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Analysis of LULUCF actions in EU Member States as reported under Art. 10 of the LULUCF Decision

FINAL STUDY

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Abbreviations

AFOLU	Agriculture, Forestry, and Other Land Use
CAP	Common Agricultural Policy
CH_4	methane
CM	cropland management
CO_2	carbon dioxide
$CO_{2\text{-eq}}$	carbon dioxide equivalent
COP	Conference of the Parties
CRF	common reporting format
CSC	carbon stock change
DOM	dead organic matter
EAFRD	European Agricultural Fund for Rural Development
EFA	Ecological Focus Area
EU	European Union
GAEC	Good Agricultural and Environmental Condition
GHG	greenhouse gas
GM	grassland management
HWP	harvested wood products
ha	hectare
IACS	Integrated Administration and Control System
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LPIS	Land Parcel Identification System
LUCAS	Land Use/Cover Area frame Survey
LULUCF	land use, land use change, and forestry
MACC	marginal abatement cost curve
MFF	Multi-annual Financial Framework
Mton	Megaton (1 million metric tonnes)
N_2O	nitrous oxide
NIR	national inventory report
NVZ	nitrate vulnerable zone
RDP	Rural Development Programme
SFM	sustainable forest management
SMR	statutory management requirements
UNFCCC	United Nations Framework Convention on Climate Change

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Executive summary

Aim of the study

The aim of this study is to support the European Commission in the implementation of the LULUCF (land use, land use change, and forestry) Decision (Decision no 529/2013) with a focus on its Article 10 provisions. Under Article 10 Member States must submit information on their most relevant current and future LULUCF actions in land use activities such as afforestation, forest management, cropland and grassland management, and wetlands management. The study analyses the initial and progress LULUCF action reports submitted to the European Commission between 2014 and 2017.

Methods

Between May and September 2017, the study team analysed 51 Article 10 reports. The information provided in the reports was first synthesized based on a set of indicators such as scope, goal, planning period, link to national priorities, type of policy instrument, sources of funding, expected impact, and data sources. The synthesis results were then analysed in order to identify the most often reported actions, the policy instruments used to support the actions, the LULUCF priorities shared by the Member States, and the most cost-effective measures. The analysis tried also to find out how wide spread the use of spatially explicit data in LULUCF accounting is among the Member States, and how the methodologies for estimating GHG emission could be improved to ensure more accurate results. One of the study tasks was also to try to provide an estimate of the aggregated impact of the activities on GHG emissions, and compare it with relevant findings from other studies in this field. Finally, the analysis was also oriented to those LULUCF actions that could be enhanced to maximize the pursuit of their mitigation potential. The analysis built not only on the Article 10 reports, but also on literature review and expert judgment.

Synthesis findings

The synthesis of Article 10 reports listed 679 LULUCF measures and policies in an array of ongoing and planned initiatives mainly in forestry and agriculture. The Article 10 reports are not built on a harmonized template, and therefore present information with a heterogeneous level of detail and of types of information. The reported LULUCF actions cover different constellations of the Member States without a clear pattern relevant to climatic zones or land use coverage. The majority of measures and policies are implemented at national level, with the exception of the UK, Germany, Italy, and Spain where regional approaches prevail.

The stated objectives of the actions vary across the Member States and categories of measures. Measures targeting both conservation of carbon in existing forests and grassland/grazing land/pasture management mostly have GHG emission reduction and carbon sequestration as their primary objectives. In other areas, LULUCF mitigation benefits take a secondary role in the overall rationale of the activities.

There is no systematic information about the planning periods available in the Article 10 reports. The most commonly reported time frames are those of the current 2014-2020 EU policy programming period, usually referring to Common Agricultural Policy (CAP).

Reports often identify several strong links between the reported measures and national policy priorities such as rural development, multi-functionality of forests, biodiversity protection,

water protection, climate change mitigation and adaptation, industrial innovation, or the circular economy. Most Member States subordinate LULUCF actions to other policy priorities (such as sustainable forest management), usually adopted before the LULUCF sector was formally given an active role in climate change mitigation. In that sense, the reports submitted under Article 10 are a collection of more or less LULUCF-relevant policies and measures rather than an inventory of activities fulfilling a mitigation strategy in the LULUCF sector.

Overall the actions are implemented predominantly through economic incentives (mainly CAP payments) and to a smaller extent also strategic documents, and legal requirements. Information on costs and sources of funding was sporadically provided, usually pointing to the CAP funds: European Agricultural Fund for Rural Development (EAFRD) and European Agricultural Guarantee Fund (EAGF). This information was sufficient to imply the involvement of national funding sources, but not specific enough to estimate the cumulative cost of the reported actions, or to determine the share of national budget participation.

The Member States describe the expected impacts mainly in qualitative terms. Reports contain very limited information on the actual emission consequences of polices and measures. The quantitative data in this respect is scarce and often subject to high uncertainty. No EU-level impact of the reported measures and policies on GHG emissions could therefore be aggregated. Finally, the reports do not tend to provide the data sources and details of the methodologies used, but refer to the National Inventory Reports instead.

Policy instruments

The Common Agricultural Policy, and particularly its Rural Development programmes, are key to the Member States' climate action in LULUCF sector. The CAP frames and provides support to a wide range of actions across the LULUCF activities. The CAP funds (EAGF and EAFRD) are the main source of EU financial support, and it follows requirements under both: Pillar I (direct payments based on cross-compliance, ecologic focus areas, and greening) and Pillar II (rural development). Rural development programmes, and their "Agri-environment-climate" measure (M10) and "Investments in forest area development and improvement of the viability of forests " (M08) in particular, seem to play the key role in driving the Member States' LULUCF actions. The one concern noted in this respect is a relatively short time span of CAP supported measures (usually from 5 to 7 years) that may not be sufficient to provide long lasting GHG impacts and therefore fall short from the climate integrity perspective.

The LULUCF actions stem also from the national forestry policies, shaped in part to reflect the concept of sustainable forest management. The role of multi-functional forests is often raised by the Member States as a way of seeing forests as providers of goods and services, including biomass for energy and other commercial uses, and climate mitigation. Forest management is the most frequently reported LULUCF activity covering a broad range of actions, including many designed to enhance forest productivity and resilience to fires. A bulk of sustainable forest management practices and actions are supported under the CAP.

Additional EU policy instruments reported by the Member States as encouraging the LULUCF actions include: the LIFE programme, the Natura 2000 legislation, the Nitrates Directive, the INSPIRE Directive, and the Renewable Energy Directive. Only a few policy tools designed at national level were identified, including among others fiscal instruments to encourage a higher biomass uptake.

