

## Going beyond 40% - options to ensure LULUCF maintains the high environmental integrity of the EU climate and energy package

Berlin, 22.04.2016

Report prepared for Fern

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## Acronym list

AFOLU:	Agriculture Forestry and Land Use
AR:	Afforestation and Reforestation
C:	Carbon
CO <sub>2</sub> :	Carbon Dioxide
CM:	Cropland Management
CP:	Commitment Period
D:	Deforestation
EEA:	European Environment Agency
EC:	European Commission
EIA:	Environmental Impact Assessment
ESD:	Effort Sharing Decision
EU:	European Union
EU ETS:	EU Emissions Trading System
FM:	Forest Management
FMRL:	Forest Management Reference Level
GHG:	Greenhouse gas
GM:	Grazing land management
IPCC:	Intergovernmental Panel on Climate Change
JRC:	Joint Research Centre
KP:	Kyoto Protocol
LULUCF:	Land Use, Land Use Change and Forestry
LURL:	Land Use Reference Level
MA:	Marrakesh Accords
MMR:	Regulation on the Mechanism for Monitoring and Reporting
MS:	EU Member States
Mt:	Megatons
UNFCCC	United Nations Framework Convention on Climate Change

## Executive summary

### Background and approach

The European Union (EU) has a target to reduce greenhouse gas (GHG) emissions by at least 40 per cent by 2030. This is an economy-wide target and therefore includes the Land Use, Land Use Change and Forestry (LULUCF) sector. During the first half of 2016, the European Commission (EC) will make a legislative proposal for how to link LULUCF to the EU's climate and energy framework. The Commission has outlined three possible ways for integration in the impact assessment prepared for the 2030 climate and energy framework:

- Option 1: LULUCF pillar: maintain non-CO<sub>2</sub> agriculture sector emissions in the Effort Sharing Decision (ESD), and further develop a LULUCF sector policy approach separately
- Option 2: Land sector pillar: merge the LULUCF and non-CO<sub>2</sub> agriculture sector emissions into one new independent pillar of the EU's climate policy
- Option 3: include LULUCF in the Effort Sharing Decision (ESD)

Böttcher and Graichen (2015) showed that if all LULUCF credits were included in the Effort Sharing Decision (Option 3), depending on accounting rules used, the effort needed to reach the 40 per cent target would be reduced by between 7.5 and 16 per cent of total emissions. This means a 2030 target for sectors in the ESD and EU Emissions Trading System (ETS) of between 37.4 per cent and 34 per cent (instead of an at least 40 per cent target). The study highlighted that implications of the different options depend to a large degree on the design of accounting rules for different land use activities. In that paper we concluded that the LULUCF sector should be accounted for separately to not harm ambition in other sectors.

Independent of the question which option will be chosen and what level of flexibility will be allowed between different sectors, there is the need to develop a target for LULUCF. This target can either be a separate target without any flexibility between sectors or an integrated target allowing for a certain exchange between sectors. In any case criteria and rules for accounting are needed that ensure environmental integrity of the inclusion of LULUCF into the overall EU target as required by the Paris Agreement. A LULUCF target is also a prerequisite for exploiting the term 'at least' and increasing the EU's overall target beyond 40%.

The aim of this study is to develop options to identify LULUCF credits with high environmental integrity that could help the EU to formulate a target for the sector. These options are developed by applying criteria and indicators that ensure environmental integrity of potential LULUCF credits. Where possible the volume of credits resulting from the sector is determined. The options are evaluated regarding how they reflect data availability, how robust the metrics are (low uncertainty when measured/collected, low inter-annual variability), whether they follow a transparent approach, and how relevant they are to the LULUCF sector. Also the question how suitable metrics are to set incentives to improve management in the LULUCF sector is of relevance.

### Results and conclusions

Based on available data and assumptions on future development of GHG emissions and removals from the LULUCF sector, we find that options exist to allow the EU increasing its level of ambition by including LULUCF in its 40% target and ensuring environmental integrity. Current rules are not sufficient to fulfil principles of environmental integrity such as those defined in the Marrakech Accords. A number of basic changes are proposed, such as moving towards land-based accounting, changing base years for cropland and grazing land management, changing accounting for afforestation and forest management.

The level of ambition could be increased further if accounting was made conditional to environmental performance, e.g. the maintenance or increase of carbon (C) stocks. The additionality of mitigation in LULUCF can only be guaranteed if the target is set after such rules have been formulated.

Despite the fact that challenges of data availability exist for some EU Member States (MS) (e.g. regarding data on emissions and removals from cropland and grazing land management) most options can be implemented without additional efforts. Data gaps need to be identified and addressed by research and the development of guidance. In order to develop accounting rules further and increase coherence and consistency of the use of rules, especially regarding the Forest Management Reference Levels (FMRLs), an oversight body would help to provide independent guidance and supervision.

## 1. Background and aim

The European Union (EU) has a target to reduce greenhouse gas (GHG) emissions by at least 40 per cent by 2030. In early 2016, the European Commission will make a legislative proposal for how to integrate LULUCF to the EU's climate and energy framework. The European Commission (EC) has outlined three possible ways of how the integration could be implemented:

- Option 1: LULUCF pillar: maintain non-CO<sub>2</sub> agriculture sector emissions in the Effort Sharing Decision (ESD), and further develop a LULUCF sector policy approach separately
- Option 2: Land sector pillar: merge the LULUCF and non- CO<sub>2</sub> agriculture sector emissions into one new independent pillar of the EU's climate policy
- Option 3: include LULUCF in the Effort Sharing Decision (ESD)

The options imply different levels of fungibility between LULUCF and other sectors. Option 1 could mean that there is no exchange of credits between the LULUCF pillar and other sectors or the ESD, or at least that these are significantly limited. Options 2 and 3 would allow an exchange of credits from the LULUCF sector with other sectors. Option 2 implies full fungibility between agriculture and LULUCF as this is the main motivation for having a land sector pillar. Option 3 implies full fungibility between the ESD sectors and LULUCF if LULUCF is treated like all other sectors in the ESD. There are no constraints on fungibility between sectors in the current ESD and only one overall target per MS. Böttcher and Graichen (Böttcher and Graichen, 2015) showed that if all LULUCF credits were included in the ESD (Option 3), depending on accounting rules used, the effort needed to reach the 40 per cent target would be reduced by between 7.5 and 16 per cent of total emissions. This means a 2030 target for sectors in the ESD and ETS of between 37.4 per cent and 34 per cent (instead of an at least 40 per cent target). The study highlighted that implications of the different options depend to a large degree on the design of accounting rules for different land use activities. In that paper we concluded that the LULUCF sector should be accounted for separately to not harm ambition in other sectors, meaning any removals accounted for would be additional to the 40% target.

The current accounting system for LULUCF under the Kyoto Protocol (KP), implemented in the EU legislation through Decision 529/2013/EU, results in credits or specific units which are subtracted or added to the emissions from other sectors. Therefore this paper assesses an accounting approach that continues to result in credits (or debits) from the land sector. This choice should, however, not prejudice the choice of future accounting options in the EU because other options such as a treatment of emissions and removals in an accounting approach similar to all emissions under the ESD exist.

Independent of the question which option will be chosen and what level of flexibility will be allowed between different sectors, there is the need to develop a target for LULUCF. This target would either be a separate or an integrated target. Since LULUCF is part of the 2030 climate and energy package, the credits from this sector should relate to the overall target, thereby increasing the overall ambition of the EU's 2030 target, exploiting the 'at least' of the EU's 'at least' 40%.

Achieving this goal requires the development and application of criteria and conditions to ensure environmental integrity of the overall target that is required by the Paris Agreement. The following aspects should be covered:

- The overall level of ambition of the 40% target must not be lowered.



- There need to be minimum thresholds for quality and maximum thresholds for quantity of LULUCF credits.
- Flexibility can only be allowed with a minimum threshold of effort, e.g. if concrete national action plans and policies are implemented.
- LULUCF accounting needs to be properly and independently monitored.

