme, and sharing of information through Commission Working Groups and seminars.
- The individual geographically explicit estimates are then then statistically aggregated and included in CRF Table 4, to provide the **core monitoring indicators**, namely **reported estimates at national level per land use and land use change category**.

[235] While IPCC guidance provides a broad definition of the different land use categories, it lacks explicit definitions and blurs the distinction between land use (the function of the land, for example grazing livestock) and land cover (the observed nature, e.g. grasses). Land use definitions proposed in the future ISO standard on land use may better reflect the LULUCF universe of discourse: "Total of arrangements, activities and inputs that people undertake in a certain land cover type to maintain it or produce change", see New Work Item Proposal for the development of Land Use Meta Language (19144-3) within ISO/TC 211/WG 7 (Information communities)

[236] For example, LIFE CROLIS - CROatian Land Information System. The main aim of the LIFE CROLIS project is to develop and implement a harmonised land monitoring data model that enables the integration and processing of Land Cover (LC), Land Use (LU) and land management data from different data sources, and its use for a variety of purposes. This will be the first multi-scale and multi-purpose land information monitoring system in Croatia. https://europa.eu/!ry48db

The principle behind IPCC and UNFCCC monitoring is to make the best use of available datasets, avoiding the need to duplicate costly data collection. Relevant activity data have already been collected using a variety of techniques under other, related, policy areas for a significant number of years. Nevertheless, a step up in terms of re-use of available data and introduction of new data collection techniques, and streamlining of data collection with new initiatives such as restoration targets, removal certification objectives and prioritisation of protection carbon sinks provides a pathway towards increasing estimate accuracy and policy effectiveness.

10.8.1. Agricultural land

For agricultural land falling under the scope of the CAP, the Member States are required to establish and operate an Integrated Administration and Control System (IACS) to manage and control CAP payments. IACS consists of a number of interconnected databases and IT systems that help national administrations to grant the correct payment to the right beneficiary. In this system geographically explicit data is the foundation of the system for the identification of all agricultural parcels in Member States (known as the Land Parcel Identification System, LPIS) [237] and the aid application system (developed in geo-aid application [238], since 2018 for both area- and animal-related payments).

Much of this information is therefore based upon a combination of remote sensing data and underpinned by specialised Copernicus services, which provide in-season information to farmers to ensure compliance with conditionality and other contracted supplementary payments.