Methods used to determine land use and GHG impacts

Although the Article 10 reports do not include much information on the methodologies used to determine land use or GHG emission and removals relevant to the reported LULUCF actions, analysis based on other recent studies shows a high potential for improvement in both areas. It seems that an improvement of land use data availability and accuracy is possible and could lead to a better quality monitoring of LULUCF activities also in terms of their GHG impacts. The improvement could be done by exploiting the potential to complement the various existing data sets such as Land Parcel Identification System (LPIS) deployed widely under CAP, Eurostat's Land Use and Land Cover Survey (LUCAS) and Copernicus, the EU Earth Observation programme, offering state of the art quality of land use data.

Mitigation potentials, cost-effectiveness, and potential for enhancement

As most Member States did not provide any quantitative estimates of the impact of their LULUCF actions on GHG emissions and removals, or information on levels of uptake of actions, a top down assessment, based on the literature review, has been made for five broad categories of LULUCF action relevant to the measures reported under Article 10. In general, wide ranges of the estimated mitigation potentials for comparable actions have been identified. An attempt to provide an aggregate mitigation potential of each of the five selected categories at EU level by 2030 shows that forest management carries the highest mitigation potential (148 Mton CO_2-eq/year by 2030 for the assumed area of 138,000 kha). It is followed by carbon sequestration in mineral soils (50 Mton CO_2-eq/year by 2030 for the assumed area of 125,000 kha), and reducing emissions from organic soils (30 Mton CO_2-eq/year by 2030 for the assumed area of 4,000 kha), avoided deforestation (2.7-3 Mton CO2-eq/year by 2030 for the assumed area of 11.5 kha), and afforestation (1.58 Mton CO_2-eq/year by 2030 for the assumed area of 240 kha). In terms of the mitigation potential per hectare, "avoided deforestation" offers by far the highest mitigation impact of 235 – 263 ton CO_2-eq/ha/year.

The identified cost-effectiveness evidence, based mostly on literature, does not allow formulating quantitative estimates of the mitigation efforts in LULUCF sector. The literature review suggests that there are low opportunity costs of mitigation actions in some land use activities contrasting with the level of capital costs required for the initial investment. Moreover, management related measures can be cost-neutral, whereas measures in which the use of the land is changed can be very costly.

The potential to enhance LULUCF actions in the post 2020 framework was analysed based on the Article 10 reports, literature, and expert judgment. In forestry, forest management and avoiding deforestation have been considered to be the most promising actions, provided that forest management enhancement meets the needs of the circular economy and ensures as durable GHG emission removals as possible. In agriculture, soil carbon sequestration has been identified as suitable for enhancement to the benefit of climate mitigation.

Conclusions and recommendations

Several conclusions and recommendations have been formulated:

- **Focus on exploiting mitigation potential from LULUCF in a targeted and cost-effective way**: agriculture and forestry policies, as well as wider environment, climate, energy and biodiversity policies, contribute to increasing GHG sinks and reducing GHG emissions from land use sectors in a complex range of ways. While there are signs of some positive actions taken by Member States to pursue LULUCF mitigation potential, there is little evidence to suggest that these actions are designed to exploit the potential for LULUCF mitigation in the best feasible manner. In the future, mitigation action undertaken by Member States should focus on exploiting mitigation potential from LULUCF in a targeted and cost-effective way, going beyond the minimum requirements of compliance with the current EU legislation and using tailored tools and governance solutions (e.g. better coordination between relevant ministries at national level).
- **Address data and knowledge gaps:** the GHG impacts of the reported measures are hardly ever quantified by Member States, mainly due to the data and knowledge gaps. Data and knowledge gaps should be addressed by (i) exploiting the potential of using land use data from the existing EU data sets such those under LPIS and LUCAS, and the EU Earth Observation programme, Copernicus (ii) supporting further research in the areas that can help the Member States to minimize the negative impact of the uncertainty that is inherent to the sinks and sources in LULUCF.
- **Use a common reporting template:** the reports submitted under Article 10 are very heterogeneous. The use of a template and clear, harmonised reporting questions would allow a better EU-28 overview of LULUCF actions and their expected impacts and costs, and facilitate sharing of experience and discussion among Member States.
- **Harness the preparation of the long-term plans and strategies for greater coherence and effectiveness:** we have not identified any national strategies dedicated to LULUCF that would help frame the short-term and longer-term actions required to pursue the mitigation in the sector, however LULUCF is covered in a number of other strategic documents adopted at national level. The proposal for the Governance of the Energy Union Regulation[1] (to come into force after 2020) states that Member States shall prepare long-term low emissions strategies and the integrated National Energy and Climate Action Plans, which will also cover the LULUCF sector. Creating such strategies and plans would not only improve coherence of the Member States' actions in this area, but also improve cost-effectiveness.
- **Clarify priorities for LULUCF funding:** CAP funds are the main sources of finance supporting LULUCF actions, and CAP itself covers almost all measures reported under Article 10. Further progress in climate mainstreaming in the next multiannual financial framework (MFF) is therefore important to ensure a greater focus on EU budget's potential to support climate action in land use sectors. More clarity on priorities

[1] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the Governance of the Energy Union, amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/73/EC, Council Directive 2009/119/EC, Directive 2010/31/EU, Directive 2012/27/EU, Directive 2013/30/EU and Council Directive (EU) 2015/652 and repealing Regulation (EU) No 525/2013, COM(2016)0759 final, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2016:759:REV1

through the development of dedicated LULUCF strategies, as suggested above, could bring significant benefits in terms of availability and targeting of EU budget and other policy support.

- **Ensure actions are compatible with wider environmental sustainability:** with the post-2020 time horizon in mind, several potential enhanced LULUCF actions are identified which could contribute to climate change mitigation in the sector. They should be pursued in a manner consistent with wider climate and environmental sustainability.

1 Introduction

1.1 Context

The EU's goal is to limit its greenhouse gas (GHG) emissions by 20% by 2020 (from 1990) levels. Within the current EU legal framework, emissions and removals of GHG resulting from the EU land use, land use change and forestry (LULUCF) sector are not counted towards the target. Instead, under the provisions of the Kyoto Protocol (1992) some LULUCF activities are accounted for in the EU's emission reduction commitments, and could be counted towards their delivery. The commitments put forward by the EU under the Kyoto Protocol's successor, the Paris Agreement (2015), allow for LULUCF emissions and removals to be counted towards the EU's nationally determined contribution. Moreover, according to the Agreement, its long term climate mitigation objectives cannot be achieved without a contribution from the LULUCF sector, as LULUCF creates GHG sinks that should balance GHG sources "in the second half of this century"[2].

The EU has made progress in developing a new legal framework to reflect the new climate action ambition for the 2020 to 2030 time horizon, as set out in the European Council conclusions of October 2014[3]. The proposed legislation, known as the 2030 Framework for climate and energy, sets an economy-wide target of at least a 40% domestic reduction of GHG emissions compared to 1990 emissions to be achieved by 2030, and foresees a LULUCF contribution to achieving the target.

