

EU LULUCF Regulation explained

Summary of core provisions and expected effects

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Table of Contents

Abbreviations	5
The EU LULUCF Regulation in a nut shell	6
1. Introduction	7
1.1. Aim of this paper	7
1.2. Background	7
2. Explaining reporting and accounting	8
2.1. The difference between reporting and accounting	8
2.2. Land-based versus activity-based accounting	9
2.3. Net-net, gross-net and accounting against a reference	10
3. Description and analysis of the LULUCF Regulation	11
3.1. General concept of the Regulation	11
3.2. Categories of land included in the Regulation	12
3.3. Pools and gases included in the Regulation	14
4. The accounting rules	14
4.1. Accounting for afforested land and deforested land	14
4.2. Accounting for managed cropland, managed grassland and managed wetland	15
4.3. Accounting for managed forest land and harvested wood products	16
4.3.1. How accounting against the forest reference level works	16
4.3.2. How the forest reference level is constructed	16
4.3.3. How emissions from harvested wood products are estimated	19
4.4. Accounting for natural disturbances	20
4.5. Flexibilities	21
4.5.1. How general flexibilities work	21
4.5.2. How the managed forest land flexibility works	22
5. Discussion of opportunities and risks	22
5.1. Emissions and removals from LULUCF in EU Member States	23
5.2. Data sources for improved accounting	26
5.2.1. LULUCF Regulation demands improved data	26
5.2.2. Opportunities for including additional data	27
5.3. Evaluation of environmental integrity	28
5.4. Linkages to other policies	29

6.	Conclusions	30
7.	List of References	33
	Annex – Linkages of land accounting categories in the LULUCF Regulation to inventory categories under the UNFCCC	36

Abbreviations

C	Carbon
CAP	Common Agricultural Policy
CL	Cropland
CM	Cropland management
CRF	Common Reporting Framework
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ETS	Emission Trading System
EU	European Union
FL	Forest land
FM	Forest management
FMRL	Forest Management Reference Level
FRL	Forest Reference Level
GHG	Greenhouse gas
GL	Grassland
GM	Grassland management
HWP	Harvested wood products
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LPIS	Land Parcel Information System
LULUCF	Land Use, Land Use Change and Forestry
MRV	Monitoring, reporting and verification
MS	Member State of the European Union
NFAP	National Forestry Accounting Plans
NFI	National Forest Inventory
RED	Renewable Energy Directive
UNFCCC	United Nations Framework Convention on Climate Change
WL	Wetland

The EU LULUCF Regulation in a nut shell

- The EU Regulation for the Land Use, Land Use Change and Forestry sector (LULUCF Regulation, Regulation (EU) 2018/841, European Commission 2018f) creates the EU legislative framework for emissions and removals from the land use sector for the period 2021-2030 and establishes for the first time a target for this sector.
- The Regulation requires Member States to ensure that the LULUCF sector does not generate net emissions and contributes to the enhancement of sinks in forests and soils („no-debit” obligation).
- In order to keep track of this target, the Regulation defines accounting rules against which progress is measured. To this end, it extrapolates a number of general rules and principles that were already introduced by the Kyoto Protocol and builds on existing EU accounting rules set out in the 2013 LULUCF Decision (Decision 529/2013/EU, European Commission 2013).
- It forms a third column of EU climate policy next to the EU Emission Trading System (EU ETS, Directive (EU) 2018/410, EU 2018) addressing emissions from power stations, industrial plants and airlines and the Effort Sharing Regulation (ESR, Regulation (EU) 2018/842, European Commission 2018g) addressing sectors not covered by the ETS but excluding land use and thus integrates LULUCF into the EU’s 2030 climate and energy framework.
- The Regulation introduces new elements, such as flexibilities for trading accounted amounts from land use between EU Member States and limited flexibility within countries for compensation between the land use sector and the ESR.
- It makes accounting of the land use categories cropland, grassland, and – after 2025 – also wetland mandatory and moves from a narrow definition of land use activities under the Kyoto Protocol to coverage of all land uses on managed lands, corresponding to categories used for reporting under the United Nations Framework Convention on Climate Change (UNFCCC).
- Importantly, the baseline for managed forest lands – the forest reference level – now excludes any anticipated effects of future policies and is based on the observed management practices in the past.
- Overall, the changes result in a very wide coverage of emissions and removals from the sector that Member States will be held accountable for until 2030, increasing overall environmental integrity of the framework compared to the previous legislation. This means that no “backsliding” occurred with its introduction, i.e. no loosening of rules compared to those under the Kyoto Protocol and the LULUCF Decision.
- Compared to earlier rules, the LULUCF Regulation increases incentives for improving land management in the EU as it further reduces accounting for the implications of recent management changes, rather than historic trends.
- But the Regulation also holds room for further improvements. The current rules for establishing reference levels for accounting of forests need to provide the proof of being effective as the rules allow for different approaches. In addition, the rules do not set incentives for long-term planning of mitigation measures in the sector and do not provide

safeguards for negative impacts on biodiversity and nature protection e.g. regarding old-growth forests.

- However, the framework should be regarded as only one element for ensuring sustainable land management within the EU. There needs to be a better alignment with other policies and strategies addressing land use, such as the recast of the Renewable Energy Directive (RED II, Directive 2018/2001/EU, European Commission 2018b), the proposal for the new Common Agricultural Policy (CAP, European Commission 2018d) and the Strategy for long-term EU greenhouse gas emissions reductions European Commission 2018a for alleviating environmental and climate concerns related to the utilization of forests and soils.

1. Introduction

1.1. Aim of this paper

This paper aims to provide an overview of the Regulation (EU) 2018/841 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework (LULUCF Regulation, European Commission 2018f) and facilitate understanding of its content and implications. To do so, we first describe the most important aspects of the Regulation. We compare these with the rules under the current EU LULUCF Decision (Decision No 529/2013/EU, European Commission 2013) applicable until 2020 and present the major changes. Finally, we give a first glimpse at potential implications of the rules for individual Member States and the EU and discuss opportunities as well as risks related to the Regulation.

The paper addresses representatives of NGOs, national authorities and other interested experts and non-experts. It is meant to provide an overview of the main aspects the LULUCF Regulation deals with and to highlight some of the crucial changes that were introduced. It also analyses the implications the accounting rules might have by using publically available data sources and discusses data issues and risks for environmental integrity.

1.2. Background

Under the current energy and climate policy, the EU has set mitigation targets to reduce GHG emissions by 20 % in 2020 and by at least 40 % until 2030 compared to 1990. For achieving these targets, on the one hand the EU introduced the EU Emission Trading System (EU ETS, Directive (EU) 2018/410, European Commission 2018c) that is addressing emissions from power stations, industrial plants and airlines operating between European countries. On the other hand the Effort Sharing Regulation (ESR, Regulation (EU) 2018/842, European Commission 2018g) addresses all sectors not covered by the EU ETS, except for one: the land use sector. The land use sector, formally “Land use, land use change and forestry” (LULUCF), is special: Most importantly, land use activities can result in emissions **and** removals of CO₂. It is currently the only sector which actually removes CO₂ from the atmosphere. In 2015, the EU LULUCF sector represented a net reported carbon sink of about 309 Mt CO₂-eq. in the whole of the EU. This sink was dominated by CO₂ absorbed from existing and new forests. While being a net sink, the sector was also a source of CO₂ emissions for some land use categories. The largest source was land conversion, especially from forests to other land uses (deforestation), and emissions from organic soils under cropland. Since 2000, the reported net annual LULUCF sink has been on average 320 Mt CO₂-eq., with a slight decreasing trend in the last five years.

In July 2016, the European Commission tabled a legal proposal for a Regulation on the inclusion of greenhouse gas emissions and removals from the LULUCF sector into the EU 2030 energy and climate targets. On 30 May the Regulation was officially adopted by the Parliament and Council and entered into force on 9 July 2018 (Regulation (EU) 2018/841, European Commission 2018f). The LULUCF Regulation replaces the current LULUCF Decision (Decision 529/2013/EU, European Commission 2013) from 2013. For the first time, the LULUCF Regulation establishes a target for this sector in EU law. In order to keep track of this target, the Regulation defines accounting rules for the period 2021-2030 applicable to measure progress.

The LULUCF Regulation introduces the obligation for Member States to ensure that emissions do not exceed removals from land use, land use-changes and forests (“no net debit” obligation). Whether emissions exceed removals is assessed over two consecutive periods, the first from 2021-2025 and the second from 2026 -2030. The Regulation should contribute to the EU’s 2030 emission reduction target and its nationally determined contribution under the Paris Agreement (UNFCCC 2015). It extrapolates a number of general accounting rules and principles that were already introduced in the EU LULUCF Decision and implements additional rules, such as the flexibility that Member States can buy and sell net removals to other Member States and a limited option to compensate with emission allocations under the ESR if emissions in the LULUCF sector would exceed removals. The LULUCF Regulation extends the coverage of the accounted areas from only forests to all land uses on managed lands. Importantly, the baseline for managed forest lands against which developments in this area are measured – the forest reference level – now excludes any anticipated effect of future policies and is based on the observed management practice in the past.

2. Explaining reporting and accounting

Before examining the LULUCF Regulation article by article and applying it to EU Member States GHG emission data, we are introducing and discussing some of the underlying concepts and principles for counting of emissions and removals from land use, land-use change and forestry.

2.1. The difference between reporting and accounting

Assessing progress towards agreed targets requires a transparent, accurate, comparable, consistent monitoring system for greenhouse gas emissions and removals.

Reporting aims at documenting the level and development of GHG **emissions** and **removals** over time. It intends covering all anthropogenic emissions and removals (e.g. industrial emissions) but also emissions and removals from biological processes on land areas directly or indirectly influenced by human activities (e.g. emissions from the drainage of peatlands). International guidelines for the reporting of emissions and removals in GHG inventories by countries have been developed and adopted under the UNFCCC and the same guidelines are used in the EU. If complete, reporting under the UNFCCC forms an important basis for assessing the impact of human activities on emissions and removals and thus its impact on climate change.