The aim of this report is to present options to identify LULUCF credits with high environmental integrity that could help the EU to formulate a target for the sector; a prerequisite for increasing its level of ambition beyond the 40% target. These options are developed by applying criteria and indicators that ensure environmental integrity of potential LULUCF credits. Based on publically available reported data and LULUCF scenarios for the 2021-2030 period, the identified options are assessed regarding the resulting net credits or debits from LULUCF. The options are evaluated regarding how they reflect data availability, how robust the metrics are (low uncertainty when measured/collected, low inter-annual variability), whether they follow a transparent approach, and how relevant they are to the LULUCF sector. Also the question how suitable metrics are to set incentives to improve management in the LULUCF sector is of relevance.

## 2. Approach and data

We address the aim of this study in two consequent steps where we a) develop options to apply criteria and indicators to ensure environmental integrity of potential LULUCF credits and b) determine, where possible, the volume of credits that could help the EU developing a target and thus being more ambitious.

We use historical data (1990-2012) on LULUCF emissions for different categories based on data reported by Member States to the UNFCCC. We use the most recent data reported in 2014 as compiled in the Joint Research Centre (JRC) LULUCF tool.<sup>1</sup> The data include emissions and removals from the LULUCF activities: Afforestation and Reforestation (AR), Deforestation (D), Forest Management (FM), Cropland Management (CM), and Grazing Land Management (GM). In addition historical non-CO<sub>2</sub> emissions from agriculture are taken from the tool.

For the projection of GHG emissions in 2030 we use data from the EC published in the Trends to 2050 Report.<sup>2</sup> The projected data included in the EC report span from the year 2005 to 2050. More details on auxiliary data and their sources can be found in Böttcher and Graichen (2015).

## 3. The role of accounting rules for ensuring environmental integrity and challenges

The Marrakesh Accords (MA) form a set of principles that were established to ensure environmental integrity of the use of LULUCF credits (see Box 1). These principles are partly aimed at ensuring climate protection but also take other issues in the land-use sector into account, such as biodiversity and the sustainable use of natural resources. Based on the Marrakesh Accords accounting rules were developed and applied in the first and second commitment period of the Kyoto Protocol.

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<sup>1</sup> Version of May 2015, personal communication G. Grassi. An older version is available on the JRC website: <ftp://mars.jrc.ec.europa.eu/Afoludata/Public/DS242>.

<sup>2</sup> EC 2014: EU energy, transport and GHG emissions, trends to 2050 - Reference scenario 2013 <http://ec.europa.eu/transport/media/publications/doc/trends-to-2050-update-2013.pdf>

### Box 1: Definition of environmental integrity

The objective of environmental integrity is to guarantee sustenance of important biophysical processes that provide ecosystem services and to protect the resilience, diversity, and intactness of ecosystems within the environment. The decision on transparency of action and support in the Paris Agreement requests that further modalities and procedures of the treaty '*need to ensure environmental integrity*'. In the Paris Agreement the term is further defined as '*integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth [...]*'<sup>1</sup>.

The European Commission interprets environmental integrity as the set of principles as outlined in the Marrakesh Accords<sup>2</sup>. The principles in the Marrakesh Accords respond to concerns that the use of LULUCF activities should not undermine the environmental integrity of the Kyoto Protocol. They should '*govern the treatment of LULUCF activities*' in the following way:

- a) That the treatment of these activities be based on **sound science**;
- b) That **consistent methodologies be used over time** for the estimation and reporting of these activities;
- c) That the aim stated in Article 3, paragraph 1 of the Kyoto Protocol (the **emission reduction target** of 5% relative to 1990) **not be changed** by accounting for land use, land-use change and forestry activities;
- d) That the mere **presence of carbon stocks be excluded** from accounting;
- e) That the implementation of LULUCF activities contributes to the **conservation of biodiversity and sustainable use of natural resources**;
- f) That accounting for land use, land-use change and forestry does **not imply a transfer of commitments to a future commitment period**;
- g) That **reversal of any removal** due to LULUCF activities be **accounted for at the appropriate point in time**;
- h) That accounting **excludes 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.

For the purpose of this study environmental integrity includes aspects of climate integrity as well as other aspects e.g. related to biodiversity, high carbon stocks and other environmental sustainability aspects.

<sup>1</sup> see <https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>

<sup>2</sup> see: <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+WQ+E-2015-007729+0+DOC+XML+V0//EN&language=en>

Principle h) of the MA requests that accounted amounts need to be human-induced and additional. This principle resulted in a cap of FM credits in the first and accounting against a Forest Management Reference Level (FMRL) in the second commitment period. FMRL accounting factors out the contribution of influences that are beyond direct human control (such as climate effects) or indirect (such as the legacy effect of age-classes in forests) and rewards the effect of recent changes in forest management practices. Such factoring out of past practice effects was proven to be a technically feasible way to implement the Marrakesh Accords (Böttcher et al., 2008).

Accounting at an appropriate point in time as requested by principle g) can limit the risk of unbalanced accounting over time, where credits might be issued but the carbon released later without being accounted for, e.g. because the emissions are excluded under the natural disturbances provision. Under KP CP2 MS have the option to apply a provision on natural disturbances that allows the exclusion of emissions following extreme events such as fires and storms. Subsequent removals from lands subject to the natural disturbances provision have to be excluded from accounting (IPCC, 2013). However, there is the risk that removals from these lands might have been issued prior to the disturbance event that is then considered force majeure and its emissions excluded from accounting. The integrity of an emission reduction target would be violated if such credits were used to achieve the target and compensating in other sectors. Therefore, credits issued in previous periods on the same land that is later subject to natural disturbances would have to be replaced with other units, or face full emissions.

Other principles from the MA cannot be related directly to accounting rules that are currently used, such as principle e) that puts a request that accounting contributes to the conservation of biodiversity and sustainable use of natural resources. There are potential conflicts with this principle that can evolve, for example, from the treatment of biomass removals for bioenergy use that are (when applying current accounting rules) 'hidden' in the FMRL for forest management accounting (McKechnie et al., 2014). Environmental integrity as defined by the principles set out in the MA can only be achieved when a stringent and consistent but also honest approach is taken to setting the reference levels. Detailed guidelines, however, currently do not exist. The FMRL estimates of MS underwent a technical assessment by the UNFCCC but not a detailed review as inventories are subject to. In order to increase coherence and consistency of the development and technical correction of FMRLs in case of methodological inconsistencies, an oversight body would help to provide independent guidance and supervision.

Sustainability criteria developed for biomass production for transport fuels under the EU Renewable Energy Directive include criteria relating to high biodiversity lands and lands with high C stocks that shall not be converted for biofuel production. The decision on broadening these criteria to solid and gaseous bioenergy feedstocks is currently being discussed. Sustainability criteria for biomass production are neither sufficient to ensure environmental integrity of LULUCF credits if they apply only to bioenergy, nor do they ensure emission reductions if LULUCF is not appropriately accounted for.

Criteria addressing biodiversity have not been considered explicitly in accounting rules for LULUCF as for now, despite the fact that mitigation measures in the sector have impacted biodiversity negatively, e.g. through large scale afforestation of highly biodiverse grasslands and peatlands (IUCN UK, 2014). It is questionable whether accounting rules can be formulated that are sufficiently specific to preserve high biodiversity lands from conversion. An alternative measure could be the requirement for Environmental Impact Assessments (EIAs) for large scale mitigation projects similar to other environmental interventions. According to the EIA Directive 2011/92/EU<sup>3</sup> (amended in 2014) EIAs are mandatory for industrial installations but also dams, quarries and open-cast mining exceeding a certain area. According to the directive, MS can additionally determine that also projects that carry out '*afforestation and deforestation for the purposes of conversion to another type of land use*' need to undergo such an assessment (see Annex II d of Directive 2011/92/EU). However, such EIAs should be required

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<sup>3</sup> <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32011L0092&qid=1458289189437&from=en>

only for large scale projects or projects in environmentally sensitive areas as it constitutes a clear disincentive for afforestation activities as a mitigation measure.