In July 2016 the European Commission proposed a Regulation on inclusion of GHG emissions and removals from LULUCF into the 2030 climate and energy framework, and to replace and update the existing LULUCF Decision (Decision No 529/2013/EU, setting the accounting rules in line with the Kyoto Protocol)[4] as of 2021. The proposed Regulation lays down the accounting rules applicable to GHG emissions and removals from the LULUCF sector, building on the existing rules. It also requires Member States to ensure that the overall LULUCF sector does not generate net emissions (the so called "no debit rule"[5]).

It is therefore clear that in the post 2020 period, emissions and removals by LULUCF sector will gain in political salience, and pursuing the sector's mitigation potential will become

[2] UNFCCC (2015), Paris Agreement, http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

[3] European Council 23 and 24 October 2014 – Conclusions, EUCO 169/14, http://data.consilium.europa.eu/doc/document/ST-169-2014-INIT/en/pdf

[4] Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities, OJ L 165, 18.6.2013, p. 80–97

[5] This requirement was later removed from the legislative proposal by the European Parliament, but the legislative process is not finished yet (as of beginning of October 2017) so it is impossible to say if it will or will not be laid out in the adopted regulation. See Amendment 17 Recital 7 of Amendments adopted by the European Parliamenton 13 September 2017 on the proposal for a regulation of the European Parliament and of the Council on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry into the 2030 climate and energy framework and amending Regulation No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and other information relevant to climate change (COM(2016)0479 – C8-0330/2016 – 2016/0230(COD)) (Ordinary legislative procedure: first reading), http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2017-0339+0+DOC+XML+V0//EN&language=EN

increasingly important. Until 2020 however, the EU Member States will continue to apply the accounting and reporting obligations set out in the LULUCF Decision.

This study presents an analysis of LULUCF actions as reported by the Member States under Article 10 of the LULUCF Decision and, on that basis, attempts to identify opportunities for a sustainable pursuit of the LULUCF mitigation potential post 2020.

Article 10 requirements

Under Article 10 of the LULUCF Decision, the EU Member States have to report to the European Commission on their current and future LULUCF actions. The information they provide should cover the duration of the accounting period of 1st January 2013 – 31st December 2020 and include the following information relating to the activities:

> a) a description of past trends of emissions and removals including, where possible, historic trends, to the extent that they can reasonably be reconstructed;
>
> b) projections for emissions and removals for the accounting period;
>
> c) an analysis of the potential to limit or reduce emissions and to maintain or increase removals;
>
> d) a list of the most appropriate measures to take into account national circumstances, including, as appropriate, but not limited to the indicative measures specified in Annex IV of the Decision, that the Member State is planning or that are to be implemented in order to pursue the mitigation potential, where identified in accordance with the analysis referred to in point (c);
>
> e) existing and planned policies to implement the measures referred to in point (d), including a quantitative or qualitative description of the expected effect of those measures on emissions and removals, taking into account other policies relating to the LULUCF sector;
>
> f) indicative timetables for the adoption and implementation of the measures referred to in point (d).

Structure of this study

This study presents the findings from the synthesis and analysis of Article 10 reports. Below in this chapter, the methodology applied in this study is explained. In chapter 2 an overview of the LULUCF actions reported by the Member States is provided, based on the synthesis of the reports addressed in detail in Annex I. Chapter 3 deals with LULUCF priorities across the EU, and the strategic approaches taken towards the mitigation potential of this sector. In chapter 4 the main policy instruments identified from the reports are presented in more detail, focusing on the CAP as the main source of economic stimulus for LULUCF actions in the EU Member States. Chapter 5 provides an overview of the methodologies used by Member States to determine land use and GHG emissions from land based activities. This overview draws on an external study rather than on the Article 10 reports themselves (as the information they include was scattered and often non conclusive in terms of the methodologies applied). Chapter 6 provides an attempt to attach quantitative estimates of mitigation impact to the measures reported under Article 10, and then comment on their cost-effectiveness. It also deals with the potential for enhancement of certain LULUCF actions

in the future. Finally, conclusions, including an identification of areas where there is scope for improvement, are drawn in chapter 7.

1.2 Methodology

This work under study has been divided into three phases: synthesis, analysis, and presentation of findings.

Synthesis

The synthesis phase consisted in a review of the initial and progress reports on LULUCF activities in EU Member States (referred to also as Article 10 reports), as submitted by the Member States to the European Commission between 2014 and 2017. All Article 10 reports received by the Commission up to June 2017 were made available to the consultants by DG CLIMA (51 in total[6]). The review was conducted with the aim of extracting the information relevant to the research questions and indicators presented in Table 1 below[7]. The relevant information was fed into a database, designed in a way that facilitates synthetizing of the findings at EU level. A short summary report has been drafted (see Annex I).

The synthesis was conducted between June and August 2017.

Table 1 List of indicators and research questions guiding the synthesis and analysis of the Member States LULUCF actions as reported under Art. 10 of the LULUCF decision

Measure/policy indicators

- scope, goal, planning period
- link to national priorities
- type of policy instrument
- sources of funding
- expected impact (based on the potential mitigation impact described by MS)
- data sources (geographical information systems, satellite / Copernicus, CAP/LPIS) monitoring accuracy (Tier 1-2-3)

Research questions

- What are the measures most often selected in the different areas of intervention (cropland management, grazing land management, soil management, wetlands, forest management...)?
- What kind of policy instruments are most often selected to implement specific measures?
- Which groups of countries share common priorities in the LULUCF sector?
- What is the expected aggregated impact (across the EU) of the most significant measures?
- What appear to be the most cost-efficient and/or effective measures?
- How many Member States mention the use of spatially explicit (geographic) data in the implementation of their policies?
- What is the potential for the use of satellite data, digital geographic information and more specifically of Copernicus data?

[6] Up to XX 2017, Portugal hashad not submitted either of the reports required under Article 10 of the LULUCF decision. Germany, Romania and Slovenia had only submitted the initial reports.

[7] The indicators and the research questions have been formulated in the terms of reference of this study.

- How many Member States exploit CAP/LPIS data in the implementation of their policies?
- What potential exists for further integration of agriculture and climate policy datasets?
- How many Member States use (or plan to use) Tier 1, 2 or 3 methodologies to estimate their emissions, by land accounting category?
- What opportunities are available for improving technical accuracy of emission estimates?

- An assessment of the reported policies and measures aggregate impact using the figures presented in Member State information reports, from the synthesis report;
- The potential given by Member States for future enhanced mitigation actions;
- Comparison with the mitigation options and potential identified in previous Commission material used in the LULUCF legislative proposal;
- Review and identification of the potential enhanced mitigation actions for the period 2021-2030.

Analysis

The project team, including agriculture, forestry, and soils experts, conducted further analysis of the findings, based on the research questions. It quickly became clear that some of the research questions, particularly those related to land use and GHG emission estimates methodologies, could not be answered based on the Article 10 reports, which in general either failed to provide the relevant information, or provided it in differing levels of detail. The relevant information therefore had to be collected from the most recent studies available.