Accounting, in contrast to reporting, relates to the definition and tracking of the achievement of a GHG mitigation target and can therefore address a variety of accounting elements, such as the reference against which targets are compared or the emission sources or sinks included in the target.

In the LULUCF sector, directly and indirectly human-induced emissions and removals are occurring. An example of directly induced emissions is biomass harvest in forests, e.g. for

bioenergy. Human activities, e.g. the extraction of wood from the forest, directly lead to emissions into the atmosphere, however they are often delayed as the burning happens later and not at the point of time of harvesting. The removals from forests that have been planted are a case of directly human-induced removals. The planting activity, however, can have happened already decades ago. It might also be that the trees regenerated naturally. This can also be interpreted as an indirect-human induced or even natural effect. Another example of indirect human-induced removals is the increased growth of trees due to increased CO₂ concentration in the atmosphere and nitrogen deposition from agriculture and transport. A differentiation between direct and indirect human induced effects is thus not always easy. The identification of direct human-induced emissions and removals is important on the one hand because it allows assessing the mitigation potential but also the level of ambition of emission reduction implied in a mitigation target. A differentiation of direct and indirect human-induced and natural effects is also important for an effective planning of mitigation measures as direct effects can usually be addressed more easily by policies and measures.

Accounting therefore goes beyond reporting and sets the reported emissions and removals into perspective to a target. An important element of accounting is the reference, baseline or base year against which a target for GHG emissions and removals is compared to. These can be historic or projected data. Accounting against a reference level of emissions or removals in the LULUCF sector aims to factor out management effects and thus allows to assess progress of countries but also to compare the level of ambition of targets between countries.

Under the UNFCCC, an accounting framework for the LULUCF sector was introduced by the Marrakesh Accords (Decision 16/CMP.1) in 2001 and comprised a set of principles for LULUCF accounting. These were meant to respond to concerns that the inclusion of LULUCF activities in measuring progress towards mitigation targets should not undermine the environmental integrity of the Kyoto Protocol. Additionally, the provisions were meant to provide safeguards against anticipated risks associated with the inclusion of LULUCF into the Kyoto Protocol. The principles included that that accounting should exclude “*removals resulting from: (i) elevated carbon dioxide concentrations above their pre-industrial level; (ii) indirect nitrogen deposition; and (iii) the dynamic effects of age structure resulting from activities and practices before the reference year.*” The principles were thus aimed at ensuring climate protection (exclude mere presence of carbon stocks, account for reversal of any removal) but also took other issues in the land use sector into account (LULUCF activities should contribute to the conservation of biodiversity and sustainable use of natural resources). Based on the Marrakesh Accords, accounting rules for LULUCF activities were developed and applied in the first (2008-2012) and second commitment period (2013-2020) of the Kyoto Protocol.

The LULUCF Regulation does not directly refer to the accounting principles of the Marrakesh Accords, which were an element of the Kyoto Protocol that will end in 2020. Nevertheless, the LULUCF Regulation strongly builds on some of the Kyoto Protocol accounting rules which were based on these principles. In addition the Regulation refers to “sustainable management practices in the LULUCF sector” as defined by Forest Europe (1993), see also Forsell et al. (2018).

2.2. Land-based versus activity-based accounting

The LULUCF Regulation introduces an important change towards a harmonisation of reporting and accounting approaches as it refers to “land-based accounting” (applicable under the UNFCCC accounting framework) in contrary to “activity-based accounting” (applicable under the rules of the Kyoto Protocol and its implementation into EU law, the 2013 LULUCF Decision). The LULUCF

Regulation hence builds directly on emissions and removals annually reported in GHG inventories by EU Member States under the UNFCCC.

A “land-based approach” to accounting takes as a starting point the total carbon stock (C stock) changes in all carbon pools on all **land areas**. An “activity-based approach” estimates the impact of C stock changes that can be attributed to designated land use **activities** and assigns the land areas to these activities. Under the Kyoto Protocol, an activity-based accounting approach was chosen. The two approaches exist in parallel because in the early stage of the Kyoto Protocol, the focus was on including human activities, such as deforestation and afforestation. A narrow definition of activities was meant to avoid the inclusion of large gross removals, e.g. from existing forests.

The more activities, pools and gases are included in activity-based accounting, the closer resulting emissions and removals correspond to emissions and removals under land-based accounting. Since land-based accounting is more comprehensive, i.e. includes more emissions and removals, it reflects the impact on the atmosphere more accurately and can therefore be considered more environmentally integer. However, the reporting effort might increase with more land classes included.

2.3. Net-net, gross-net and accounting against a reference

Depending on the land category, the LULUCF Regulation applies different accounting methods for defining the references against which emissions and removals in the target period are accounted.

Net-net accounting (accounting compared to a base year or base period, see Figure 2-1 a) is the same method which is used in other sectors (for example emission reductions compared to 1990). This method is applied to several LULUCF land categories. The reference value for managed cropland, grassland and wetlands pursuant to Article 7 of the Regulation are the average net emissions and removals of the years 2005 to 2009. The average annual net emissions and removals in the commitment period will be compared to the reference value. As a result, a country with decreasing net emissions in the commitment period would receive credits under this approach (even when the category remains a net emission); a country with a declining sink would have to account this as debits (although the category is still a net sink). In conjunction with the no net debit rule, net-net accounting implies that the climate effect of this land category should remain the same as in the base period – or improve.

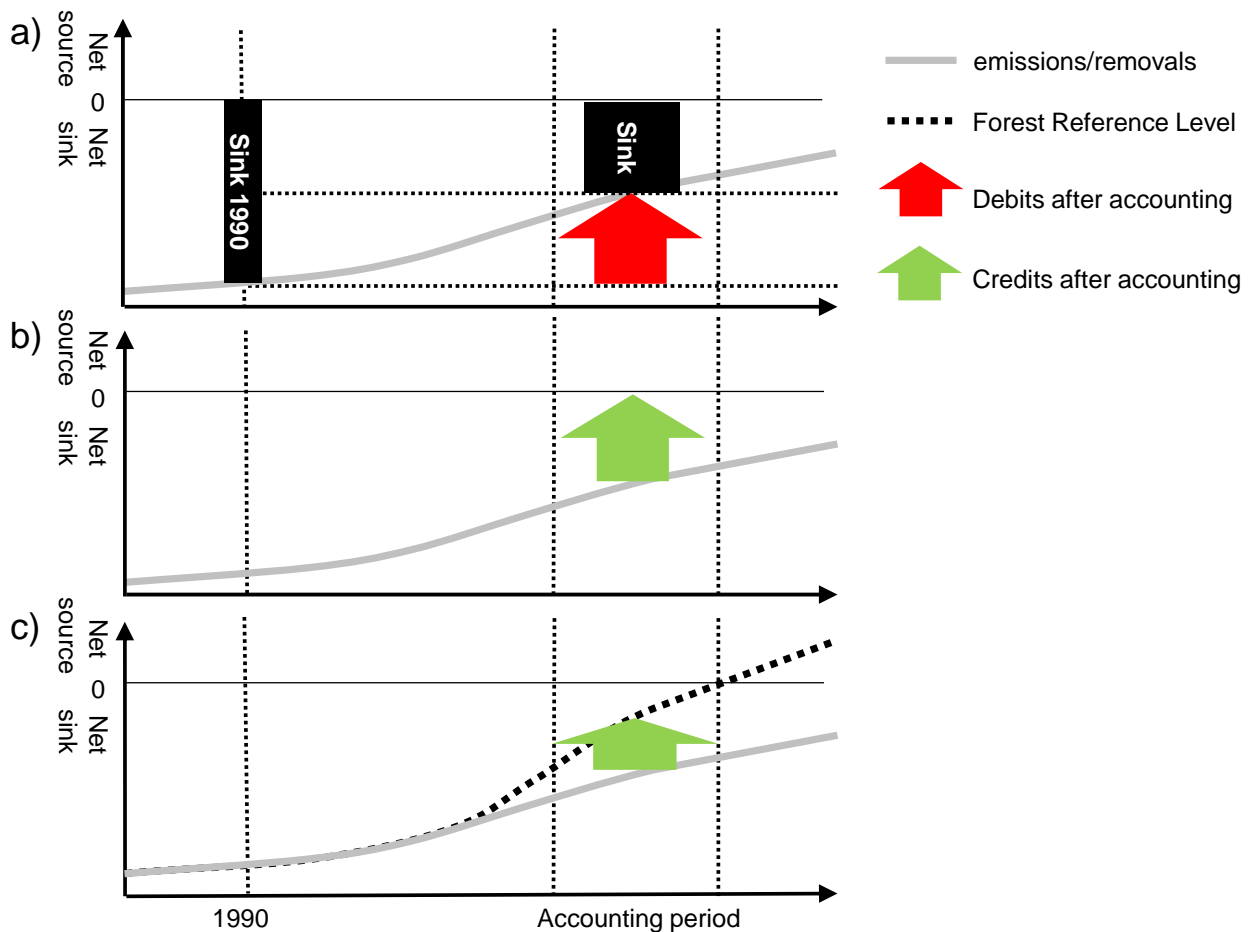
Gross-net accounting only considers emissions and removals that occur during the accounting period. No comparison with any historic or future reference is made (actually it is compared to zero, see Figure 2-1 b). It is applied to deforested and afforested land in the LULUCF Regulation and under Article 3.3 of the Kyoto Protocol. It also was the accounting method for forest management (Article 3.4) in the first commitment period of the Kyoto Protocol. A country with a declining net sink would receive credits if the net sink still exists in the accounting period (compared to a zero line). Hence, all emissions or removals from the deforested and afforested land are accounted for. In this logic, afforestation and deforestation are 100% attributable to human behaviour and are thus fully considered.

In the second Kyoto Protocol commitment period, a **reference level accounting** approach was adopted for forest management, which has been modified under the LULUCF Regulation for managed forest land. It is applied by introducing a forest reference level (FRL), which is the counterfactual value of emissions and removals that would occur in managed forest land in the absence of any future change in management practices compared to the reference period (see

Figure 2-1 c). The aim is to level out natural fluctuations in forests and only account for the anthropogenic impact of changes in the management practice. The detailed method for accounting of managed forest land under the Regulation is described in chapter 4.3.