Current accounting rules as applied in the second commitment period do not set a focus on additional mitigation as strongly as they could. This is especially true for the treatment of afforestation. Afforestation and reforestation emissions and removals are accounted for on a gross-net basis. All areas that were subject to afforestation or reforestation since 1990 and have not been deforested thereafter can be accounted for, meaning that high numbers of credits can be accumulated. This includes explicitly activities that took place way before the implementation of climate policies related to the UNFCCC process. Focusing on additionality would mean to account afforestation/reforestation using a more recent starting year (that would have to be updated again for future commitment period) or apply a rolling window of 20 years, which is used by the UNFCCC for reporting.

MS can choose to apply annual or commitment period accounting for LULUCF. This rule is of relevance to the integration of LULUCF in the EU 2030 target. Under the ESD MS need to comply with annual reduction targets. MS that intend to use LULUCF credits for ESD compliance would have to select annual accounting. The experience under the KP has been that annual accounting of LULUCF leads to significant recalculations e.g. after the periodic national forest inventories. If these recalculations lead to reduced removals a corresponding quantity of LULUCF credits needs to be replaced with other units.

To conclude, current accounting rules form an important tool for ensuring environmental integrity as they reduce LULUCF credits and debits to amounts that can be considered directly human-induced. Though improvements have been made, current accounting rules do not fulfil completely the Marrakesh Accords principles of environmental integrity. However, there are a number of options for improving the rules further and for increasing the level of integrity.

## **4. Options for improving environmental integrity of potential LULUCF credits**

In the following we present options to increase environmental integrity of potential LULUCF credits. The options range from an amendment of existing accounting rules to new rules for accounting and minimum conditions to allow the use of potential credits for achieving the target. The options can partly be combined.

### **4.1. Land-based accounting**

An option to improve accounting rules that is expected to lead to higher environmental integrity is to move from the current activity-based accounting approach applied under the Kyoto Protocol to a land-based approach in line with the UNFCCC.

A land-based approach to accounting takes as a starting point the total C stock changes in all pools on all land areas. An activity-based approach estimates the impact of C stock changes that can be attributed to designated activities and assigns the land areas to these activities. Due to the different concepts of how LULUCF activities are defined by the Kyoto Protocol, the emissions and removals estimated related to these activities are not the same as the emissions and removals reported in the LULUCF sector under the UNFCCC. In most cases the area under activity-based accounting is equal or smaller to the area under land-based accounting. The more activities, pools and gases that are included under activity based accounting, the higher the environmental integrity of the system. Activity-based accounting implies a selection of activities and can result in 'cherry-

picking' by MS by choosing narrow definitions of activities. The wider activities are defined, the closer emissions and removals get to land-based accounting.

Considering a larger area and more sources and sinks increases environmental integrity as the risk of an unbalanced accounting is potentially reduced. This is especially true for forest management accounting. Areas of unmanaged forests that can be excluded under activity based accounting would then be included. To ensure methodological consistency the FMRL would have to be corrected for the additional area included.

Land-based accounting consistently with UNFCCC reporting would also change important relations for accounting of afforestation and deforestation compared to current rules. Land converted to forest land would leave the category after a certain period (typically 20 years) to be then reported under forest land remaining forest land. Compared to current rules, which include all land afforested and kept under forest since 1990, this option would include only the last 20 years and therefore reduce afforestation removals considerably. If deforestation was treated equally, also forest land converted to other land would not stay in that category but change to the respective new land use. However, the latter could be interpreted as 'back-sliding' from KP rules where a reporting hierarchy of land use changes was established<sup>4</sup>. Also, the implications of rule changes are expected to be smaller because highest emissions from deforestation typically occur in the year of the deforestation event and following years show decreasing emissions over time.

In any case (wide activity-based or land-based accounting), rules need to avoid the selective choice of categories by mandatory accounting of significant categories identified in the UNFCCC inventory.

**Data availability:** Data already exists as this is the format in which MS report to UNFCCC, so there is no additional data needed. In fact, instead of two accounts there would be only one, reducing monitoring efforts of MS. Currently MS need to convert UNFCCC reported numbers using a proxy to estimate numbers for KP reporting. This option would thus also reduce the risk of introducing additional uncertainty and errors.

**Robustness and transparency:** A land-based accounting approach would ensure a more comprehensive coverage of emissions and removals and simplify both the reporting and the accounting. More consistency with reporting of other sectors would be achieved. However, the land-based accounting as implemented in Convention GHG inventories does not need to be geographically explicit, thus accounted areas do not need to be identifiable. This specific feature reduces the transparency of the current land-based accounting and the monitoring and reporting rules would need to be developed further in order to retain a linkage between accounted credits and changes on the ground.

**Suitable to set incentives:** Land-based accounting increases incentives to make additional efforts regarding afforestation activities because afforested land would only be a limited amount of time considered as afforestation.

**Suitable to identify environmental integrity:** A more comprehensive accounting of all lands increases transparency and also integrity. The risk of back-sliding from Kyoto rules can be addressed by keeping deforestation accounts separate to track the land also after 20 years.

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<sup>4</sup> According to Decision 2/CMP.610 and Decision 2/CMP.7, for reporting consistency and transparency, mandatory activities take precedence over elective activities, Deforestation over Afforestation/Reforestation over Forest Management activities.

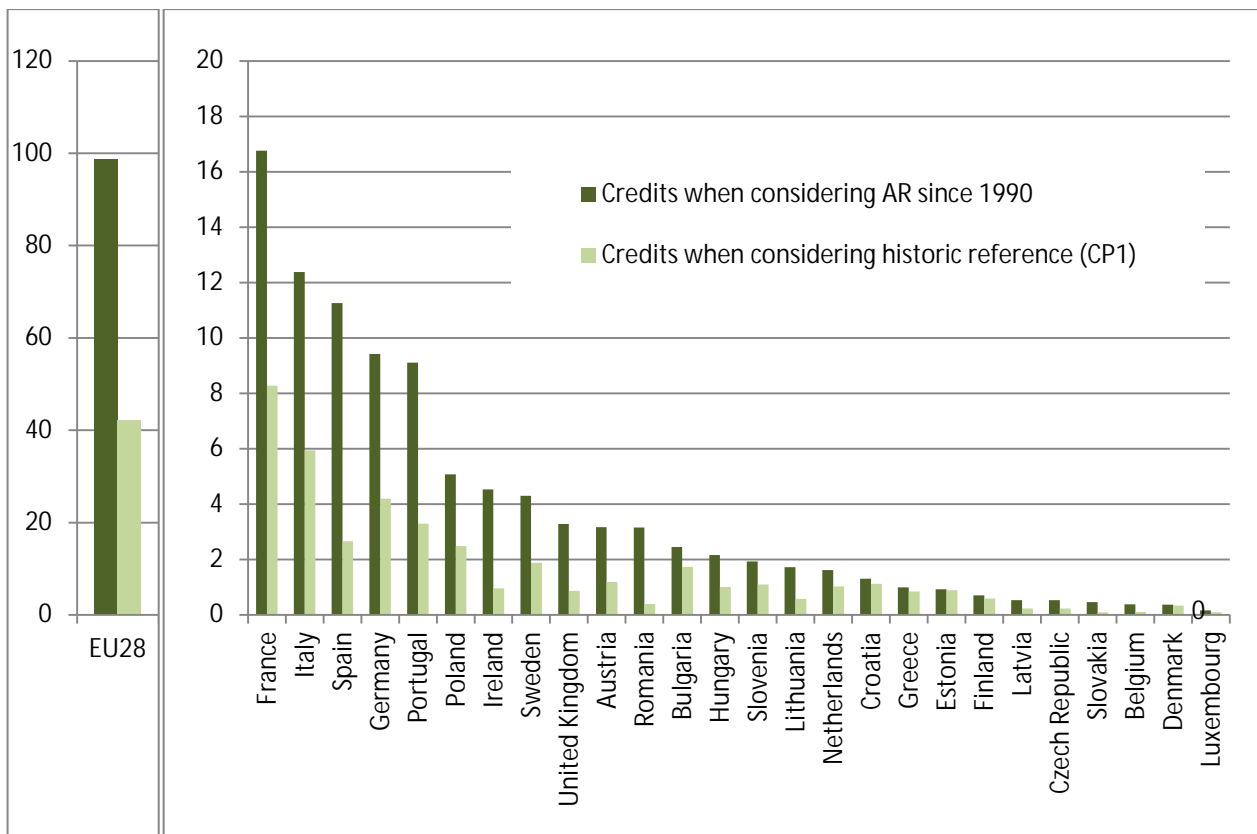
## 4.2. Change of existing accounting rules