The main reports and studies that informed the analysis conducted under this study include:

- Olesen, A.S., Lesschen, J.P. et al. (2016), Agriculture and LULUCF in the 2030 Framework[8]
- Martineau, H., Wiltshire, J. et al. (2016), Effective performance of tools for climate action policy - meta-review of Common Agricultural Policy (CAP) mainstreaming, report for DG Climate Action, RICARDO-AEA[9]
- Bertaglia, M., Milenov, P. et al. (2016), Cropland and grassland management data needs from existing IACS sources, JRC[10]
- Pilli, R., Fiorese, G. et al. (2016), LULUCF contribution to the 2030 EU climate and energy policy, JRC[11]

[8] Olesen, A.S., Lesschen, J.P. et al. (2016), Agriculture and LULUCF in the 2030 Framework , https://publications.europa.eu/es/publication-detail/-/publication/55feb3a5-3c29-11e6-a825-01aa75ed71a1

[9] Martineau, H., Wiltshire, J. et al. (2016), Effective performance of tools for climate action policy - meta-review of Common Agricultural Policy (CAP) mainstreaming, https://ec.europa.eu/clima/sites/clima/files/forests/lulucf/docs/cap_mainstreaming_en.pdf

[10] Bertaglia, M., Milenov, P. et al. (2016), Cropland and grassland management data needs from existing IACS sources, http://publications.jrc.ec.europa.eu/repository/handle/JRC102591

[11] Pilli, R., Fiorese, G. et al. (2016), LULUCF contribution to the 2030 EU climate and energy policy, http://publications.jrc.ec.europa.eu/repository/handle/JRC102498

- Capros, P., De Vita, A. et al. (2016), EU Reference Scenario 2016 - Energy, transport and GHG emissions Trends to 2050, report for DG Energy, DG Climate Action and DG Mobility and Transport, E3M-Lab[12]
- Perez Domingues, I., Fellmann, T., et al. (2016), An economic assessment of GHG mitigation policy options for EU agriculture (EcAMPA 2), JRC[13]
- Hart, K., Allen, B., et al. (2017), The consequences of climate change for EU Agriculture: Follow up to the COP21 UN Climate Change conference, report for the European Parliament, IEEP[14]
- Schmid, C., Weiss, P. (2017), Aggregated results of the evaluation of Member State reporting systems for cropland and grazing land management (preliminary findings for DG Climate Action, not yet published as of end of September 2017), Ecofys
- Weiss, P., Freibauer, A., et al. (2015), Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/EU, Task 3 of a study for DG Climate Action: 'LULUCF implementation guidelines and policy options', IEEP[15]
- Frelih-Larsen, A., Bowyer, C. et al. (2016), Updated Inventory and Assessment of Soil Protection Policy Instruments in EU Member States, report for DG Environment, Ecologic Institute.[16]

The analysis was conducted in September 2017. Its findings are presented in this study.

Presentation of findings

The final phase of this project consisted in preparation of a brochure and other communication material, and presentation of the study findings at the COP23 in Bonn in November 2017 as well as at a stakeholder event in Brussels in January 2018.

[12] Capros, P., De Vita, A. et al. (2016), EU Reference Scenario 2016 - Energy, transport and GHG emissions Trends to 2050, https://ec.europa.eu/clima/sites/clima/files/strategies/analysis/models/docs/full_referencescenario2016report_en.pdf

[13] Perez Domingues, I., Fellmann, T., et al. (2016), An economic assessment of GHG mitigation policy options for EU agriculture (EcAMPA 2), http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101396/jrc101396_ecampa2_final_report.pdf

[14] Hart, K., Allen, B., et al. (2017), The consequences of climate change for EU Agriculture: Follow up to the COP21 UN Climate Change conference, http://www.europarl.europa.eu/RegData/etudes/STUD/2017/585914/IPOL_STU(2017)585914_EN.pdf

[15] Weiss, P., Freibauer, A., et al. (2015), Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/EU, Task 3 of a study for DG Climate Action: 'LULUCF implementation guidelines and policy options', forest.jrc.ec.europa.eu/media/cms.../232/LULUCF_Guidance_on_CM_and_GM.pdf

[16] Frelih-Larsen, A., Bowyer, C. et al. (2016), Updated Inventory and Assessment of Soil Protection Policy Instruments in EU Member States, report for DG Environment, Ecologic Institute. http://ec.europa.eu/environment/soil/pdf/Soil_inventory_report.pdf

2 Overview of the LULUCF actions in the EU Member States

The overview of the **679 measures and policies** reported by the EU Member States under Article 10 of the LULUCF Decision between 2014 and 2017 shows that there is a wide array of ongoing and planned initiatives across the sectors, mainly in forestry and agriculture.

The most frequently reported areas of intervention are:

- *Forest management*
  understood as any activity resulting from a system of practices applicable to a forest that influences the ecological, economic or social functions of the forest
- *Protection against natural disturbances*
  understood as any activity aiming at preventing any non-anthropogenic events that cause significant emissions and the occurrence of which is beyond the control of the relevant Member State
- *Afforestation and reforestation*
  understood as direct human-induced conversion of land that has not been forest to forest through planting, seeding and/or the human-induced promotion of natural seed sources
- *Biodiversity/nature conservation measures*
  understood as preservation and conservation of wild fauna and flora and natural habitats and ecosystems
- *Biomass for energy use*
  understood as use of biodegradable fraction of products, waste and residues from agricultural and/or forestry resources for energy production
- *Grassland, grazing land and/or pasture management*
  understood as any activity resulting from a system of practices applicable to land used for livestock production and aimed at controlling or influencing the quantity and type of vegetation and livestock produced
- *Nutrient, tillage and water management*
  understood as interventions that reduce the inputs to or disturbance of the soil including changes in fertiliser management, manure use, reduced, minimum, conservation and no tillage systems and related actions associated with the reduction in emissions from land to water ways including those aimed at reducing nutrient levels or eroded soil material in water bodies.
- *Conservation of carbon in existing forests*
  understood as management in the already existing forests aimed at preservation of their carbon pools
- *Restoration of degraded land*
  understood as any activity aimed at rehabilitation of land degraded by one or a combination of anthropogenic and natural factors such as: disturbance, erosion, organic matter loss, salinization, acidification, drainage or other processes that curtail productivity