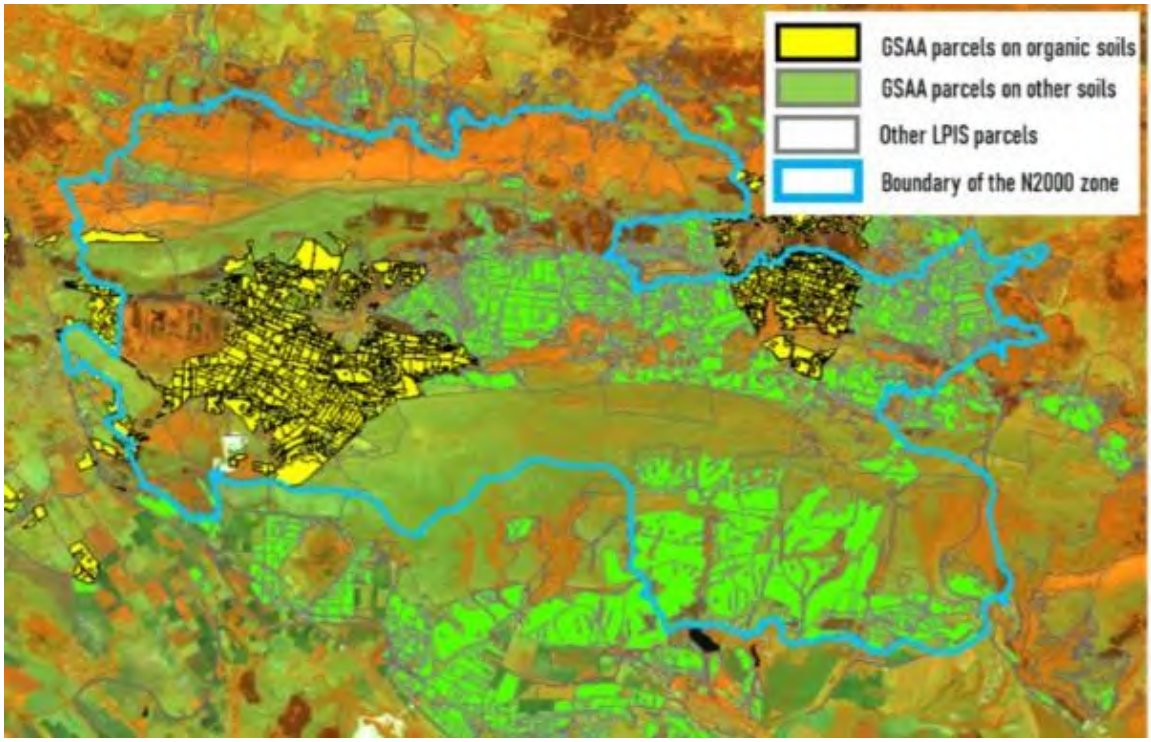


Figure 21 Example interaction of the GeoSpatial Aid Application (GSAA) concept developed under the CAP, combining information within a Natura 2000 zone in Rayanovtsi (BG) related to organic soils (histosols) and wetlands. Using information for the Bulgarian Paying Agency (Agricultural State Fund - DFZ) and Bulgarian Soil

237 The LPIS is built on the basis of maps, particularly aerial or satellite ortho-images, as well as land registry documents and other data which provide information on a certain parcel.

238 LPIS 2014/640 art 6, GSAA 2014/809 art 17, basic act 2013/1306 art 70

The CAP (IACS) data clearly offers a strong synergy with objectives of climate action. The high degree of auditing, due to the high financial motivation, of CAP beneficiaries' claims also provides for a very strong base quality for the data collected. These annual databases remain accessible for a minimum of 10 years. This removes a risk of uncertainty with respect to the activity data collected.

A majority of Member States have already started exploring the combined use of these data for the purpose of climate activity data reporting, but some time is still needed to achieve the necessary semantic interoperability between the local IACS and generic IPCC concepts, and thereby enable reporting quality upscaling. The exploration of IACS data sharing under INSPIRE has been carries out by the JRC in. Trials to explore the specific issues related to IACS/LULUCF interoperability have been conducted for a limited number of Member State systems. This work will be continued by the JRC[239] facilitating relevant IACS data sharing across the EU[240],in the respect of the relevant EU legislation (data protection, establishment of specific infrastructures, including the recent High Value Data set 'initiative')[241] and taking into account the EU proposals of the evolution data ecosystems (INSPIRE and EU common data space).

For agricultural land outside CAP, while some Member States do provide coverage, there is no legal obligation and some gaps exist. Nevertheless, the same tools, if extended and including Artificial Intelligence (AI) based segmentation and mapping, could provide activity data, at least to a certain degree. Furthermore, and complementing targeted tools using Copernicus Sentinel data, additional information could be derived and gaps could be filled using land use/land cover Copernicus Pan European products[242] coordinated by the European Environment Agency, for example with the future Corine Land Cover Plus (CLC+) service, for which a specific LULUCF instance is being developed to be available by 2023. An existing alternative still within the Copernicus Land Monitoring Service (CLMS) are the high resolution layers produced periodically – that include grasslands, tree cover and an emerging layer on production by crop product – or the products from the global component of CLMS[243] such as the annual Copernicus global land cover product at 100m resolution (Figure 22). It is notable that Copernicus products – derived from a global satellite system as well as specially contracted services – cover all the EU including the outermost six French regions plus the Azores, Madeira and the Canary Islands[244]. Continued development of these and improved services, for the current EU geographic coverage including outermost regions, will be of high strategic importance for LULUCF monitoring.