Alternatively to a change of the entire accounting system from activity-based to land-based accounting, the existing rules for single activities can be improved. Some of the options can be combined with a system change.

### 4.2.1. Afforestation and reforestation

Current rules include emissions and removals from afforestation and reforestation that occurred on land converted to forest since 1990. Rules that ensure environmental integrity need to encourage additional action. If post 2020, accounting rules would be applied that are more consistent to UNFCCC reporting, areas planted more than 20 years ago would enter the forest management category and be accounted for against an FMRL. Böttcher and Graichen (2015) approximated the impact of rule changes for AR by comparing removals from that category to a historic period to mimic the effect of excluding contributions of older planted areas. The implications of such a net-net accounting of AR are displayed in Figure 4-1. We assumed accounting against a historic period to mimic the effect of accounting as under UNFCCC reporting. Data constraints do not allow the application of a transition period to the publically reported data.

**Figure 4-1: Annual AR credits for 2021-2030 when applying alternative accounting rules [in Mt CO<sub>2</sub>]**



Source: Böttcher and Graichen (2015).

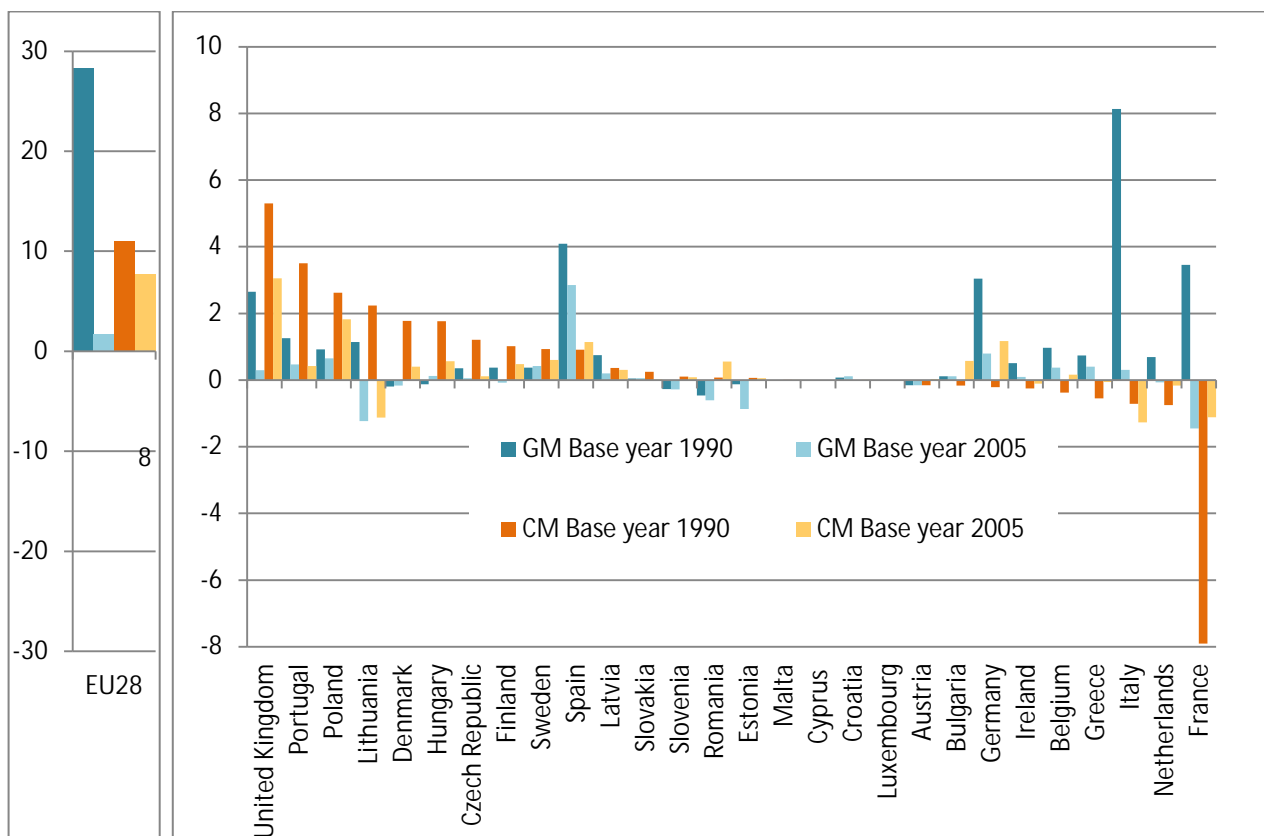


#### 4.2.2. Cropland and grazing land management

Another option for rule changes of selected activities is a change from base year 1990 to base year 2005 for cropland and grazing land management. These two categories are already accounted for net-net compared to emissions and removals in 1990. Historic data of the EU sum show that a change from source to sink occurred for grazing land management in the past. This implies that a change of the base year can have a large effect on accounted emissions and removals (see Figure 4-2). It appears that for EU28 changing the base year to 2005 would lead to a slight decrease of net credits from cropland and a much stronger decrease of net credits for grazing land management since cropland emissions are lower and grazing land forms a sink instead of a small source. The same observation can be made for most countries regarding grazing land, and half of the countries regarding cropland. However, the figure reveals also that MS situations can be very different depending on emission trends between 1990 and 2005.

Similarly to the option for improving afforestation accounting, this rule change would put more emphasis of accounting on recent activities and increases incentives to change management practices as the ambition level is updated. Such changes are expected to ensure environmental integrity of credits from these categories.

**Figure 4-2: Annual CM and GM credits (+) and debits (-) for 2021-2030 when applying different base years [in Mt CO<sub>2</sub>]**



Source: Böttcher and Graichen (2015).

### 4.2.3. Forest management

An alternative accounting approach for forest management to the currently applied accounting against the FMRL compares emissions and removals during the commitment period to a historic base period, i.e. the previous commitment period (Böttcher and Graichen, 2015; Ellison et al., 2014). Accounting FM emissions against a historic base period is an alternative accounting option for FM that would be similar to a net-net approach and thus be more similar to rules applied for other activities in LULUCF and other sectors. The implications of such an accounting approach were documented by Böttcher and Graichen (2015) who accounted FM against the period of 1991-2000. The main advantage of such an approach is that it does not require setting up projected reference levels. As a disadvantage can be noted that the approach does not consider that MS face C dynamics in their forests that are driven by past practices. Such effects ought to be excluded from accounting according the Marrakesh Accords. This requirement can partly be addressed by choosing a historic period that is as close the commitment period as possible.