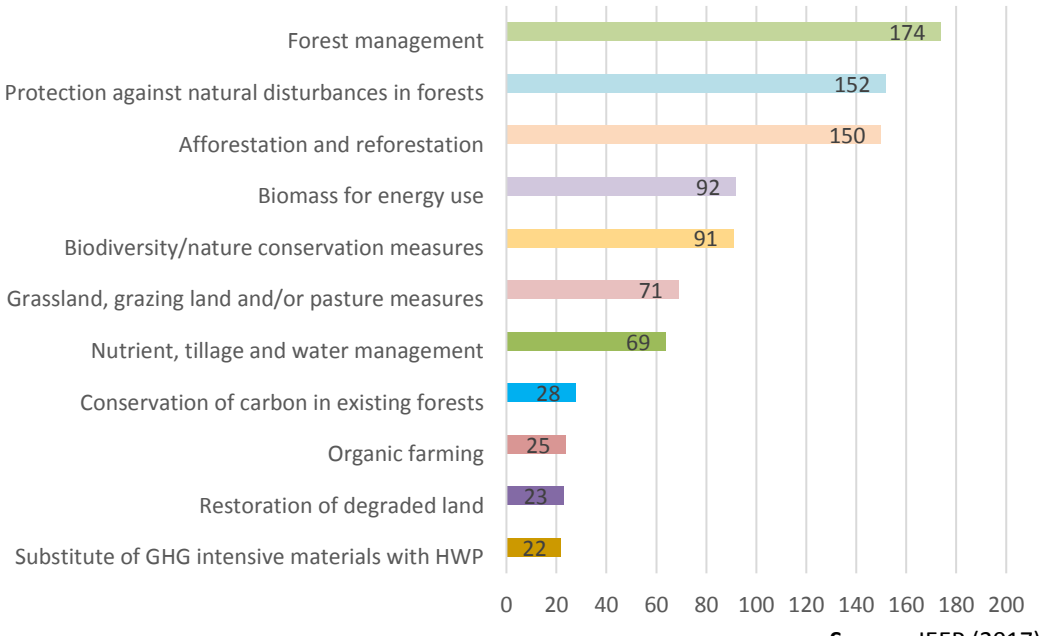
- *Organic farming*
  understood as an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes, as set out in the Council Regulation no 834/2007[17]

- *Substitution of GHG intensive materials with harvested wood products (HWP) (excluding energy feedstocks)*
  understood as activities aiming at replacing certain materials with harvested wood products in order to avoid the GHG emissions from the production of those materials that would occur if the replacement did not take place, e.g. use of wooden construction material instead of concrete or plastic.

- *Avoided deforestation*
  understood as any activity preventing or stopping long-term or permanent loss of forest cover and transformation of forest into another land use.

Figure 1 below presents the number of measures and policies identified as relevant under the main areas of intervention. Forest management, the broadest category, comes at the top of the list in terms of number of reported measures. Wherever possible, forestry activities protecting against natural disturbances such as fires have been identified, and extracted from the forest management category, if explicitly mentioned, and included in the category "protection against natural disturbances".

Figure 1 Number of measures and policies reported per area of intervention

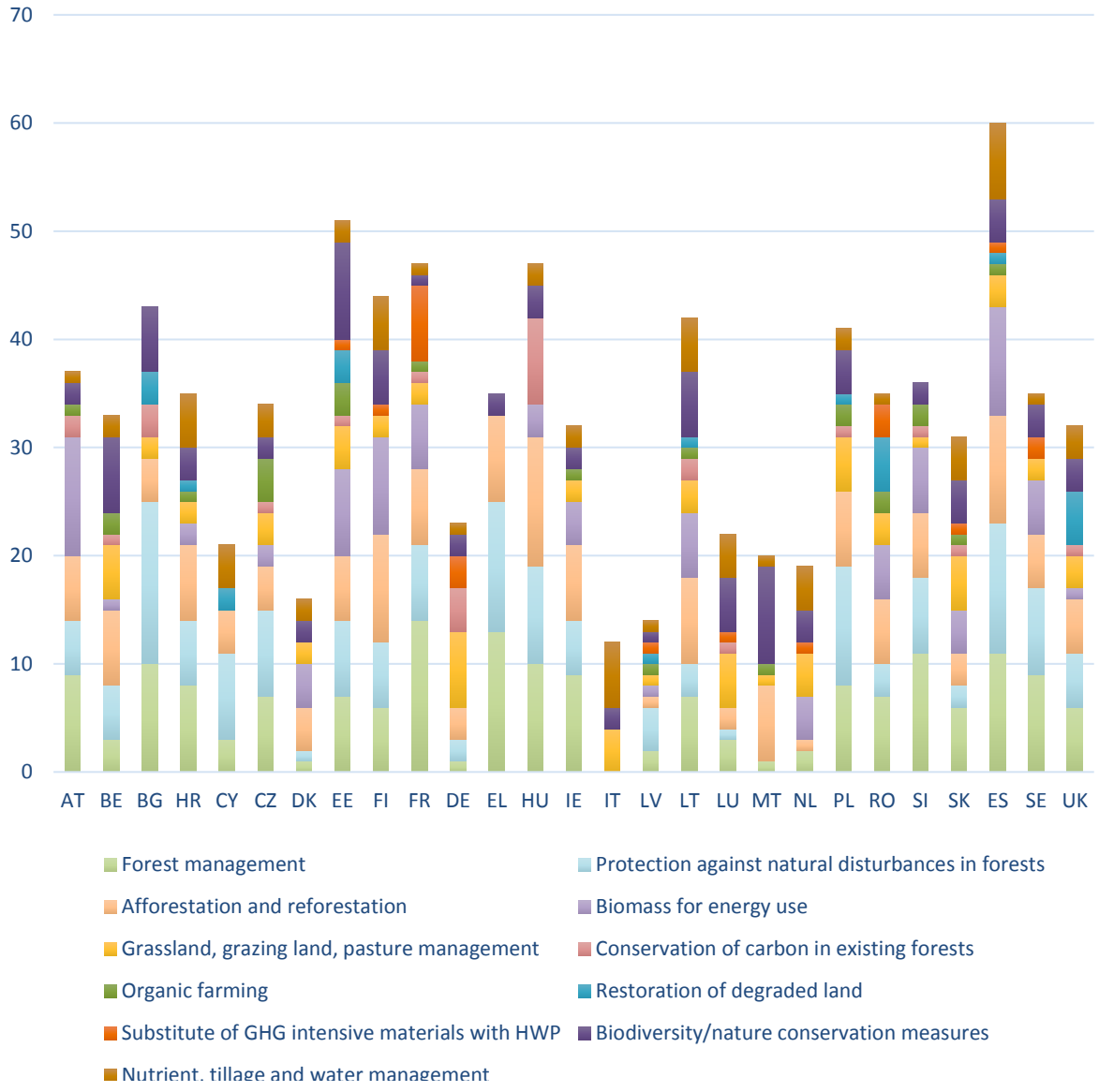


Source: IEEP (2017)

[17] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, OJ L 189, 20.7.2007, p. 1–23, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32007R0834

Figure 2 below shows an overall distribution of the reported measures per Member State and the selected areas of intervention. The number of measures represented in the chart should be interpreted with care, as the Member States did not follow the same reporting approaches, resulting in diverse approaches to granularity of reported information detail, including disaggregation of LULUCF actions into concrete measures and policies.