Accounting against a reference level means that in the category managed forest land – which makes up most of the LULUCF removals in the EU, see Figure 5-1 – the generation of accountable removals is much more limited than under a net-net or even a gross-net approach.

Figure 2-1: Illustration of different accounting methods: a) net-net, b) gross-net, c) accounting against a reference level



Source: Adapted from Böttcher and Graichen 2015

3. Description and analysis of the LULUCF Regulation

3.1. General concept of the Regulation

The EU's nationally determined contribution under the Paris Agreement of at least a 40 % domestic reduction of economy-wide greenhouse gas emissions by 2030 compared to 1990 specified that the policy on how to include LULUCF into the 2030 GHG mitigation framework “will

be established as soon as technical conditions allow and in any case before 2020.” Such framework for the reporting and accounting of emissions and removals from the LULUCF sector has been established with the adoption of the LULUCF Regulation. As carbon removals by forests and soils are reversible and are thus subject to very different accounting rules and targets than other sectors, it was decided to treat the sector as a separate pillar in the Union climate policy framework. The LULUCF Regulation can therefore be seen as the “third pillar” of the EU climate framework besides the ETS and the ESR.

The essential commitment for Member States under Article 4 of the LULUCF Regulation is to ensure that to ensure that emissions do not exceed removals from land use, land use-changes and forestry for the periods from 2021 to 2025 and from 2026 to 2030, calculated as the sum of total emissions and total removals in all of the land accounting categories defined in the regulation (“no debit” obligation). This means that each Member State needs to ensure that accounted GHG emissions (debits) from land use in some land accounting categories are entirely compensated by accounted removals (credits) from land use in other categories. A description of the categories applicable for accounting under the Regulation is provided in chapter 3.2.

As an example: If a Member State converts forests to other land uses (deforestation) or increases emissions from croplands, it must compensate for the resulting emissions, e.g. by planting new forests (afforestation), by improving the sustainable management of existing forests, enhancing C stocks in soils on croplands or grasslands or by using so-called “flexibilities”. These flexibilities imply the following options: Member States are allowed to balance a potential deficit by using emission allowances from the other non-ETS sectors covered by the Effort Sharing Regulation, by agreeing to trade removals with other Member States or by using net removals banked from the first accounting period (2021-2025) to the second period (2026-2030) (see chapter 4.5).

The LULUCF Regulation sets the rules for the time frame 2021-2030 and divides it into two periods of 5 years, 2021-2025 and 2026-2030. Separate accounting balances are calculated for each of these periods and compared to two separate reference levels that are also multiplied by five to match these periods. This means while data is reported annually, accounting only takes place twice covering 5-year periods: for the first time when 2025 inventory data is reported (in the year 2027) and for the second time in 2032 when the inventory data for 2030 is reported. The main reason for these longer cycles is the complexity of data collection.

3.2. Categories of land included in the Regulation

The Regulation defines six main land accounting categories (see Article 2 of the Regulation):

- Afforested land
- Deforested land
- Managed cropland
- Managed grassland
- Managed forest land
- Managed wetland

Compared to the LULUCF Decision and the reporting and accounting framework under the Kyoto Protocol, categories were broadened and renamed to achieve consistency with reporting under the

UNFCCC and to reflect the transition from activity-based to land-based accounting. For example, the activity cropland management (CM) is transferred to the category managed cropland.

For land-use changes, per definition a previous land category will transform into a new land category 20 years after the date of conversion (IPCC 2013a; 2006). Within the category “afforested land” Member States can derogate from the 20 year transition period in duly justified cases, see chapter 4. Table 3-1 presents the transitions between land categories and how they are represented in the aggregate land accounting categories.

It is rather straightforward that all land areas converted to forests are aggregated to “afforested land” and all land areas where forest was converted to other land uses are grouped to „deforested land“. Instead, for example, the „managed cropland“ category does not only include all land areas of cropland that remained cropland and land areas that have been converted to cropland, but it also includes all land areas that were cropland in the past 20 years and were converted to wetlands, settlements and other land. The most relevant conversion may be the extension of settlements to cropland or grassland areas and related emissions and removals will be allocated under „managed cropland“ or „managed grassland“ in the EU accounting system for which this may not be the expected category. Emissions and removals from settlements remaining settlements, other lands remaining other land, or the conversion from settlement to other land or from other land to settlement are not part of the EU land accounting categories; therefore the related boxes are empty in Table 3-1. The emissions and removals on these land categories are comparatively small, e.g. “other lands” comprise mainly mountains with bare rocks.

Table 3-1: Definitions of land accounting categories and transitions between categories after land use change

		before					
		forest land	cropland	grassland	wetlands	settlements	other land
after	forest land	managed forest land	afforested land	afforested land	afforested land	afforested land	afforested land
	cropland	deforested land	managed cropland	managed cropland	managed cropland	managed cropland	managed cropland
	grassland	deforested land	managed grassland	managed grassland	managed grassland	managed grassland	managed grassland
	wetlands	deforested land	managed cropland	managed grassland	managed wetland	managed wetland	managed wetland
	settlements	deforested land	managed cropland	managed grassland	managed wetland		
	other land	deforested land	managed cropland	managed grassland	managed wetland		

Source: Own visualization based on LULUCF Regulation Article 2

How the land accounting categories are linked to the UNFCCC inventory categories can be seen in Table A-1 in the Annex.

3.3. Pools and gases included in the Regulation

A carbon pool is defined as a biogeochemical feature or system within which carbon or any greenhouse gas containing carbon is stored (see Article 3 of the LULUCF Regulation). The LULUCF Regulation defines six relevant carbon pools (see Annex I of the Regulation):

- above-ground biomass
- below-ground biomass
- litter
- dead wood
- soil organic carbon;
- for afforested land and managed forest land: harvested wood products.

Good practice guidance for the verification of carbon pools can be found in (IPCC 2013a).

The relevant greenhouse gas occurring in the LULUCF sector is mainly CO₂. However, the LULUCF Regulation also takes into account certain sources of methane (CH₄) and nitrous oxide (N₂O) from the sector. These gases are reported under the categories „forest fertilization“, „forest fires“ and „drainage of forest soils“. Also direct N₂O emissions from fertilizer applied to forests are reported. N₂O emissions from fertilizer application on cropland and grassland and other non-CO₂ emissions from soils are part of the emissions of the agriculture sector and do not belong to the LULUCF sector.

4. The accounting rules

4.1. Accounting for afforested land and deforested land

Accounting for afforested land and deforested land is based on gross-net accounting (see Figure 2-1 b). This means that total net removals or net emissions resulting from afforestation or deforestation that are occurring during the accounting period are taken into account.

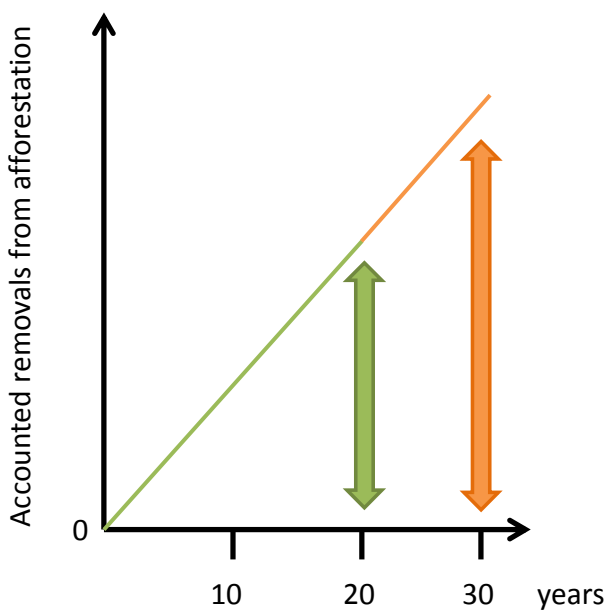
Unlike in other categories, Member States may use a longer transition period (30 instead of 20 years) for afforested land to the land accounting category „managed forest land“ if duly justified based on the IPCC Guidelines (see Article 6 of the Regulation and IPCC (IPCC 2013a; 2006)).

Figure 4-2 illustrates the theoretical implications of changes in the transition period for accounted amounts of emissions and removals from afforestation. It is assumed that a Member State afforests continuously over the respective time period. The application of a transition period of 20 years means that net removals caused by afforested areas are fully accounted for 20 (or even 30) years (because accounted against the zero line) and then they are taken out of the category „afforested land“ and will be accounted for in the category „managed forest land“. In this category these net emissions/removals are accounted against the forest reference level which leads to significantly lower accounted credits or even debits from such lands. This is because the net emissions/removals are compared to a reference or projected afforestation rate that was assumed as part of the country's forest reference level and not to a zero rate.

A change in the transition period to 30 years implies that credits can be fully accounted for another 10 years, compared to the transition period of 20 years and considerably more credits from

afforestation can be claimed due to the extended period during which gross-net accounting can be applied. Assuming constant rates as Figure 4-1 does, the amount would be significantly higher than accounted removals from a 20-year period. For countries with historically high afforestation rates, this option is clearly an advantage and increases their net removals in the accounting periods. The option might reduce the incentives for continuing afforestation because also older afforestation areas are included.

Figure 4-1: Idealised illustration of the effect of a prolonged transition time for afforestation on accounted removals



Source: Own illustration

For calculating emissions and removals from afforested and deforested land (and also managed forest land), Annex II of the LULUCF Regulation indicates specific parameters of forest definitions for each Member State. The parameters are minimum values for forest area, tree crown cover and tree height for each Member State. Areas range from a minimum of 0.05 ha for Czech Republic and Austria to a minimum of 1.0 ha for Spain and Malta. Tree crown cover ranges from a minimum of 10 to 30 % and tree height is specified as a minimum of either 2, 3 or 5 m for each country. The different values reflect different national circumstances and differences in forest types and also allow the Member State to apply definitions consistent with their national forest definitions.