A way to keep the approach of FMRL accounting would be a reformulation or reinterpretation of the FMRL. Currently the rules to set FMRLs rely on the assumed future harvest levels (see Annex II of the Cancun Decision<sup>5</sup>), which depend on age structure and silvicultural practices but in most of the cases also on other policies (e.g. bioenergy) as well as market effects. While age structure is a given result from past practices, silvicultural practices and assumptions on policies and expected markets effects can be changed. Policies can influence future harvest levels but their contribution is difficult to assess unless policy determines an explicit harvest level, which is rarely the case. Market effects can only be assessed by economic models but rely on many assumptions. This makes FMRLs including policies and market effects highly depending on assumptions. An alternative setting of the FMRL could exclude policies other than concrete silvicultural rules and exclude market effects. The reference level would then reflect the impact of current age structure and the continuation of current management, but ignore the future demand of harvest. Böttcher et al. (2008) demonstrated that this approach is technically feasible. However, it is unclear how it would affect credits and debits from FM accounting. Such an approach is considered to increase transparency, credibility and ultimately also environmental integrity as it does not require assumptions on future wood demand and the risk of overestimated harvest rates, thus reducing the risk of expected credits or the failure to account for emissions caused by bioenergy use. Such an alternative construction of the FMRL that is based on continuing current silvicultural practices rather than guessing future harvest levels can help to reduce arbitrary assumptions on future wood demand. The advantage to a historical net-net accounting is that the impact of age structure is not ignored, an important prerequisite according to the MA.

Ellison et al. (2014) discussed alternative caps to FM accounted emissions and removals. Current rules set the cap using the same method for all MS (3.5% of 1990 base year emissions, excluding LULUCF). It allows MS with high emissions in 1990 to account for more credits than lower emitting countries. The cap is thus unrelated to the importance of the forest sector or the size of forest cover. Ellison et al. argue that removing the cap would increase incentives to improve forest management. This holds true for forest rich countries that had comparably low base year emissions in 1990. However, it remains unclear whether potential credits from FM will exceed the cap of any country in the second commitment period. It is expected that if rules for FM accounting are improved, and technical corrections to FMRLs are applied towards the end of the commitment period, only a very limited number of MS will actually reach their current caps. Caps were introduced to ensure that credits from forest management do not water down the target for other

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<sup>5</sup> FCCC/KP/CMP/2010/12/Add.1



sectors. Unless rules are significantly improved, or unless there is a separate target for LULUCF caps can be an important safeguard to environmental integrity.

Not accounting for FM credits or debits at all could potentially be considered an option. However, an important pathway to mitigation by improving forest management in countries with real potential would be excluded and thus remove any incentives for countries to implement improvements. Exclusion of single activities would also result in unbalanced accounting. Finally, an exclusion would not necessarily be consistent with the Paris Agreement that calls to make 'any effort of mitigation', including also through the maintenance and enhancement of sinks.

#### 4.2.4. Implications of changes to accounting rules

For assessing the overall implications for accounted emissions and removals for LULUCF we assume the following changes:

- Afforestation/reforestation – we assume accounting against a historic period to mimic the effect of accounting as under UNFCCC reporting, as data availability does not allow the application of a transition period (see Figure 4-1).
- Deforestation – we assume gross net accounting i.e. no change of rules as data availability does not allow the application of a transition period.
- Forest management – we assume two alternative options: 1) accounting against a historic period (CP1, i.e. 2008-2012), 2) FM credits/debits set to zero to visualize the contribution of FM.
- Cropland and grazing land management – we assume accounting against the base year 2005.

Figure 4-3 shows that such rule changes would result in significant changes in net accounted emissions and removals compared to current rules. Large changes could occur for countries like Germany, Italy and France but also Finland. Less affected would be Sweden, Austria or Latvia. However, for all MS net credits would be reduced or debits increased if accounting rules changed. Looking at the EU sum reveals the implications most strongly. The credits potentially be achieved under the continuation of current rules would be reduced to 20% of credits under current rules or even reversed to debits of a similar magnitude. This is mostly resulting from FM accounting against either a forward looking baseline or a historically higher sink and the cut-off of AR credits from before the 20-year period. Table A-1 in the Annex gives details on the contribution of different activities to net LULUCF credits and debits under rule changes.

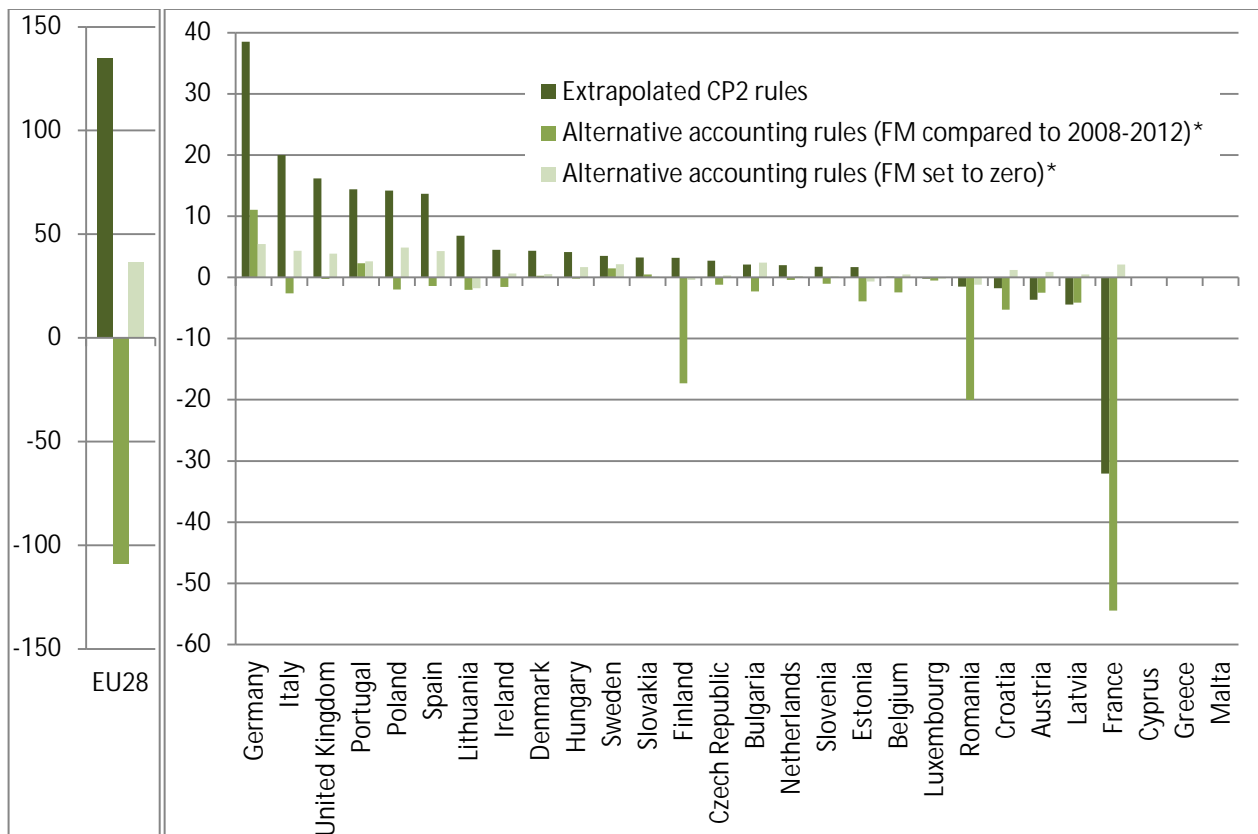
**Data availability:** The above discussed options do not need additional data other than the ones already reported by countries.

**Robustness and transparency:** There is the risk of unbalanced accounting if rule changes are applied only to selected activities and if these changes introduce more exceptions. This is especially true if certain categories are excluded from accounting. However, certain rule changes would increase transparency and harmonization of accounting across activities.

**Suitable to set incentives:** Specific rule changes can set incentives to make additional efforts e.g. in CM or GM activities because only very recent changes would be accounted for. However, longer-term activities might become less attractive because their benefits to MS are reduced.