Figure 2 Reported measures and policies per area of intervention and Member State

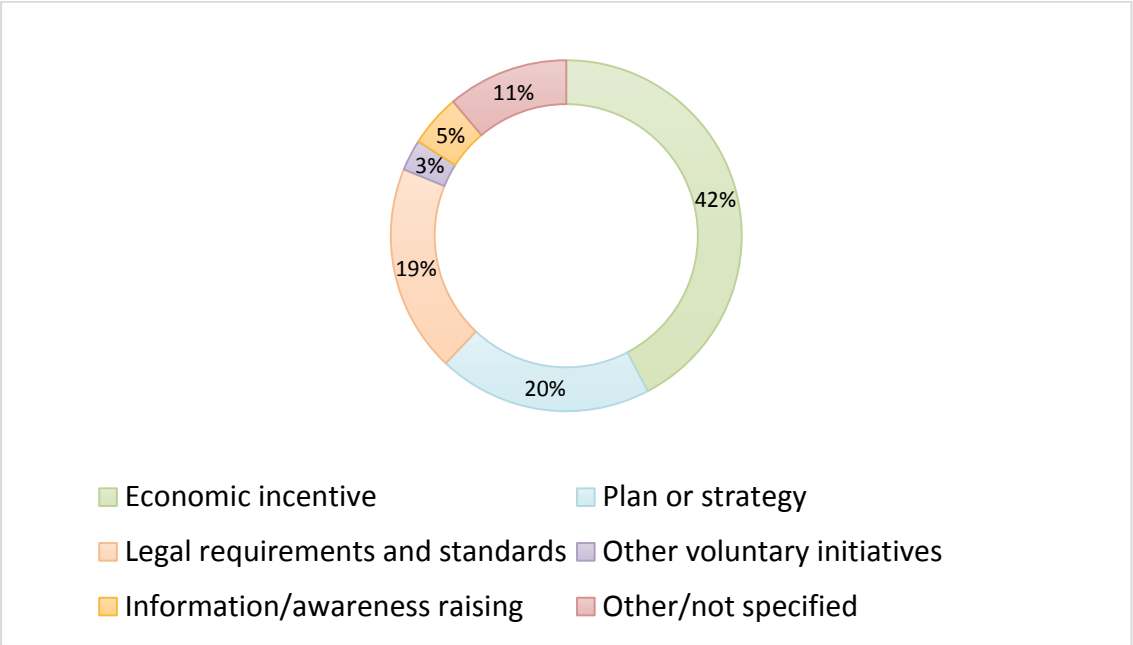


Source: IEEP (2017)

The majority of reported measures and policies are implemented through economic incentives (figure 3). Notably, all CAP-related measures are counted as economic incentives (a more detailed breakdown of economic incentives is presented in Box 1 below). Plans and strategies (e.g. Renewable Energy Action Plans or Forest Management Plans) also play a prominent role in the LULUCF related activities. Many Member States refer to their laws and

regulations (e.g. Forest Codes), as a source of binding principles and standards that are relevant to climate action in the LULUCF sector.

Figure 3 Type of instruments implementing the reported measures and policies



Source: IEEP (2017)

Box 1 Categories of the reported economic incentives

The economic incentives supporting the reported LULUCF measures come from EU and national budgets.

- The EU budget is deployed mostly though CAP funds: The European Agricultural Fund for Rural Development, EAFRD (CAP pillar II) and the European Agricultural Guarantee Fund, EAGF (CAP pillar I).
  - EAFRD: payments for measures eligible under EAFRD Regulation (Regulation No 1305/2013)[18]
  - EAGF: direct payments, i.e. multi-purpose targeted payments framed by EAGF Regulation[19]
- Other funds are also: The Cohesion Fund (e.g. Restoration of exhausted and abandoned peatlands and drained peatlands in EE), European Social Fund (e.g. under Bulgaria's Operational Program for Administrative Capacity, the project "Strategic Planning in the Bulgarian Forests - a Guarantor for Effective Management and Sustainable Development") and the LIFE programme (e.g. Development a framework to account and monitor tree crops CO_2 sequestration in EL, or Support

[18] Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/200, OJ L 347, 20.12.2013, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1305

[19] Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009, OJ L 347, 20.12.2013, p. 608–670, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1307

to projects dedicated to conservation of nature and biodiversity in EE) are also mentioned, although only sporadically.

- National budgets (including regional and local budgets) are deployed as a way of co-financing the measures supported by the EAFRD and other EU funds, but also as a standalone source of funds supporting initiatives such as promotion of bioenergy production through feed-in tariffs.

Using the reporting template suggested by the Commission is not mandatory, and therefore the reports present information with a **heterogeneous level of detail and of types of information**. All of them address the LULUCF Decision Article 10 requirements, although to different extents.

In terms of the **scope** of the measures and policies, they appear to cover different constellations of the Member States without any clear pattern relevant to climatic zones or land use coverage. It can be noted however, that, unsurprisingly, Member States with prominent forestry sectors place emphasis on forestry related activities. A similar observation can be made for Member States with a prominent agricultural sector. At Member State level the available information suggests that the majority of measures and policies are implemented at national level, with the exception of the UK, Germany, Italy, and Spain where regional approaches prevail, in line with the governance structures of those countries.

The stated **objectives** vary across the Member States and categories of measures. Measures targeting both conservation of carbon in existing forests and grassland/grazing land/pasture management mostly have GHG emission reduction and carbon sequestration as their primary objectives. In other areas of intervention, emissions reduction and sequestration are rarely described as a primary objective, and appear to be rather a co-benefit, suggesting that LULUCF mitigation benefits take a secondary role in the overall rationale of the activities.

Although provision of the indicative **timetables** for the adoption of measures is required under the Article 10 of the LULUCF Decision, there is no systematic information about the planning periods available in the reports. The most commonly reported time frames are those of the current 2014-2020 EU multi-annual financial framework, usually referring to CAP.

Reports often identify a number of strong **links between** the reported **measures and national policy priorities other than mitigation,** such as rural development, multi-functionality of forests, biodiversity protection, water protection, climate change adaptation, industrial innovation, or the circular economy.

Where national policy on climate mitigation is a key driver, there are different approaches to setting priorities (e.g. the UK approach applies MACC curves to identify and prioritize actions across the whole LULUCF sector, and then links these to potential policies; other Member States do not set priorities among the LULUCF activities but explain how they fit in a broader context of national policy priorities). A dominant approach is to subordinate LULUCF actions to **other policy priorities** (such as sustainable forest management), usually adopted before the LULUCF sector was formally given an active role in climate change mitigation. In that sense, the reports submitted under Article 10 are a collection of more or less LULUCF-relevant policies and measures rather than an inventory of activities fulfilling a mitigation

strategy in the LULUCF sector. The identified LULUCF sector priorities are presented in section 4.1 of this study.