4.2. Accounting for managed cropland, managed grassland and managed wetland

Accounting for managed cropland, managed grassland and managed wetland is based on net-net accounting (cf. Figure 2-1). This means that net emissions or removals in the periods from 2021 to 2025 (except for wetlands, see below) and from 2026 to 2030 are compared to the average annual emissions and removals in a base period. The difference of net emissions or removals compared to net emissions in the reference period is accounted for. The base period defined in the LULUCF Regulation is the period from 2005 to 2009. In the LULUCF Decision the reference year was a single year (2005).

Using a base period instead of single years as a reference for accounting has several advantages: Fluctuations in emissions or removals between years and extreme values that are e.g. due to natural disturbances such as storms, are levelled out.

Accounting of emissions and removals from managed wetland is planned to be mandatory from 2026 onwards. The Regulation, however, leaves the option for the Commission to postpone mandatory accounting for managed wetland by five years if necessary, because not all Member States have yet gained experience with the use of the methodologies to estimate emissions from wetlands provided by the IPCC Wetland supplement (IPCC 2013b). Member States can notify the Commission by the end of 2020 if they want to include managed wetlands in their accounting from 2021 onwards.

4.3. Accounting for managed forest land and harvested wood products

4.3.1. How accounting against the forest reference level works

Accounting for managed forest land is based on accounting compared to a “Forest Reference Level” – FRL (see Figure 2-1 c). The FRL is the counterfactual value of emissions and removals that would occur in managed forest land in the future based on the continuation of “sustainable forest management practices”, as documented in the period from 2000 to 2009 and assuming a constant ratio of raw material and energy use. Annex IV of the LULUCF Regulation defines criteria for the establishment of such FRL. The main idea of this concept is to separate anthropogenic effects, e.g. caused by management changes, from natural growth effects in the forest (e.g. due to the age of forests). Management changes include also changes in the use of wood as raw material or for energy production.

It is important to recognize that only the difference between the FRL and the reported net emissions and removals is accounted for. This means that the accounted amount will probably deviate considerably from the annually reported net emissions and removals in the LULUCF inventory under UNFCCC. A country with a reference level that expects a large net sink without management changes (under business as usual assumptions) will face debits if an intensification of management decreases the sink compared to previous levels despite the fact that the forest is still a net sink of CO₂. The idea behind accounting against a reference level is to account for the anthropogenic effect of management changes on the carbon storage in forests. This is why Member States can have a natural net sink of managed forests but debits from accounting at the same time – or vice versa.

Article 8, paragraph 2 of the LULUCF Regulation applies a cap of 3.5 % of total base year emissions to the total accountable net removals from managed forests. This means the maximum accountable net removals from managed forest land in each accounting period are limited to 5 times of the emissions in the base year per Member State as specified in Annex III of the Regulation (1990 for the majority of Member States). The cap excludes carbon pools of harvested wood products (excluding paper) and dead wood. This rule continues the previous capping of removals from the Kyoto Protocol. This gives an indication that no “backsliding” occurred with the introduction of the Regulation, i.e. no loosening of rules compared to Kyoto Protocol and LULUCF Decision with potential negative impacts on climate and environmental integrity.

4.3.2. How the forest reference level is constructed

The construction of the FRL has a major influence on the expected credits and debits from accounting. For the establishment of forest reference levels the LULUCF Regulation therefore

introduced a list of criteria to ensure environmental integrity (to be found in Section A of Annex IV). In addition, the Commission published “Guidance on developing and reporting Forest reference Levels in accordance with Regulation (EU) 2018/841” for Member States on the establishment of FRLs.

In general the FRL is meant to reflect the “*continuation of sustainable forest management practice, as documented between 2000-2009 with regard to dynamic age related forests characteristics in national forests, using the best available data*”. Most importantly, this rule bases the Forest Reference Level solely on observed management practices in the past and excludes any assumptions about the effect of future policies. The definition of sustainable forest management is taken from the Ministerial Conferences on the Protection of Forests in Europe („Forest Europe“) as stated in the preamble of the LULUCF Regulation (recital 16). There, sustainable management is defined as “*the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems*” (Forest Europe (1993) as cited in Forsell et al. (2018)).

When comparing the FRL constructed that way with the reported net emissions/removals during the accounting period, only the net emissions and removals caused by management changes having occurred since 2009 are accounted for.

Additional criteria require that “*reference levels should ensure a robust and credible accounting, to guarantee that emissions and removals resulting from biomass use are properly accounted for*”. Carbon stored in harvested biomass is transferred to wood products that have different lifetimes or it is consumed as bioenergy for generating heat and power. For more transparency on the impacts of biomass harvest FRLs should include the carbon pool of harvested wood products with two calculations: one assuming all harvested biomass carbon is immediately emitted and one assuming that it is transferred into wood products with typical decay rates (see (d) of section A of Annex IV of the Regulation). These two calculations allow to assess the effect that harvested wood products have on the LULUCF accounts. In case a country increases biomass harvest above the historic intensity level, it matters whether the additional biomass is used for energy or for materials. The FRL builds on the assumption that the ratio between material and energy use of forest biomass as observed between 2000 and 2009 remains constant (see (e) of section A of Annex IV of the Regulation). This assumption ensures that increased harvest for bioenergy use is accounted for as a debit in the LULUCF sector. As bioenergy use is not counted as emissions in the energy sector the accounting under the LULUCF sector is important for environmental integrity and balanced accounting.

The above mentioned criteria and specific guidance indicate that the reference level required under the LULUCF Regulation is likely to be more robust than under the Kyoto Protocol. At the same time, the reference level constitutes a considerably higher level of sophistication and requires more detailed analysis of historic trends compared to the Forest Management Reference Levels (FMRLs) established for the second commitment period under the Kyoto Protocol. The FMRLs submitted by Member States and partly also projected by modeling work commissioned by the European Commission did not factor out management intensification triggered by expected increased demand and therefore could also include anticipated harvest increases due to implemented policies and market situation. The new rules under the Regulation exclude future policies and the danger of credits potentially generated by an overestimation of future harvest level.

Overall the new rules for accounting of managed forest land foster the principle that only direct human-induced effects are included. A common prerequisite for accounting against a reference level is the need for consistency between GHG inventories, relevant historical data and the projection related to managed forest land. Explicitly the Regulation requires that the model used to construct the reference level needs to be able to reproduce historical data from the inventory (see (h) of section A of Annex IV of the Regulation). Changes in methods for producing the inventory necessarily lead to inconsistencies with the FRL. For this case technical corrections are foreseen.

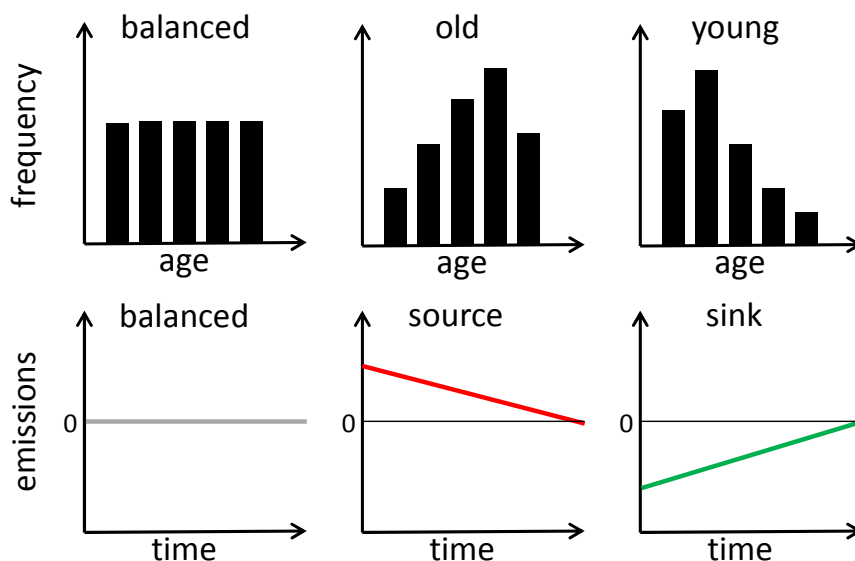
In 2019 the National Forestry Accounting Plans including the proposed FRLs submitted by Member States were reviewed by a LULUCF Expert Group consisting of European Commission, individual and national experts. This resulted in an synthesis reports for each Member State with technical recommendations for corrections and improvements (European Commission 2019). The submission of revised forest reference levels is required by 31 December 2019, followed by the adoption of a delegated act by the Commission that fixes the reference levels by 31 October 2020. The reference levels for the period from 2026 to 2030 are due by 30 June 2023 and follow the same procedure of technical assessment, resubmission and fixation.

Still, it might become necessary to recalculate the estimated reference level values, e.g. due to changes in methodology for producing the inventory by Member States. Such a change would have an effect on the forest reference level, making it methodologically inconsistent with the inventory. Before accounting against inventory data is finally conducted after the end of the first and second compliance period in 2027 and 2032, a technical correction needs to be carried out. Technical corrections can have a large impact on the reference levels and also on the emissions and removals to be accounted. Due to the fact that the technical corrections need to be carried out only during the time of accounting, the final reference level values might remain unknown until even 2027 and cause considerable uncertainties for Member States.

Box: How the FRL factors out age-class effects of emissions and removals from managed forest land

Forests consist of trees of different age. Depending on their age trees sequester CO₂ more or less rapidly. Typically younger trees grow more quickly than older trees but this very much depends on species and site conditions. More importantly, older forests hold higher carbon stocks than younger forests. Assuming three landscapes with shares (frequencies) of younger and older trees (balanced, old and young, see figure below) and assuming the same management intensity (in terms of area harvested) these developments of the carbon balance of these three landscapes significantly differ (see lower figures). This effect is the main reason why the reference level approach was introduced (Böttcher et al. 2008).