[239] Article 65 in the Horizontal Regulation of the new CAP which foresees explicit *data keeping and sharing*

[240] The overall objective of the 'IACS data sharing process' is to ensure discoverability, efficient access (single entry point) and effective re-use of spatial IACS data (interoperability and use cases) in a coherent policy environment. Consequently, the soil health use cases proposed in this AA allow to prototype, test and illustrate the importance of data sharing in the domains of agriculture, environment and climate as well as the benefits for the administration in their evaluation, monitoring and reporting duties (notably in the LULUCF context).

[241] Implementing act under preparation following article 13 of the Open data and PSI Directive

[242] https://land.copernicus.eu/pan-european

[243] Annual global land cover change maps: Global component of the Copernicus Land Monitoring Service (https://lcviewer.vito.be/about).

[244] It should be noted that EEA products for Outermost regions are available through a specific technical download service on demand. Furthermore the region of Saint-Martin (FR) is only covered by the Global component of the Copernicus Land Monitoring Service at 100m ground sampling distance.



Figure 22 - Copernicus annual global land cover product: this global 100m resolution map product, derived from PROBA-V satellite observations, is processed to ensure continuity with Copernicus Sentinel-2 observations.

Specifically for the Wetlands land category (and land converted to wetlands), the Commission has set out a two-year programme with the Joint Research Centre to develop remote sensing-based methods to provide annual monitoring for LULUCF reporting requirements. This work will be completed by the beginning of 2023.

A further project[245] has been contracted by the Commission to create a system to report on land cover change within Natura 2000 sites, on an annual basis, with a focus on grasslands is also underway. Activities that could correspond to an intensification (ploughing and mowing events), will be included in a series of environmental indicators. The monitoring technology will use both Sentinel 1 (SAR) and Sentinel 2 (optical) satellite sensors.

While remote sensing can provide many pertinent land cover and land use parameters, soil is far more complex to observe. The EU's LUCAS Soil[246] dataset is the only harmonised data collection programme on soil organic carbon covering all EU MS. Data are available for 2009, 2015 and 2018 (2021 Q2). LUCAS Soil 2022 has been specifically adapted to provide statistically robust assessments of soil carbon stocks in croplands at NUTS2 level and grasslands and woodlands at NUTS0. A major adaptation has been an increase in sampling depth to 30 cm to comply with IPCC Reporting obligations.

10.8.2. Forest

Current activity data collection for forest lands (and conversion to and from forests, afforestation and deforestation) relies heavily on static ground surveys of small sample plots, collected through periodic *national forest inventories*, usually on a 5 or 10yr basis. These inventories provide a range of statistical sample data designed to provide estimates

[245] Copernicus For Natura 2000, http://www.cop4n2k.eu/

[246] https://ec.europa.eu/jrc/en/publication/lucas-soil-largest-expandable-soil-dataset-europe-review

on a range of parameters (e.g. forest type and tree species, age class distribution, dead wood, etc) at a national or regional level.

The relative richness of the statistics means that most Member States with significant forest cover apply relatively sophisticated methods (Tier 2 or 3) for the estimating of GHG emissions and removals from forests. However, a number of limitations still remain: the data are difficult to interpret on an annual basis; they are not well harmonised between Member States; for most [247] Member States these do not fully deliver *geographically explicit* datasets, especially for afforestation and deforestation, and impacts of pest, drought and fire disturbance; and extending the data collection (for example, annualising data sampling or increasing sampling density) time intensive and very costly.

Fortunately, it becomes more apparent that, like for agricultural land, remote sensing data in combination with the rich data source of the inventories helps address these issues. The European Commission Knowledge Centre on Earth Observation (KCEO) established in April 2021[248], will facilitate the uptake of products and information from Copernicus to support EU Policies in various sectors including LULUCF. Furthermore, the Commission has reported[249] on recommendations to better leverage the potential of earth observation tools by integrating the traditional inventory approaches to create mutually beneficial synergies. The report notes that remote sensing is a powerful tool able to plug information gaps, because of its synoptic view and the possibility to monitor large areas with sufficient frequency. In Europe, the report concludes that Copernicus provides all the necessary tools to produce the required information on forest disturbances such as fires[250]. These tools include data from seven Sentinel satellites and different sensors and six different services producing standardised datasets on regional, European and global level integrating Sentinel satellite imagery and data from complementary sources. Such tools are moreover used for applications in different parts of the world, such as by the European Commission for monitoring of forest cover changes in the humid tropics,[251] and by forest remote sensing services from Brazil, Canada and the US to deliver operational applications especially in the fields of fire monitoring and deforestation.