In terms of the **type of activities**, overall 461 measures (concrete action on the ground) are identified; and 218 policies are outlined (embedded in policy roadmaps and action plans), implemented predominantly through economic incentives, strategic documents, and legal requirements. However, in this study, the distinction between **policies and measures** was not always straightforward, as the Member State reports do not share a consistent approach either within or between reports to recording policies or considering measures separate to policies. Some Member States present a mix of policies, and measures supported by policies. Others present primarily policies. In general, policies (government intervention designed to promote specific behaviours) are less targeted than specific measures (actions taken by land managers etc.), containing a number of actions to for example improve forest retention or increase use of HWP in construction. Some Member States report policies at national and regional levels, combining action on agriculture and forests (only general mention of RDP is listed among the reported actions).

Information on costs and sources of **funding** was sporadically provided, usually pointing to the CAP funds: EAFRD and EAGF. This information was sufficient to imply the involvement of national funding sources where EU programmes are co-financed, but not specific enough to estimate the cumulative cost of the reported measures and policies, or to determine the share of the national budget participation without separate reference to rural development programmes. It also becomes very clear that the **CAP, and particularly its rural development programmes**, are key to the Member States' climate action in LULUCF sector (CAP relevance is explained in more detail in section 5.1.)

The Member States describe the expected **impacts** mainly in qualitative terms. Reports contain very limited information on the actual or projected emission consequences of polices and measures. The quantitative data in this respect is scarce and often subject to high uncertainty. No EU-level impact of the reported measures and policies on GHG emissions could therefore be aggregated. A number of Member States noted that it is difficult to attribute specific emission factors to specific policies or measures and therefore have not done so. Chapter 6 addresses the question of the mitigation potentials of selected LULUCF measures, based on the existing literature and the available information from the reports.

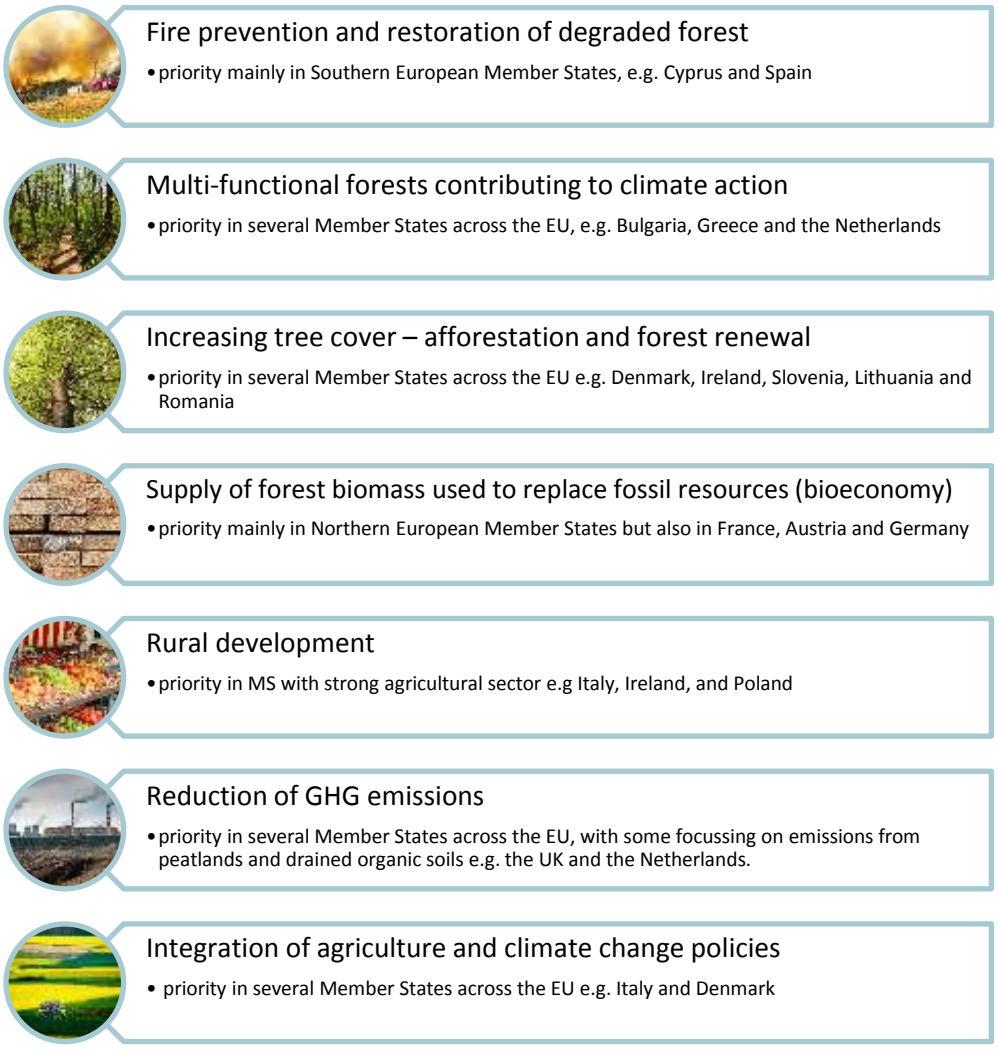
Finally the reports do not tend to provide the **data sources** and details of the methodologies used, but refer to the National Inventory Reports instead. Chapter 5 provides an overview of the available information on the land use and GHG emission determination methods, based on the existing studies.

3 LULUCF in Member States' priorities and strategies

3.1 Common priorities in the LULUCF sector

The overview of the Article 10 reports identified a number of priorities for LULUCF sectors at national level. The Article 10 requirement does not oblige Member States to explicitly mention their LULUCF priorities in the reports, but some mentioned them explicitly. In other Member States, the priorities in this area could be derived based on the prevalence of areas of focus of the Article 10 reports. There were also some Member States where no LULUCF priority could be identified. Figure 4 below shows those priorities mentioned by more than one Member State, based on the explicit and implicit information provided in the reports.

Figure 4 LULUCF priorities shared by some Member States



Source: IEEP (2017)

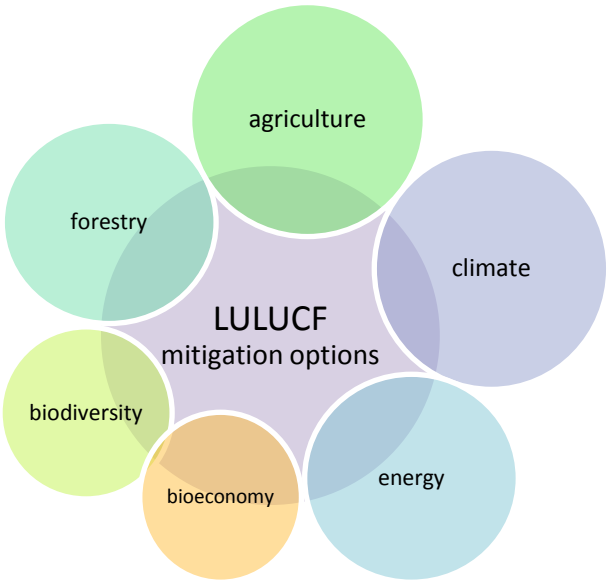
Apart from the above list of priorities shared by several Member States, there are also LULUCF priorities that have been mentioned by individual Member States. For instance, the Czech Republic's priority is linked to climate resilience, and Denmark prioritises, among other things, protection of the aquatic environment and ground water resources.