According to Article 8, paragraph 5, the FRL shall take the age-class structure of forests into account by starting from conditions in the period 2000 to 2009 and projecting emissions and removals under continued sustainable forest management practices using best available data. These effects of age-class structure are also included in the GHG inventory data. A comparison of the FRL (taking into account effects of age-class structure) and the GHG inventory data (reflecting changes in emissions and removals due to age-class structure and forest management) theoretically reveals the effect of management changes, but there are other influencing factors such as weather in particular years, climate change, CO₂ and nitrogen deposition or natural disturbances. Depending on how the forest reference level is constructed, the model used for projection can also factor out other influencing parameters like that of climate change or nitrogen deposition on tree growth (Vetter et al. 2005).



Source: Böttcher et al. (2008), Vetter et al. (2005)

4.3.3. How emissions from harvested wood products are estimated

As described above, the FRL includes separate estimates for emissions and removals from harvested wood products (HWPs). Different methods for reporting and accounting for HWPs are provided in the 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006) and one specific approach was adopted as part of the IPCC “2103 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol” (IPCC KP Supplement) (IPCC 2013a). This so-

called production approach accounts for all harvested wood products produced from wood harvested in a country, ignoring imports and exports of wood and wood products. It was adopted as part of the 2013 LULUCF Decision (European Commission 2013) and continues to apply under the LULUCF Regulation for the period after 2020. The production approach estimates the annual HWP carbon stock change originating from wood harvested in the reporting country only and includes the exported wood products, but excludes the imported wood products. It is important that consistent approaches to HWP are taken on a global scale in order to avoid double-counting and gaps in accounting of emissions from HWP as a result of trading of such products.

The default approach applied by most Member State distinguishes three categories of products: paper, wood panels, and sawn wood. It is assumed that the harvested wood is sorted to these categories and the CO₂ embedded within the wood, after a certain period of use, is emitted to the atmosphere. The residence time of CO₂ in the product pools is estimated using a first order decay function for each product group and default half-life values specified in Annex V of the Regulation. Energy wood and wood in landfills is excluded and considered to cause emissions immediately.

4.4. Accounting for natural disturbances

The LULUCF Decision already introduced the provision that Member States may exclude emissions from extreme events such as wind falls from storms, insect outbreaks or fires in forests from accounting. This was also already accounted for during the second commitment period under the KP, when accounting of forests became mandatory. In many countries natural disturbances are a feature of the forest ecosystem. As there are limits to managing and controlling emissions from extreme events, the provision grants countries an option for reducing the risk of large debits from these events. The rules for doing so were provided by the IPCC Kyoto Protocol Supplement (IPCC 2013a). The general approach for the exclusion of effects from natural disturbances is following three steps:

- Based on statistics, a “background level” of emissions from natural disturbances for a country is documented for the past. This describes the normally occurring emissions in the absence of extreme events. According to Article 10, paragraph 1 of the LULUCF Regulation, average emissions by natural disturbances in the period from 2001 to 2020 excluding statistical outliers are the basis for the calculation of the background level.
- If emissions of an event during the accounting period exceed the background level (plus a certain margin to reflect uncertainties), it can be considered “extreme”. If emissions from forests in an accounting period exceed the background level plus a margin, the exceeding emissions may be excluded from the accounted emissions. Article 10, paragraph 2(b) specifies that also subsequent removals on the land affected by the natural disturbance have to be excluded from the accounting until 2030. Thus, effectively, the related forest areas on which extreme events occurred are excluded from the accounted land areas until 2030.
- The exclusion comes with some additional rules specified in Annex VI of the LULUCF Regulation, e.g. that the areas where the events took place are exactly known and a documentation that shows that removals on these areas after the event, when the forest is recovering, are excluded, too. This makes implementation of the provision technically demanding but it is an important instrument for countries where such events can easily exceed normal years of emissions and removals by an order of magnitude. Emissions from

harvesting and salvage logging¹ after the disturbance event, emissions from deforestation after the disturbance event and emissions from prescribed burning on the disturbed land areas cannot be excluded.

4.5. Flexibilities

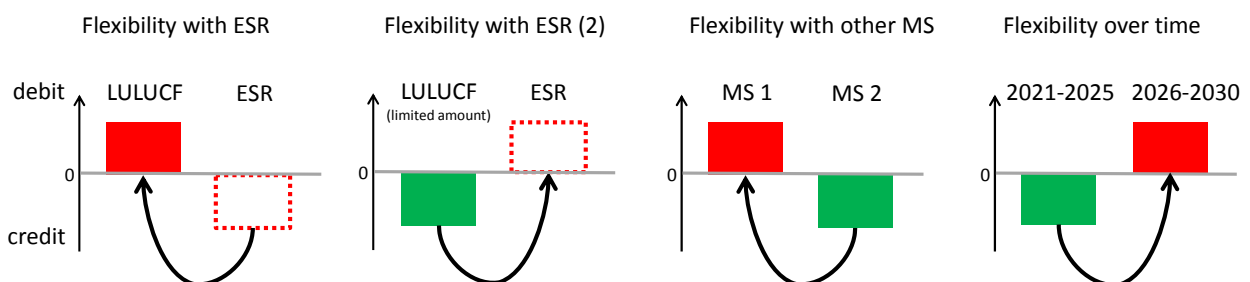
4.5.1. How general flexibilities work

The LULUCF Regulation includes provisions for Member States to achieve compliance through a number of flexibilities. Three options that are referred to as “general flexibilities” are described in Article 12 of the Regulation (Figure 4-2).

1. Member States may delete annual emission allocations (AEAs) under the Effort Sharing Regulation (ESR) for the non-ETS sectors covered by the regulation to compensate total net debits under the LULUCF Regulation (Article 12, paragraph 1).
2. A Member State may sell net removals under the LULUCF Regulation to other Member States that face net emissions from LULUCF accounting.
3. Finally, Member States are allowed to bank surplus net removals from the first accounting period (2021-2025) to compensate for net emissions in the subsequent accounting period (2026-2030).
4. Another type of flexibility between sectors is described in Article 7 of the Effort Sharing Regulation. It allows Member States with net removals, for instance resulting from improved land management, beyond their commitment, to use a limited number of these net removals to comply with the Effort Sharing Regulation. In total, this flexibility is capped at 280 Mt CO₂ over the ten-year period. The maximum amounts of net removals that Member States can take into account for compliance with the Effort Sharing Regulation are fixed in Annex III of the LULUCF Regulation.

Figure 4-2: Illustration of the general flexibilities offered by Article 12 of the LULUCF Regulation as well as Article 7 of the Effort Sharing Regulation

Article 12 LULUCF Regulation - General flexibilities / Article 7 Effort Sharing Regulation



Source: Own illustration

¹ Salvage logging is the practice of logging trees in forest areas that have been damaged by wildfire, floods, storms, pests or other natural disturbance in order to recover economic value that would otherwise be lost.

The general flexibilities introduce connectivity between the sectors covered by the ESR and the LULUCF sector. Such connectivity was criticized for opening the “fire wall” between the biogenic emissions and removals of land use activities and fossil fuel emissions from ESR activities and thus reduce incentives for bringing down fossil fuel emissions (Fern 2018). On the other hand the flexibilities can potentially contribute to increasing incentives for Member States in implementing measures in all sectors and helps them achieving compliance with the regulations.

4.5.2. How the managed forest land flexibility works

In addition to general flexibilities, the LULUCF Regulation allows for a compensation for Member States that face net emissions from accounting of their managed forests within an accounting period (Article 13). Originally, it was intended to overcome resistance from forest-rich countries which feared net emissions debit despite a sizeable reported sink. For this reason, they strongly favoured an approach for forest reference levels where policy assumptions, e.g. on the future use of bioenergy, can be included. While Member States finally opted for an approach for FRLs based on historic data, the Regulation introduces a new flexibility to balance potential net emissions from managed forest land in forest-rich countries. In order to reduce environmental integrity risks, a number of requirements need to be fulfilled before this flexibility can be used.

The first prerequisite is that net emissions occur for the LULUCF sector as a whole (step 1). Furthermore, the categories HWP and managed forest land still need to be a sink or at least accounted for as zero (step 2). In addition, the FRL needs to expect a higher sink than the actual net sink from these categories (step 3).

Prerequisites to use the flexibility are furthermore that:

- Member States have implemented or planned measures to ensure the conservation or enhancement of forest carbon stocks. These measures need to be formulated in their long-term low emission strategy under the Monitoring Mechanism Regulation Article 4 (MMR, Regulation (EU) No 525/2013, EU 2013), respectively Art. 15 of the Governance Regulation (EU) 2018/1999, European Commission 2018e) that Member States had to submit by 2020.
- The flexibility may only be applied if the EU as a whole complies has no net emissions from with the “no debit” rule for all land categories. This prerequisite addresses the issue that the flexibility has been criticized for removing incentives to maintain the LULUCF sinks.
- The maximum allowed compensation that has been capped at the EU level at 370 Mt CO₂ for the ten year period 2021-2030 and allocated to Member States based on their relative share of forest sinks in 2000-2009 (see Annex VII of the Regulation). This rule was introduced to ensure that the overall integrity of the EU target of at least 40% emission reduction is met.

5. Discussion of opportunities and risks

The LULUCF Regulation will be applied for the future period 2021-2030, for which reported data does not yet exist. However, the established accounting rules can be applied to publically available data of projected national emissions and removals. This allows a first glimpse at potential implications of the rules for individual Member States and the EU. In the following we present estimates of potential future accounted emissions and removals. This allows us to discuss opportunities as well as risks related to the implementation of the Regulation more concretely. It has to be noted that the projected data are highly uncertain and also other information needed for

accounting, such as values for Forest Reference Levels, are not yet known or might change in the future.

5.1. Emissions and removals from LULUCF in EU Member States

In Figure 5-1 and Table 5-1 historic emissions/removals from LULUCF categories are depicted as well as projected emissions/removals from the EU Reference scenario as published in the European Commission's report "Trends to 2050" (European Commission 2016 – numbers scaled to fit to historical data using the method described in Böttcher and Graichen 2015). Please note that these are reported values, not accounted ones.