Concretely, the use of combined time series from Sentinel-1 and Sentinel-2 for the detection, mapping and accounting of forests activities as well as land cover conversions is proposed as the way forward. The application of future datasets, for example those provided by the European Environment Agency (EEA) through CLMS high resolution layers on the tree cover and forest type (available in 10m resolution for 2018 and 20m for the earlier reference years), should be pursued so far as is currently technically feasible. The role of future of Corine Land Cover Plus (CLC+), will also be crucial in respect of land use change information. This information should complement earth observation based monitoring of natural disturbances in forests, facilitating the separation in GHG inventory reporting between managed and non-anthropogenic land cover changes. To help address forest data standardisation and access to EU harmonised data, the EEA is also supervising the development of the Forest Monitoring Information System for

[247] Except for those EU MSs producing and maintaining their inventories using a census approach, bottom-up, forest management plans (occasionally integrated with the LPIS)

[248] https://knowledge4policy.ec.europa.eu/earthobservation_en

[249] European Commission, 2020, Monitoring of Forests through Remote Sensing, https://op.europa.eu/s/oKot

[250] See for example the European Forest Fire Information System (EFFIS) under the Copernicus EMS Early Warning and Monitoring services http://emergency.copernicus.eu/

[251] C. Vancutsem, F. Achrad, J.-F. Pekel, G. Vielledent, S. Carboni, D. Simonetti, J. Gallego, L. E. O. C. Aragao, R. Nasi, 2021, SCIENCE ADVANCES Vol. 7, no. 10, eabe1603, DOI: 10.1126/sciadv.abe1603

Europe (FISE), which promises to help facilitate timely, standardised reporting on forests by Member States relevant to all Green Deal objectives.

The nature protection commitments of the Biodiversity Strategy for 2030 highlights the need to define, map, monitor and strictly protect the EU's remaining primary[252] and old-growth forests[253]. Intact forest ecosystems dominated by natural processes are rare in the EU and represent only around 2-3% of the total forest area in the EU[254]. Despite their small areal extent, these primary and old-growth forests are an irreplaceable part of the EU's natural heritage, still playing a key role for biodiversity conservation and providing a wide array of other critical ecosystem services. As well as being characterised by high carbon stock per hectare, these forests should continue to accumulate carbon – despite their maturity – in dead wood and soil organic carbon pools, while being resistant to climate hazards[255] relative to plantation forests. Stricter protection of these forests to avoid disturbance will reduce loss from carbon stocks in the short term and aid sequestration in a longer perspective.

Box 10 – EU Soil Observatory

Healthy soils are at the heart of the Green Deal for Europe. In addition to providing us with food, fibres and fuel, soils play a key role in regulating the Earth's climate, provide us with clean water, protect us from floods and preserve our cultural heritage. To close the data gaps on the European soils, the JRC launched the EU Soil Observatory (EUSO) in December 2020. Over the next two years, the EUSO will become a dynamic and inclusive platform that aims to support policymaking by:

- Providing the Commission Services and the broader soil user community with the soil knowledge and data flows needed to safeguard soils
- Supporting EU Research & Innovation on soils
- Raising societal awareness of the value of soils

Sustainable soil management and the restoration of degraded land is critical if biodiversity protection targets are to be achieved. Efficient nutrient management, including carbon sequestration to offset climate change, are key measures in the Common Agricultural Policy, while reducing pesticide residue levels are aspirations under both the Farm to Fork Strategy and the Zero Pollution Action Plan. Reduced soil sealing and organic waste cycles are both targets of the Circular Economy Action

[252] Primary forests have been defined as naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed, see FAO (2018) FRA 2020 - Terms and Definitions FRA 2020. Forest Resources Assessment Working Paper 188. Food and Agriculture Organization of the United Nations, Rome, pp. 26. http://www.fao.org/3/I8661EN/i8661en.pdf

[253] Old growth forest stands are generally considered to be stands in primary or secondary forests that have developed the structures and species normally associated with old primary forest of that type. See for example EC (2015) Natura 2000 and Forests - Part I-II. European Commission, Technical Report - 2015 – 088, pp. 108. https://doi.org/10.2779/699873.