**Suitable to identify environmental integrity:** The suggested rule changes are expected to overall increase environmental integrity. Land-based accounting, if applied to all significant categories, helps to achieve a better coverage of emissions. Changes of base years towards more recent periods increase the level of ambition and set incentives to change management. New rules for setting the FMRL can increase environmental integrity if they can avoid assumptions on future wood demand and the risk of overestimated harvest rates.

**Figure 4-3: Annual net LULUCF credits (+) and debits (-) for 2021-2030 when applying alternative accounting rules [in Mt CO<sub>2</sub>]**



\* Note: Alternative accounting rules are defined as follows: AR – accounting against historic period/land-based accounting, D – gross net accounting, no change of rules, FM – compared to 2008-2012 or set to zero to illustrate the effect of FM accounting, CM and GM – accounting against base year 2005.

Source: Böttcher and Graichen (2015) and recalculations.

### 4.3. Conditional accounting

#### 4.3.1. Assessment against a land use reference level

While the options discussed above aim to change existing accounting rules to ensure environmental integrity of increasing the ambition level, the following options set conditions to using credits from LULUCF accounting to achieve a higher target. One option is to make the use of LULUCF credits conditional to the performance against an overall LULUCF emission level.

According to Article 10 of the EU LULUCF Decision and the Regulation on the Mechanism for Monitoring and Reporting (MMR) of greenhouse gases MS are requested to provide information on the LULUCF sector development, including projections<sup>6</sup>. Guidance has been developed to enable MS to project GHG emissions from LULUCF (IEEP, 2014). Over the past five years MS have developed FM projections of GHG emissions from which FMRLs are often derived. Similarly to the FMRL a total Land Use Reference Level (LURL) could be established based on MS projections or other existing information. This would include all relevant GHG sources and sinks of a MS and describe the development without additional measures. The comparison between total reported land use emissions and removals and LURL would show if major policy changes took place in a MS that affected land use emissions. In addition, an uncertainty margin of a certain range around the projection could be included. The performance of a MS against its LURL (including the margin) would be used as a criterion to allow MS to issue credits from that sector. The difference to the FMRL would be that more categories are included, that make the projection statistically more robust. Accounting rules to derive credits and debits from single categories would not necessarily change but their use would be made conditional to the development of total net LULUCF emissions.

Figure 4-4 describes the trend of historic and projected annual EU MS emissions and removals from LULUCF for the respective accounting periods. The figure gives an impression of the variability of net LULUCF emissions of MS across commitment periods. Some MS show clear either increasing or decreasing trends (e.g. Estonia, Lithuania, Portugal, Spain). But for a number of countries trends change over time (e.g. Sweden, France, Poland, Finland). The figure illustrates also the challenges that a gross-net accounting of emissions during the commitment period but also a net-net accounting approach against a historic reference would have. In a number of MS total net emissions change quite significantly within a relatively short period of time. These changes can partly be attributed to management changes but in most cases they are driven by past practices. Historic references do not reflect well the changes occurring in the commitment period, the accounting of gross-net emissions during that time is not reflecting it either. Projections used as reference reduce accountable changes to differences in more recent management.

**Data availability:** National projections exist for some MS already. There are more consistent projections per MS available from the EU reference scenarios commissioned by EC. Accessibility of underlying data is an issue as well as the transparency of assumptions. Projections by MS and also scenarios commissioned by EC usually have variants such as sensitivity runs where variables or parameters are changed. These variants can serve as a basis to assign uncertainty margins to projections. Uncertainty margins can also be based on the variability of historic data similarly to background levels estimated when applying the provision of natural disturbances.

**Robustness and transparency:** There are high uncertainties associated with projections in general. Following existing guidance can help to increase transparency, especially regarding policy assumptions and trends in consumption. Not only the level but also the trends of projections are very sensitive to assumptions made. A LURL including all significant land use categories of a country reduces relative uncertainties and is potentially more consistent than reference levels for single categories and therefore more robust.

**Suitable to set incentives:** Accounting against a projected reference is an effective means to constrain credits and debits from accounting to policies and measures introduced and their effect on GHG emissions. This increases the motivation to implement additional measures. If uncertainty

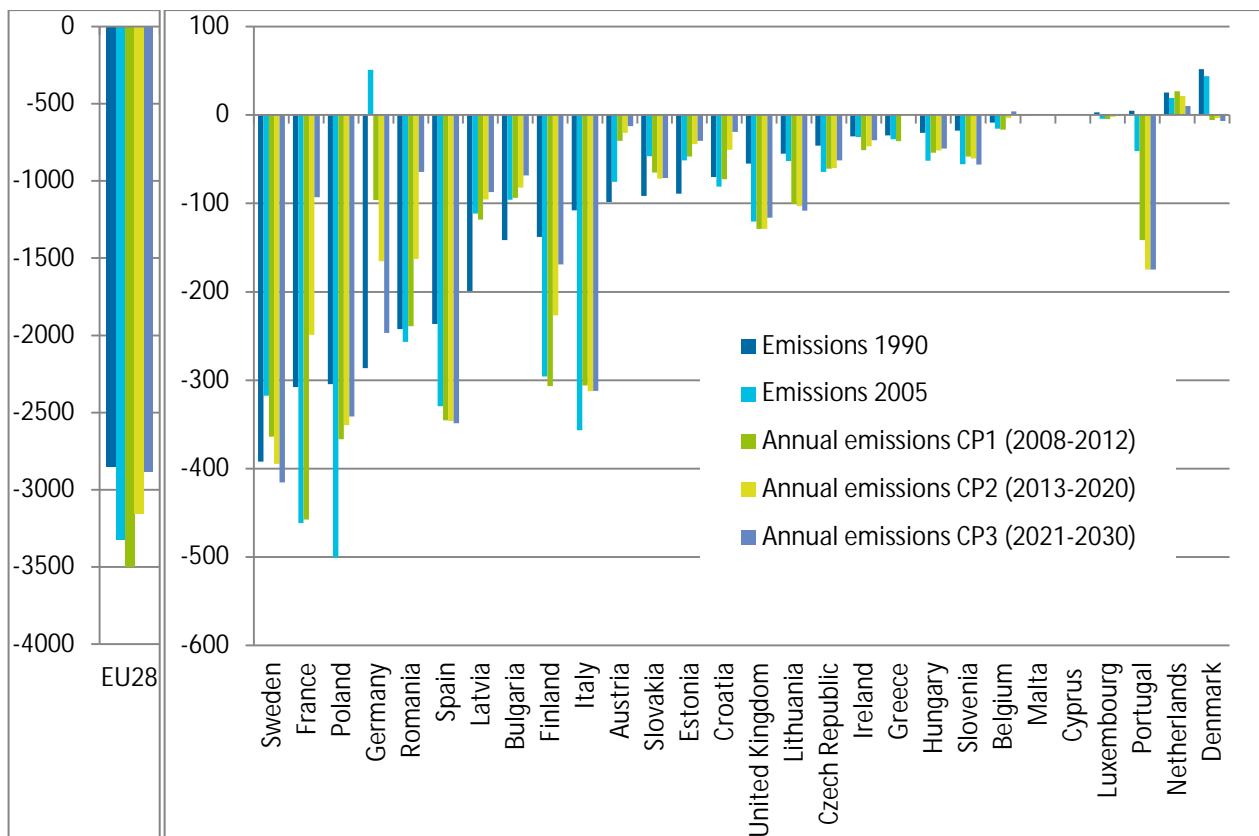
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<sup>6</sup> Projections of emissions and removals - Article 10(2)(b) Decision No 529/2013/EU (LULUCF Decision) and Projections - Article 14.1 Decision No 525/2013/EU (MMR Decision)

margins are applied, incentives are reduced because smaller changes in emissions and removals compared to the reference cannot be accounted for if they do not exceed the margin.

**Suitable to identify environmental integrity:** This option ensures environmental integrity under the condition that projections are reflecting well the development of GHG emissions without additional measures and that the establishment of a LURL is transparent. Still there is the risk of inflating projections by assumptions that in general cannot be critically reviewed or validated.