Overall, the net LULUCF sink is projected to shrink by 25% in 2050 compared to 2015, going down from removals of 327 Mt CO₂ to 243 Mt CO₂. The main contributor to the sink remains forest land, with an increasing share of new forests. Most of the removals within the LULUCF sector come from the category "managed forest land" (FL-FL in the figure). In 2015, removals from this category amounted to about 371 Mt CO₂ and mainly occurred in Germany, France, Sweden, Finland and Poland. It can furthermore be observed, that removals from this category are projected to decrease quite drastically to 161 Mt CO₂ by 2050. This is partly due to forests getting older and associated reduced growth rates in some forest types (see Box), but also due to increased harvest rates expected for the future. The underlying Reference scenario assumes that EU climate and energy targets of 2030 are met, leading to higher demand for bioenergy (as one example for increased harvest rates). There is, however, a high uncertainty in these projections.

On the other hand, removals from afforestation (L-FL) only amounted up to 53 Mt CO₂ in 2015 but are projected to increase to 129 Mt CO₂ by 2050. Main contributing countries to this development are France, Italy, Poland and Spain. The highest afforestation removals are currently observed in Spain.

Deforestation (FL-L) peaked in 2008 with emissions of 43 Mt CO₂ in that year. Highest net emissions from deforestation are reported by France and Romania. Emissions from deforestation are projected to decrease continuously in the future. This results especially from decreasing deforestation emissions in France.

Managed cropland historically had the largest net emissions within the LULUCF sector and is also projected to have the largest emissions in the future. However, emissions are projected to decrease from 75 Mt CO₂ in 1990 or 60 Mt CO₂ in 2015 to 45 Mt CO₂ by 2040. Countries with highest rates of decreasing emissions are France, Belgium and Poland. Highest emissions from managed cropland are reported by France, Germany and the United Kingdom. It should be noted that under this category also land use changes from cropland to settlements/wetlands/other land are reported.

For managed grassland (GL) it is expected that the source will become a sink in the future with about -11 Mt CO₂ in 2050. Countries with highest decreasing emissions or increasing removals are Poland, Ireland and the Netherlands. Highest actual emissions from managed grassland in 2050 occur in Germany, the United Kingdom has the highest removals in this category. It should be noted that under this category also land use changes from grassland to settlements/wetlands/other land are reported.

If net emissions and removals develop according to projected data, the net sink within the LULUCF sector will remain rather constant and range in a similar order of magnitude in 2050 as it has been in 1990 (-250 to -260 Mt CO₂).

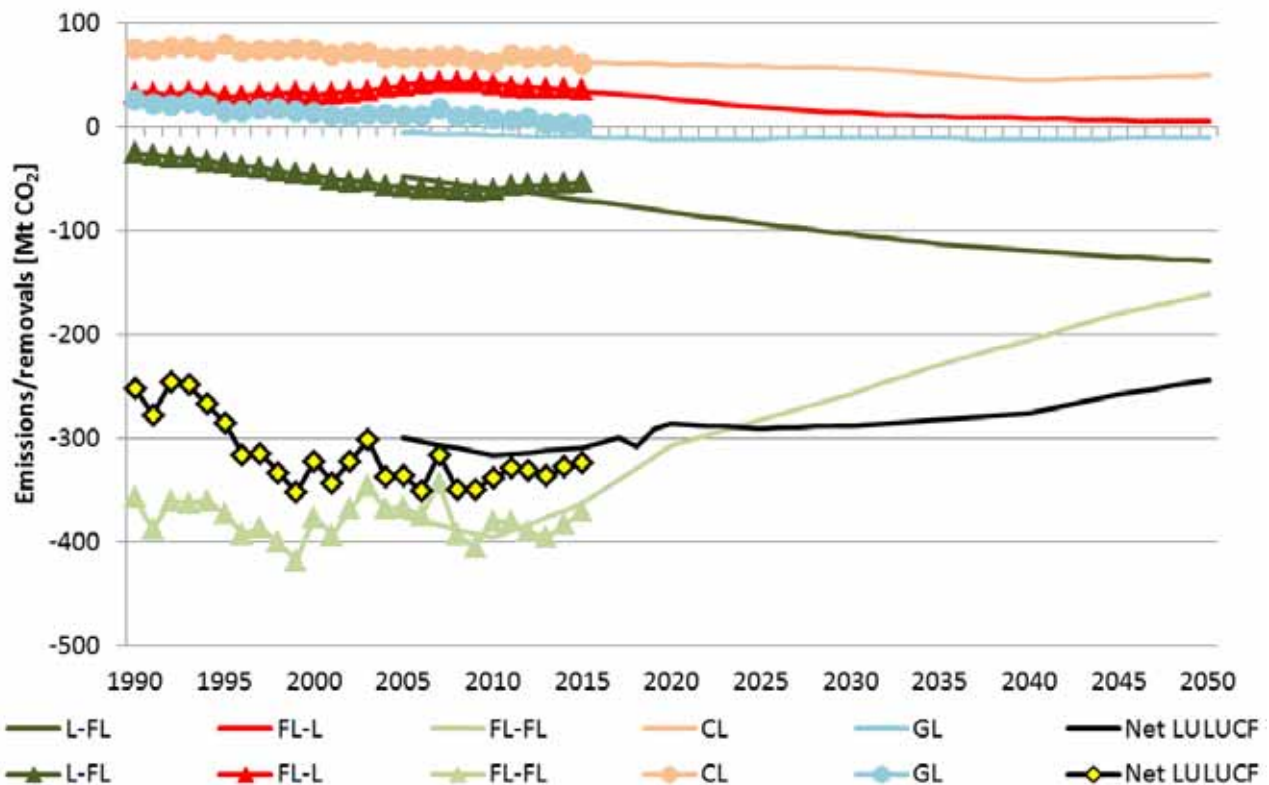
Table 5-1: Historic and projected emissions and removals within the LULUCF sector in the EU [Mt CO₂]. Negative data indicate net removals and positive data net emissions.

Category	1990	2015	2020	2030	2040	2050
L-FL	-25,7	-53,3	-82,3	-103,9	-119,3	-129,4
FL-L	31,8	35,4	26,6	13,4	7,7	5,2
FL-FL	-357,5	-371,1	-307,6	-257,1	-205,8	-161,1
CL	75,1	60,4	59,6	56,3	44,5	49,1
GL	25,6	2,6	-12,0	-11,3	-11,8	-11,2
Net LULUCF	-251,7	-323,7	-309,4	-311,3	-299,2	-263,3

Source: EU-28 inventory data under UNFCCC (submission 2017), European Commission 2016; numbers for projection scaled to fit to historical data using the method described in Böttcher and Graichen 2015.

Abbreviations used: L-FL = Land converted to forest land (afforestation); FL-L = forest land converted to land (deforestation); FL-FL = forest land remaining forest land (managed forest land); CL = managed cropland; GL = managed grassland.

Figure 5-1: Development of historic and projected emissions and removals from the LULUCF sector in the EU

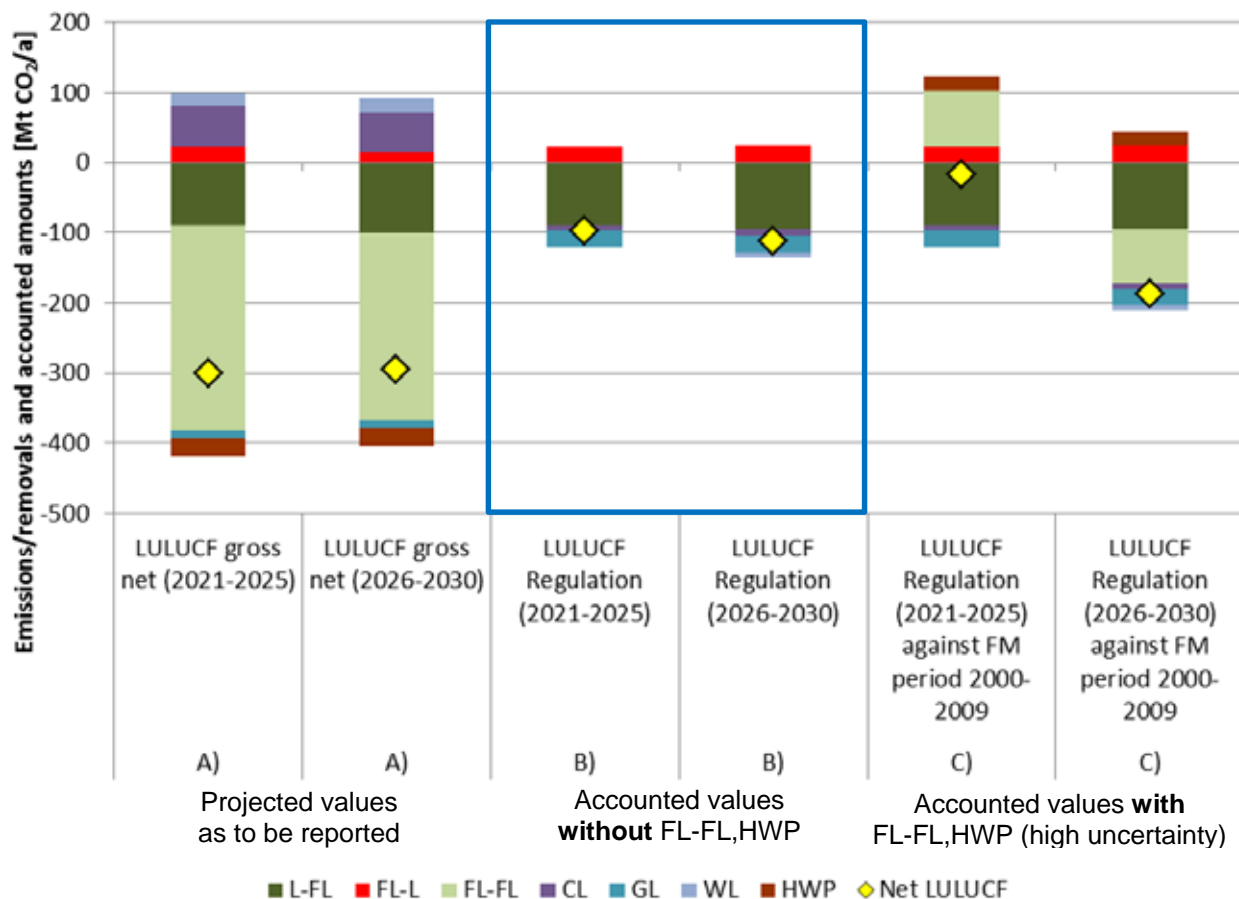


Source: Own illustration with data from EU-28 inventory data under UNFCCC (submission 2017) and projection data from European Commission 2016; numbers for projection scaled to fit to historical data using the method described in Böttcher&Graichen 2015