[254] Varying according to different sources: FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. https://doi.org/10.4060/ca9825en; or Forest Europe, 2020: State of Europe's Forests 2020. https://foresteurope.org/state-europes-forests-2020/ ; or Sabatini, F. M., Keeton, W. S., Lindner, M., Svoboda, M., Verkerk, P. J., Bauhus, J., … Kuemmerle, T. (2020). Protection gaps and restoration opportunities for primary forests in Europe. Diversity and Distributions, 26(12), 1646–1662. https://doi.org/10.1111/ddi.13158

[255] Watson, J. E. M., Evans, T., Venter, O., Williams, B., Tulloch, A., Stewart, C., … Lindenmayer, D. (2018). The exceptional value of intact forest ecosystems. Nature Ecology & Evolution, 2(4), 599–610. https://doi.org/10.1038/s41559-018-0490-x

Plan, as is the development of an Integrated Nutrient Management Plan. The EU Soil Observatory[256] supports these EU strategies by:

- Collecting high-resolution, harmonised and quality-assured soil information (showing status and trends) to track and assess progress by the EU in the sustainable management of soils and restoration of degraded soils;
- Supporting the outcomes of targeted research;
- Fostering networking, cooperation and partnerships among users of soil data and information;
- Underpinning policy development through meaningful indicators and assessments.

10.8.3. Settlements

The main remaining land category for which improved activity data and emission factors would be required under the preferred policy option is settlements, or built-up area. However, the IPCC definition of this category is very generic and 'delegates' most features to national definitions. Settlements usually contain built-up areas and associated surfaces that are not sealed (for instance open vegetated spaces, parks). As with the other IPCC categories, the actual categorisation can be more *land-use* than *land cover* related.

The main particularities of built-up land with respect to GHG flows are heterogeneity of how vegetation integrates with constructed areas, as well as the high dynamic pattern of the land use boundaries. An increase of Carbon stocks of such lands is nevertheless expected, as a consequence of both the EU afforestation initiative announced in the Biodiversity Strategy (which includes urban areas), and steady (re)greening of inhabited areas during recent decades.

Some synergies with national LPIS (see Agriculture, above) stores up-to-date information on built-up areas within agricultural land, and may contains some specific types, such as farm houses, agricultural facilities, and greenhouses. Other sources of information are national territorial management plans, or from a pan-European datasets, the Global Human Settlement Layer of JRC could be an option as well.

Copernicus land monitoring products and high resolution layers delivered by the EEA can provide vital information at a harmonised level. Currently, assessment of soil sealing (thus, corresponding to settlement zones) can be made over a specific period, analysed within user defined spatial units such as administrative boundaries, biogeographical regions or land cover classes. Current status or change in the EU27 for every 3 years between 2006 and 2015 are available, with the latest data (2018) analysis offering 10m resolution. Such spatial information can be easily reinforced and integrated with spatially explicit information on built-up areas available at country scale. Current practices are that built-up areas represent the highest hierarchy in the databases used to build land use matrices for GHG inventory purposes. Such information is generally available, i.e. through cadastral information (which is a notable INSPIRE directive theme), which defines the most accurate administrative boundaries of built-up land.

Standardised Carbon stock change and emission factors are, nevertheless, largely missing for built-up areas. Given the heterogeneity of the vegetation types and how it is integrated with constructions, a generalization of such Tier 1 factors, would lead to inaccurate estimation of C stock changes in the relevant carbon pools. Innovative

[256] https://ec.europa.eu/jrc/en/eu-soil-observatory

solutions to obtain such factors may include exploring databases associated to the programs of monitoring of built-up areas by LIDAR technologies and cadastral volumetry, records by local citizen-based or research projects (including on soils GHG in/outflows).