**Figure 4-4: Net LULUCF emissions (+) and removals (-) as reported (1990, 2005, CP1) and projected (CP2, CP3) [in Mt CO<sub>2</sub>]**



Source: Böttcher and Graichen (2015).

#### 4.3.2. Conditional forest management accounting

One of the shortcomings of accounting for forest management against an FMRL is the fact that ambitious bioenergy targets of a MS can be included in the FMRL and that because emissions from bioenergy are assumed to be zero in the energy sector, bioenergy emissions go unaccounted for (McKechnie et al., 2014). This fact is a potential threat to environmental integrity of LULUCF credits and especially problematic if forest C stocks are being reduced due to harvest for bioenergy. Principle d) of the Marrakesh Accords (see Box 1) requires that the mere presence of C stocks should be excluded from accounting. The restriction to accounting of C stock *changes* has put the focus on productivity of forests, much more than on the existing carbon stocks in forests.

EU forest C stocks have been depleted for many decades. This was in addition to the loss of forest cover. Since the middle of the 19th century forest area has been recovering at high rates. In Europe, two and a half centuries of land-use change increased the forest area by 10 percentage points and has put over 85% of the forests under management. However, when including the past loss of C stocks in European forests these increases in area have not yet resulted in net CO<sub>2</sub> removal from the atmosphere, because C stocks in the biomass, litter, dead wood, and soil carbon pools are still low due to intensive management of forests. These implications have recently been analyzed by researchers at the Max Planck Institute for Meteorology (Naudts et al., 2016). The authors conclude that *'any climate framework that includes land management as a pathway for climate mitigation should not only account for land-cover changes but also should equally address changes in forest management, because not all forest management contributes to climate change mitigation'*.

A way to better address C stocks in EU forests and set incentives to increase stocks in forest biomass and soil pools would be an accounting conditional to increasing or maintaining forest carbon stocks. Credits from LULUCF could only be issued if this condition (possibly differentiated by forest types) holds true. Figure 4-5 presents reported and projected FM emissions for EU countries. Almost all MS have been increasing their forest carbon stocks in the recent past. Historically there were only two MS that reported net emissions from FM (Denmark and Luxembourg). Projections for Austria and Ireland foresee net emissions to occur between 2020 and 2030. The potential to increase carbon stocks with forest management depend on age class structure, current C stocks, species composition and silvicultural system. Figure 4-5 reveals also that the rates of stock increases decline for the majority of countries. A saturation of this phase of C stock rebuilt at some point is inevitable but can be postponed. There is evidence that, depending on tree species, carbon stocks in managed forests can be increased if silviculture is changed towards systems with reduced anthropogenic disturbances (Fichtner et al., 2012)

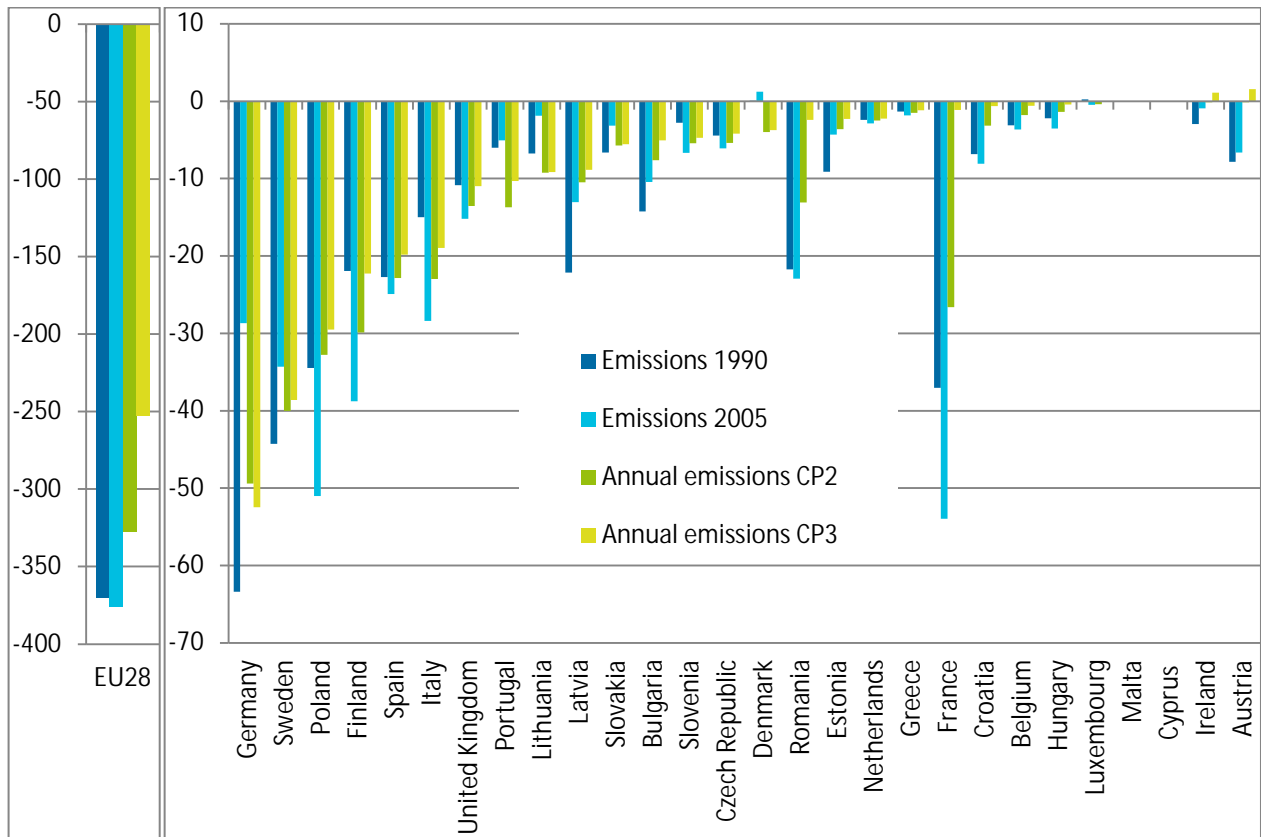
**Data availability:** Net emissions from FM are not necessarily the best indicator to monitor C stocks in forests. Unmanaged forests with increasing C stocks might not be included when applying activity-based accounting. If area-based accounting is used, the category of forest land remaining forest land includes also young forests that have been afforested more than 20 years ago. This dilutes the average C stocks of the forests, increases the net sink and thus overwrites C stock reductions taking place in older forests. There might be more appropriate indicators that can be derived from national forest inventories, such as average C stocks per forest type. That would make the indicator also more specific to forest type and thus C stock potential.

**Robustness and transparency:** Indicators can be derived from well-established information sources such as national forest inventories.

**Suitable to set incentives:** This option focuses on activities that aim at enhancing and maintaining C stocks in existing forests. MS would avoid declining C stocks in certain forest types.

**Suitable to identify environmental integrity:** This option is suitable to ensure environmental integrity of FM credits. It addresses not only C stocks in forests and their fate but also biodiversity as forests with high C stocks are typically of higher value to biodiversity.

**Figure 4-5: FM emissions (+) and removals (-) as reported (1990, 2005) and projected (CP2 and CP3) before accounting [in Mt CO<sub>2</sub>]**



Source: Böttcher and Graichen (2015)

## 5. Conclusions

Based on available data and assumptions on future development of GHG emissions and removals from the LULUCF sector, we find that options exist to allow the EU increasing its level of ambition by including LULUCF in its 40% target and ensuring environmental integrity. Such a level of ambition would ensure environmental integrity under the condition that accounting rules are changed (e.g. different treatment of afforestation). Integrity could be increased further if accounting is made conditional to environmental performance, e.g. the maintenance or increase of carbon stocks.