Abbreviations used: L-FL = Land converted to forest land (afforestation); FL-L = forest land converted to land (deforestation); FL-FL = forest land remaining forest land (managed forest land); CL = managed cropland; GL = managed grassland

The effects of the accounting rules of the LULUCF Regulation on the total level of emissions/removals are depicted in Figure 5-2, marked with a blue box. Here, no emissions/removals from managed forest land are excluded, because FRLs from Member States were not available at the time of calculation. If this category is included in the calculations, the effects can be seen at the right side of the figure (case C). In case C for the years 2021-2025 it is assumed that Member States have lower net removals from managed forest land than expected in the forest reference level. For this calculation we have used average net removals from the years 2000-2009 for managed forest land as reference level. This scenario leads to debits from this category and lowers the overall credits for the whole LULUCF sector. The opposite results are shown in case C for the years 2026-2030 where Member States are expected to have higher net removals than expected in the forest reference level. This leads to a strong increase in accounted net removals for the LULUCF sector. In case A we show emissions / removals without accounting as they are reported.

Figure 5-2: Comparison of the accounting rules in the LULUCF Regulation with other possibilities and the effect on accounted emissions and removals



Source: Own illustration; numbers for projection scaled to fit to historical data using the method described in Böttcher&Graichen 2015

Abbreviations used: L-FL = Land converted to forest land (afforestation); FL-L = forest land converted to land (deforestation); FL-F = forest land remaining forest land (managed forest land); CL = managed cropland; GL = managed grassland; WL = managed wetland; HWP = harvested wood products; FM = forest management (designation as in the LULUCF Decision)

5.2. Data sources for improved accounting

5.2.1. LULUCF Regulation demands improved data

For the year 2016, based on uncertainty estimates that are provided by Member State in their National Inventory reports (NIR), LULUCF uncertainty of the emissions level of CO₂ for the EU was estimated to be about 32 % (European Union 2019). This is higher than the uncertainty estimated for emissions from industrial processes (12 %, all gases) but lower than uncertainties associated with the agriculture (45 %, all gases) or waste sector (52 %, all gases). Also, there are differences in uncertainty between different land use categories. While forest inventories provide relatively accurate estimates of CO₂ emissions and removals from forests (20 %), cropland is more uncertain (48 %). Uncertainty of CO₂ estimates for grassland even amounts to 374 %.

The level of uncertainty is related to the data sources and methodologies applied. Regarding data sources for emission factors as one important element of reporting emissions, the IPCC Guidelines (IPCC 2006) differentiate between “Tier 1” level that uses default emission factors and other parameters provided by the IPCC, “Tier 2” level applying parameters that are specific to the country, and “Tier 3” level, i.e. higher-order methods including models and national inventory information. Potentially, Tier 3 methods can provide estimates of greater accuracy than lower tiers, and they can describe biomass and soil carbon dynamics in more detail, be sensitive to national climate conditions, and give information on inter-annual variability. Higher tier level emission factors typically require more highly stratified activity data, i.e. area information, to correspond with country-specific emission factors and parameters for specific regions and specialised land-use categories. As options for preparing activity data, the IPCC Guidelines differentiate between Approach 1 providing total land-use area, with data on conversions between land uses, e.g. derived from one land use map and national statistics, Approach 2 that includes changes between categories and Approach 3 that provides spatially-explicit land-use conversion data, e.g. estimated from repeated land use inventories or time series of land use maps from remote sensing data.

The LULUCF Regulation includes more mandatory land accounting categories compared to the LULUCF Decision and the Kyoto Protocol, in particular managed cropland and managed grassland (and managed wetlands at a later stage). There is a high demand for tracking land use with high resolution and producing consistent maps of land use changes but also for more accurate emission factors at higher tier levels to ultimately reduce overall uncertainties of GHG estimates. Both elements, activity and emission data, can contribute significantly to improving GHG accounts and accuracy of emission and removal estimates.

The current capacities of Member States to report complete and accurate emissions and removals in cropland, grassland and wetland categories are very different. The EU National Inventory Report 2019 reported that emission factors used by Member States to calculate CO₂ emissions and removals from managed forest land were country specific for 26 of 28 countries. Country specific emission factors for emissions from organic soils under managed cropland were reported only by 7, for managed grassland only by 8 countries. Cyprus has so far not been able to report on cropland and grassland due to the lack of a system for data compilation, rather than data availability. On the other hand, Romania has started to use data from the Land Parcel Identification System (LPIS), an information system based on aerial or satellite photographs recording most agricultural areas in Member States serving under the Common Agricultural Policy (CAP) to verify eligibility for area-based subsidies, for quality checks of their GHG inventory.

There can be various reasons for problems with land use emission reporting and the use of data sources additional to national information, as identified by the Independent Monitoring study (Böttcher et al. 2018). For some categories, there is a lack of specific emission factor data. This

applies to wetland reporting but also land uses such as orchards where country specific factors are needed to provide accurate estimates. There are generic global emission factors provided by the IPCC Guidelines but they can deviate from the specific country situation quite strongly. Countries also lack activity data, especially those who are seeking to apply spatially explicit methods for reporting of management changes within a certain land use category, e.g. cropland areas where reduced tillage is applied.

If data is available, there might be consistency issues related to data and data might be incomplete. For establishing consistent estimates for the base year or period, complete time series are needed that cover a period long enough to include the base period. Another challenge is the compatibility of data. Countries that seek to include additional data collected for other purposes, e.g. data for environmental monitoring, need to overcome compatibility issues arising from different definitions and units used. Finally, access to accurate, consistent and complete data is not sufficient if there is a lack of interpretation capacities and tools to convert data into information. Countries that need to process raw data, e.g. from satellite remote sensing, need to build up capacities of experts that are able to process, correct and tailor the data into information relevant for reporting and accounting.

5.2.2. Opportunities for including additional data

The lack of national data can be overcome by national research, inventories and surveys that are costly and time consuming. There are also opportunities in making use of international data sets. This can be international data bases of research results including country specific estimates but also country specific estimates from global datasets derived from remote sensing. Using this information would allow Member States to improve their methodologies and move from global default values ("Tier 1") to methods using country specific information ("Tier 2" or "Tier 3") being more appropriate to represent ecosystem types, climatic regions and land use systems in that country. There are a number of available datasets that have already been tested for potential use for LULUCF reporting (Bertaglia et al. 2016) and that can contribute to improving the accuracy of LULUCF accounts in Member States:

- IACS/LPIS, Integrated Administration and Control System and Land Parcel Identification System, has been set up by Member States for implementation of the Common Agricultural Policy, it consists of geo-referenced polygons of management units with information on land cover since 2005.
- LUCAS, Land Use/Cover Area Frame Survey, includes data on land cover and land use for four years (2003, 2006, 2009, and 2012), but the time series is not consistent as there are changes in total coverage and classification.
- FSS, Farm Structure Surveys, regular survey in all Member States of individual agricultural holdings for Eurostat collecting information on land use area, crops grown, livestock and economic indicators.
- CORINE Land Cover, land cover map of Europe for the years 2000, 2006, and 2012 differentiating 44 classes of land types.
- Copernicus products, including products from the Eionet Action Group on Land monitoring in Europe (EAGLE) project and the Harmonised European Land Monitoring (HELM) project.

Improving the accuracy of emission factors and increasing the level of reporting for specific categories can be achieved by using models. Soil models are one example of how to make reporting more sophisticated. Experience has shown that higher accuracy of soil emission

estimates comes at the cost of simplicity and often also transparency. Moving to higher levels makes only sense if adequate input data can be provided. There are a number of use cases available for countries seeking to increase tier level for reporting soil emissions to draw from:

- The soil carbon model YASSO that has been considered or already used for reporting purposes by a number of Member States, including Austria, Estonia, Finland and Latvia;
- The EUKI funded project INVESTIGATE that aims at forming the network and capacity building for knowledge transfer on improving national GHG inventories for organic soils in Denmark, Finland, Germany, Latvia, and Romania;
- The Soil Organic carbon and Land Use Mapping (SOLUM) project that develops a spatially integrated soils and land use dataset for Ireland.

5.3. Evaluation of environmental integrity

The LULUCF Regulation addresses a number of issues that NGOs and other stakeholders had criticized in the LULUCF Decision and the Kyoto Protocol. Hence, the adoption of the LULUCF Regulation was mainly considered to entail improvements for environmental integrity (see for example Fern 2018). Major changes compared to the LULUCF Decision and an evaluation of their implications is presented below.

Overall, the EU sets for the first time a binding commitment for each member States for the emissions and removals from the LULUCF sector.

Regarding intensification in forest management, the LULUCF Regulation is much stricter than earlier rules (KP and LULUCF Decision). FMRLs under the earlier Kyoto framework allowed for intensification because they could include assumptions about the effect of future policies. FRLs under the Regulation prevent this possibility; they build on historic management intensity observed in a certain base period (2000-2009) and extrapolate this into the future. The definition and calculation method for FRLs is important for avoiding both easy credits and hiding the climate impact of management intensification in the baseline.

Members States had to submit National Forestry Accounting Plans (NFAPs) by the end of 2018. These are then to be reviewed by an expert team European Commission, national and individual experts. This process is meant to increase transparency of accounting and helps to build reference levels that are credible.

Through gross-net accounting of afforestation having occurred since 1990, relatively high afforestation credits could be generated under the earlier rules of the Kyoto protocol and the LULUCF Decision. In the future, afforestation areas will only be accounted for as afforestation for 20 or maximum 30 years and will be included under forest management accounting thereafter. This leaves countries with high historic afforestation rates with fewer credits and therefore increases incentives to maintain these rates.

The reference period for managed cropland and managed grassland is more recent than the reference year specified in previous legislation and a reference period avoids accounting against effects that only occurred in one year. A reference period makes accounting thus more robust compared to single year references.

Overall environmental integrity of the EU's climate policy regarding the land use sector increases with the new rules. They make accounting of land use emissions in EU more complete, consistent and transparent. Nevertheless, the new Regulation is far from alleviating all environmental and climate concerns related to the treatment of forests and soils. Therefore, for assessing

implications of the LULUCF Regulation it is important to include also its linkages to other policies and to what degree it supports other policy goals of the EU.

5.4. Linkages to other policies

Climate change mitigation policies in the land use sector directly tackle the management of land and other natural resources and are therefore also linked to other sectors, such as energy or agriculture. On the one hand, the rules set in the LULUCF Regulation have direct and indirect effects on other policies, e.g. the recast of the EU Renewable Energy Directive (RED II, Directive 2018/2001/EU, European Commission 2018b), or the Common Agricultural Policy (CAP, Regulation (EU) 1782/2013, European Union 2013). On the other hand, the effectiveness of the LULUCF Regulation and its implementation also depend on provisions introduced by those other policies.

The agricultural sector is very closely linked to LULUCF. On 1 June 2018, the European Commission presented a legislative proposal on the recast of the CAP to cover the period after 2020 (European Commission 2018d). An important task of the new CAP will be to reflect the high ambition of climate change mitigation in the Agriculture and LULUCF sectors by addressing foremost resource efficiency, environmental integrity and climate action. The current architecture of the CAP (including the instruments of cross compliance, direct payments and voluntary agri-environmental and climate measures) will be replaced. The new structure will allow Member States to pursue different mandatory and voluntary measures to meet environmental and climate objectives defined at EU level, including climate adapted agriculture and forestry measures, to be formulated in strategic plans. However, as coherence of Member State activities with the overarching EU objectives will very much depend on the way in which Member States plan to implement specific policies, there needs to be an effective and consistent assessment of the strategic plans by the Commission (European Commission 2017).

There are also very obvious linkages between bioenergy production and use and the management of land. Therefore it is important that climate protection and renewable energy policies that aim at reducing greenhouse gas emissions also consider implications for the land use sector. The recast of the Renewable Energy Directive (RED II, European Commission 2018b) sets strong incentives for increasing the use of wood for bioenergy (for both heating and transport) through quotas. However, it defines only limited safeguards for preventing intensification and negative impacts on forests. Instead, the accounting rules assume that the climate impact of bioenergy use is fully accounted for under the LULUCF Regulation. Furthermore, the RED II does not protect highly biodiverse forests from intensification of harvest and excludes small power plants entirely from sustainability criteria. Against this background, the accounting rules in the LULUCF Regulation and especially the rules for accounting forest management become even more important. The LULUCF Regulation addresses the issue of increased bioenergy and potential impacts on emissions and removals from forests by excluding assumptions on future bioenergy policies from the forest reference levels. In the case bioenergy is imported from countries outside the EU (outside the LULUCF Regulation), RED II applies sustainability criteria to be fulfilled by the exporting countries down to the sourcing area where the biomass is coming from that require maintenance of carbon stocks and sinks. However, environmental impacts of increased bioenergy use beyond carbon (e.g. implications for biodiversity) are not covered by both EU policies.

In 2018 the European Commission presented a Communication on a “European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy” (European Commission 2018a). It makes clear reference to the land use sector by assigning the sector an important role in compensating for remaining GHG emissions towards the year 2050. This

observation refers to the recent IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels (IPCC 2018) that states that in all scenarios that limit global warming to 1.5 °C negative emissions will be necessary. Negative emissions can be either achieved by CO₂ removal technologies or by natural removals through plant growth in forests and other ecosystems. The EU strategy developed a number of policy scenarios for GHG reduction, of which two explored options for negative emission by the land use sector. The currently observed removals by the sector of about 300 Mt CO₂ per year are not enough to compensate for the remaining emissions and require additional measures strengthening the land sink. One scenario described by the IPCC promotes zero-carbon energy solutions as well as energy efficiency, and relies on negative emissions technology in the form of bioenergy combined with carbon capture and storage to balance remaining emissions. An alternative scenario assesses the impact of a highly circular economy and the potentially beneficial role of a change in consumer choices that are less carbon intensive. It also explores how the global sink can be increased, reducing the need for negative emissions technologies.

The current rules set out in the LULUCF Regulation have not been designed for accounting to strike the “balance between emissions and removals” claimed by the Paris Agreement. They are not incentivising long-term measures and strategies, either. Caps and limitations would have to be transferred into more explicit environmental safeguards to avoid negative impacts of land use based negative emissions on other ecosystem services. An important future task will be to organise the transition from accounting rules that exclude indirect effects and incentivise additional measures to rules that treat emissions and removals more equally and account for the full carbon balance with a view to net zero emissions.

6. Conclusions

With the introduction of the LULUCF Regulation and its no-debit target the EU has demonstrated its willingness for a comprehensive and robust climate regime for the land use sector. Globally, the Regulation sets important standards for the inclusion of forests and other land uses into national mitigation targets.

Compared to previous rules, the LULUCF Regulation increases incentives for improving land management. This is especially true for accounting of forest land where previous legislation set incentives to increase harvest levels through policies. Also countries facing increased harvest due to forest structure were penalized. The new rules limit forest management credits to direct management effects. This also includes shifts of wood use towards more material use.

There has also been significant improvement regarding safeguards for climate integrity. The new rules for establishing forest reference levels for the accounting of managed forest land form a substantial increase in transparency and clarity. However, their robustness and practicability can only be verified at a later stage when Member States have gained more experience in the preparation. Also, late technical corrections bear considerable uncertainties and potentially large impacts on accounted amounts and make the assessment of compliance with the no-debit target more difficult.

The flexibility offered by the Regulation is expected to motivate Member States that have problems with achieving ESR targets to invest into measures that increase removals in forestry. However, to reach the ambition as formulated in the Paris Agreement, Member States need to go beyond an accounted “no-debit” target. The LULUCF sector is expected to play a much more important role in limiting the global temperature to 1.5 degrees through increasing and maintaining the net sink that currently still exists. Under the new accounting rules, it is still possible that this physical sink will

shrink without affecting accounted amounts of credits or debits. For achieving a higher ambition level in the LULUCF sector that is becoming relevant after 2030 the accounting rules need to be accompanied with an overall mitigation target as described in the EU long-term strategy that reflects the sector's expected role.

Moreover, efforts need to be increased to better integrate different policies that are targeting the land use sector. Coherence and complementarity need to be guiding principles for future land use management regimes that have, until now, failed to streamline policies, especially those targeting biodiversity protection, e.g. preservation of old forests.

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Annex – Linkages of land accounting categories in the LULUCF Regulation to inventory categories under the UNFCCC

Article 2 of the LULUCF Regulation defines land accounting categories that aggregate certain inventory categories or are based on LULUCF categories under the Convention and a slightly different terminology is introduced for the reporting under the LULUCF Regulation (see Table A-1). The Convention inventory defines the aggregate categories as „total forest land“, „total cropland“, „total grassland“, „total wetlands“, „total settlements“ and „total other land“. Aggregated land accounting categories of afforested and deforested land do not exist in the Convention reporting. Due to this rearrangement of subcategories into different aggregate categories, separate reporting tables and separate data submissions by Member States are required under the LULUCF Regulation in addition to the inventory submissions under the UNFCCC.

Table A-1: Land accounting categories in the LULUCF Regulation and their linkages to inventory categories under the UNFCCC

Land categories	UNFCCC inventory categories included in the land accounting categories
Afforested land	<ul style="list-style-type: none"> • Cropland converted to forest land (4.A.2.1) • Grassland converted to forest land (4.A.2.2) • Wetlands converted to forest land (4.A.2.3) • Settlements converted to forest lands (4.A.2.4) • Other land converted to forest lands (4.A.2.5)
Deforested land	<ul style="list-style-type: none"> • Forest land converted to cropland (4.B.2.1) • Forest land converted to grassland (4.C.2.1) • Forest land converted to wetlands (4.D.2.1) • Forest land converted to settlements (4.E.2.1) • Forest land converted to other land (4.F.2.1)
Managed cropland	<ul style="list-style-type: none"> • Cropland remaining cropland (4.B.1) • Grassland converted to cropland (4.B.2.2) • Wetlands converted to cropland (4.B.2.3) • Settlements converted to cropland (4.B.2.4) • Other land converted to cropland (4.B.2.5) • Cropland converted to wetlands (4.D.2.2.2 and 4.D.2.3.2) • Cropland converted to settlements (4.E.2.2) • Cropland converted to other land (4.F.2.2)
Managed grassland	<ul style="list-style-type: none"> • Grassland remaining grassland (4.C.1) • Cropland converted to grassland (4.C.2.2) • Wetlands converted to grassland (4.C.2.3) • Settlements converted to grassland (4.C.2.4) • Other land converted to grassland (4.C.2.5) • Grassland converted to wetlands (4.D.2.2.3 and 4.D.2.3.3) • Grassland converted to settlements (4.E.2.3) • Grassland converted to other land (4.F.2.3)
Managed forest land	<ul style="list-style-type: none"> • Forest land remaining forest land (4.A.1)
Managed wetland	<ul style="list-style-type: none"> • Wetlands remaining wetlands (4.D.1) • Settlements converted to wetlands (4.D.2.2.4 and 4.D.2.3.4) • Other land converted to wetlands (4.D.2.2.5 and 4.D.2.3.5) • Wetlands converted to settlements (4.E.2.4) • Wetlands converted to other lands (4.F.2.4)

Quelle: Compilation by Öko-Institut from LULUCF Regulation and UNFCCC inventory