As pointed out by earlier studies, there are good reasons for forming a separate LULUCF pillar to incorporate the sector into the EU climate and energy package. This would mean that there is no exchange of credits between the LULUCF pillar and other sectors or the ESD, or at least that these are significantly limited. However, the credits from this sector will in any case relate to the overall target that offers to the opportunity of increasing the overall ambition of the EU's 2030 target beyond 40%.

Current rules are not sufficient to fulfil principles of environmental integrity such those defined in the Marrakech Accords. We present and explore alternative options of criteria and conditions to ensure environmental integrity of the overall target if LULUCF would be included in this particular way. These options include changes of current accounting rules, such as moving towards land-based accounting, changing base years for cropland and grazing land management, changing accounting for afforestation and forest management. In addition we explore options for conditional accounting that make the use of credits from LULUCF conditional to the performance of the sector or single activities.

If credits from FM are to be included and accounted against an FMRL, sustainability constraints are needed for ensuring biomass use for bioenergy results in real emission reductions. Current rules are not designed to capture these emissions that are supposed to be accounted for under LULUCF. An alternative construction of the FMRL that is based on continuing current silvicultural practices rather than future harvest levels can help to reduce arbitrary assumptions on future wood demand. This could be considered a compromise between the current approach to estimate FMRLs and historical net-net accounting that has major short-comings as it does not exclude age structure effects.

These options can form the basis of designing a LULUCF pillar that can help to determine a target for the sector and ultimately increase the level of ambition beyond 40%. The additionality of mitigation in LULUCF, however, can only guaranteed if the target is set after such rules have been formulated.

In order to develop accounting rules further and increase coherence and consistency of the use of rules such as FMRL accounting an oversight body would help to provide independent guidance and supervision.

## 6. Bibliography

- Böttcher, H. and Graichen, J., 2015, *Impacts on the EU 2030 climate target of including LULUCF in the climate and energy policy framework*, Öko-Institut (<http://www.oeko.de/oekodoc/2320/2015-491-en.pdf>) accessed 16 April 2016.
- Böttcher, H., Kurz, W. a. and Freibauer, A., 2008, 'Accounting of forest carbon sinks and sources under a future climate protocol-factoring out past disturbance and management effects on age-class structure', *Environmental Science & Policy*, (11/8) 669–686.
- Ellison, D., Lundblad, M. and Petersson, H., 2014, 'Reforming the EU approach to LULUCF and the climate policy framework', *Environmental Science & Policy*, (40) 1–15.
- Fichtner, A., Sturm, K., Rickert, C., Härdtle, W. and Schrautzer, J., 2012, 'Competition response of European beech *Fagus sylvatica* L. varies with tree size and abiotic stress: minimizing anthropogenic disturbances in forests', *Journal of Applied Ecology*, (49/6) 1306–1315.
- IEEP, 2014, *Guidance on Member State reports providing: 'Information on LULUCF actions' in accordance with Article 10 of EU Decision 529/2013/EU*, Institute for European Environmental Policy.
- IPCC, 2013, *2013 Revised supplementary methods and good practice guidance arising from the Kyoto Protocol (KP Supplement)*, Geneva ([http://www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance\\_inv.html](http://www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html)) accessed 5 November 2014.
- IUCN UK, 2014, *Ecological Impacts of Forestry on Peatlands*, International Union for Conservation of Nature.
- McKechnie, J., Colombo, S. and MacLean, H. L., 2014, 'Forest carbon accounting methods and the consequences of forest bioenergy for national greenhouse gas emissions inventories', *Environmental Science & Policy*, (44) 164–173.
- Naudts, K., Chen, Y., McGrath, M. J., Ryder, J., Valade, A., Otto, J. and Luysaert, S., 2016, 'Europe's forest management did not mitigate climate warming', *Science*, (351/6273) 597–600.



## Annex

**Table A-1: Results of LULUCF accounting per Member State for different accounting cases and activities in Gg CO<sub>2</sub>.**

	Extrapolated CP2 rules						Alternative accounting rules*						Net LULUCF (FM=0)
	AR	CM	D	FM	GM	Net LULUCF	AR	CM	D	FM	GM	Net LULUCF	
EU28	98,699	11,006	-15,122	12,127	28,261	134,972	42,108	7,699	-15,122	-145,324	1,693	-108,946	36,378
Austria	3,172	-158	-148	-6,361	-160	-3,656	1,190	23	-148	-3,406	-155	-2,496	910
Belgium	384	-375	-126	-721	966	129	100	160	-126	-2,946	370	-2,442	504
Bulgaria	2,455	-166	0	-306	112	2,094	1,736	574	0	-4,722	112	-2,300	2,422
Croatia	1,301	-5	-2	-3,118	77	-1,748	1,120	1	-2	-6,532	116	-5,298	1,234
Cyprus	0	0			0		0	0		0	0	0	
Czech Rep.	533	1,204	-53	699	350	2,734	230	110	-53	-1,520	55	-1,177	343
Denmark	375	1,772	-23	2,426	-198	4,353	338	403	-23	-292	-161	265	557
Estonia	922	70	-62	856	-125	1,660	894	58	-62	-3,236	-1,584	-3,930	-694
Finland	707	1,019	-1,366	2,485	370	3,215	588	478	-1,366	-16,924	-82	-17,306	-382
France	16,756	-7,906	-3,594	-40,799	3,452	-32,092	8,276	-1,116	-3,594	-56,560	-1,455	-54,449	2,111
Germany	9,416	-210	-731	27,015	3,045	38,535	4,198	1,171	-731	5,640	798	11,076	5,436
Greece	989	-550		-318	734		850	-61		-668	400	521	
Hungary	2,158	1,769	-35	380	-128	4,143	1,010	562	-35	-1,850	127	-185	1,665
Ireland	4,536	-252	-306	10	506	4,495	956	-110	-306	-2,198	93	-1,565	633
Italy	12,382	-713	-631	810	8,132	19,979	5,938	-1,267	-631	-6,944	307	-2,597	4,347
Latvia	538	366	-261	-5,840	743	-4,455	234	310	-261	-4,588	201	-4,103	485
Lithuania	1,717	2,232	-3	1,730	1,142	6,818	574	-1,123	-3	-232	-1,228	-2,012	-1,780
Luxembourg	160	-22	-272	-48	-26	-206	88	-3	-272	-324	-14	-524	-200
Malta	0	2		-44	0		0	0		0	0	0	
Netherlands	1,624	-754	-584	1,056	685	2,026	1,028	-168	-584	-630	-66	-421	209
Poland	5,075	2,621	-100	5,657	918	14,172	2,480	1,825	-100	-6,840	652	-1,983	4,857
Portugal	9,108	3,501	-1,548	2,105	1,253	14,420	3,294	419	-1,548	-306	466	2,324	2,630
Romania	3,156	74	-1,547	-2,717	-462	-1,496	390	557	-1,547	-18,806	-610	-20,017	-1,211
Slovakia	461	247	-22	2,522	50	3,258	88	16	-22	330	51	463	133
Slovenia	1,936	107	-758	712	-275	1,722	1,098	81	-758	-1,172	-276	-1,028	144
Spain	11,259	912	-2,339	-234	4,086	13,683	2,654	1,144	-2,339	-5,700	2,854	-1,387	4,313
Sweden	4,301	925	-775	-1,319	369	3,501	1,888	602	-775	-668	422	1,468	2,136
UK	3,278	5,296	-333	5,293	2,645	16,178	868	3,055	-333	-4,130	299	-241	3,889

\* Note: Alternative accounting rules are defined as follows: AR – accounting against historic period/land-based accounting, D – gross net accounting, no change of rules, FM – compared to 2008-2012 or set to zero to illustrate the effect of FM accounting, CM and GM – accounting against base year 2005.

Source: Böttcher and Graichen (2015) and recalculations.

## Acknowledgements

We thank Anke Herold, Eric Fee and Giacomo Grassi for providing comments on the manuscript.