3.2 LULUCF in the strategic documents

Although **no Member State seems to have a dedicated LULUCF strategy**, many Article 10 reports refer to the LULUCF measures planned for in wider policies' strategic documents adopted at national level. The most commonly reported types of strategies are: RDPs forestry sector strategies, climate mitigation/low carbon development strategies, and energy sector strategies including renewable energy action plans. The links between the reported LULUCF mitigation actions and the wider national policies have therefore been made visible by the Member States (see Figure 5 below). Nevertheless, the separation of the measures into a wide range of sectoral strategies suggest that a "silo" approach prevails in LULUCF actions planning across the EU.

Some specific examples include Article 10 reporting on climate adaptation strategies (e.g. Czech Republic), biodiversity protection strategies (e.g. Estonia and Austria), fire control action plans (e.g. Cyprus), bioeconomy strategy (e.g. Finland), action plan for wetlands (e.g. Slovakia), general/sustainable development (e.g. Austria, Finland, Cyprus) and even organic farming and nitrates action plans (e.g. Poland and Malta respectively). In terms of the agricultural policy, the strategic documents other than the Rural Development Programmes were only rarely mentioned: Poland for instance mentions its "Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020" as a policy tool for LULUCF measures implementation.

Figure 5 Main policies relevant to the LULUCF mitigation options as reported by the Member States under Article 10 of the LULUCF Decision



Source: IEEP (2017)

The absence of dedicated LULUCF strategies may stem from the non-mandatory nature of the mitigation in this sector so far. It may also be a symptom of lack of coordination and joint strategic planning across the government ministries in charge of the relevant policies listed in figure 5 above. In the future, an enhanced strategic approach based on inter-ministerial

cooperation would be important for ensuring, not only cost-effectiveness but also wider policy coherence. As noted by Hart, K. et al. (2017),

> "to ensure that the ambition for agricultural and other land use emissions is coherent, it would make sense to set out a low carbon and resilience roadmap for the sectors involved to 2050, setting out the actions required over the coming years. This should set out a multi stage approach to climate action in the sector, embedding public interventions through the CAP in a wider strategy to bring down emissions which involves the private sector and consumer concerns as well. This should include some actions in the short term, as earlier action can help to drive down costs, help improve understanding of the most effective means of mitigation and how they can be adopted in the most cost-effective way, while optimising production choices. Without incentives to action, this learning will be delayed and inaction now will simply postpone the date at which action will be required. The longer this is left, the shorter the timeframe will be to make the reductions required and therefore the greater the cuts will have to be. (…). Ensuring the right climate policy framework is in place to encourage longer-term action will be essential as well ensuring that a future CAP has the right incentives in place to support not just action on the ground but also capacity building and knowledge exchange. (…) Not all support will require public funding and private investment and greater use of financial instruments should also be considered. This agriculture specific measures will also have to be accompanied by a strong regulatory baseline and additional tools such as those to incentivise waste reduction or to influence consumption patterns and hence the demand for climate-intensive products."

The need for more strategic planning could be to some extent addressed by the inclusion of LULUCF's emission reductions and enhancement of removals in the long-term low emission strategies with a 50 years perspective, as put forward by the European Commission in the Governance of the Energy Union Regulation proposal (Article 14)[20] in November 2016. According to the proposal, after 2020 the LULUCF policies and measures will be reported as part of the integrated National Energy and Climate Plans (Article 3 of the proposal), mainly relevant to the "Decarbonisation" dimension of the Energy Union.

[20] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the Governance of the Energy Union, amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/73/EC, Council Directive 2009/119/EC, Directive 2010/31/EU, Directive 2012/27/EU, Directive 2013/30/EU and Council Directive (EU) 2015/652 and repealing Regulation (EU) No 525/2013, COM(2016)0759 final, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2016:759:REV1

4 Policy instruments driving LULUCF actions

4.1 Common Agricultural Policy (CAP)

The CAP is an important economic driver for land management and land use decisions across the EU. The CAP for 2014 to 2020 has three general objectives - viable food production, sustainable management of natural resources and climate action, and balanced territorial development (EC, 2013) – which collectively feed into the Europe 2020 objectives of smart, sustainable and inclusive growth. There are two 'Pillars' of the CAP and both have the potential to impact on decision making and promote land management and use relevant to LULUCF. The relevance of the CAP was noted by all Member States, either by identifying specific elements and instruments or by making a generic reference to the importance of the CAP for LULUCF. For example, Spain and the Czech Republic in their LULUCF reporting highlight the CAP as an important policy generically, as well as separately highlighting specific elements later in the text.

Under the CAP the key elements noted by Member States of relevance to LULUCF were **Cross Compliance Standards**, **Greening** of Pillar I payments and **Rural Development** measures under Pillar II. These three elements are discussed in detail below.

4.1.1 CAP Cross Compliance Standards

Introduction

Farmers receiving direct payments under Pillar I and area-based payments under Pillar II must comply with cross-compliance requirements across the whole farm holding, or risk losing part of their CAP payments. The cross-compliance system incorporates within the CAP "basic standards concerning the environment, climate change, good agricultural and environmental condition of land, public-health, animal health, plant and animal welfare" (EU 1306/2013, Recital (54)). There are two types of cross-compliance requirement:

- **Statutory Management Requirements (SMR)**, which require compliance with existing regulatory requirements under other EU and national legislation, including the Nitrates, Habitats and Birds Directives (SMRs refer to EU legislation that also applies to farmers not receiving the CAP support payments); and
- **Standards for Good Agricultural and Environmental Condition (GAEC)**, which are defined by individual Member States within the framework set out in the EU legislation.

Member States must set out detailed requirements for implementation of seven specific GAEC standards, taking into account "the specific characteristics of the areas concerned, including soil and climatic conditions, existing farming systems, land use, crop rotation, farming practices and farm structures" (EU 1306/2013, Article 94). Of the seven, a selection of cross-compliance GAEC standards has been identified as being key to climate mitigation (Martineau et al., 2016). These are set out in the table below (Table 2); essentially they represent the standards that relate to the potential retention and accumulation of soil carbon. The lists identified in the literature as relevant to climate mitigation and soil management are the same (Frelih-Larsen, 2016).

Table 2 GAEC standards most relevant to climate mitigation adapted from Hart et al., 2017

Main issue	No	Requirements and standards	Link to Climate Mitigation
Water	GAEC 1	Establishment of buffer strips along water courses ([1])	Protection of carbon stores in permanent grasslands and soils
Soil and carbon stock	GAEC 4	Minimum soil cover	Protection of soil carbon and reduced risk of erosion
	GAEC 5	Minimum land management reflecting site specific conditions to limit erosion	Protection of soil carbon and reduced risk of erosion
	GAEC 6	Maintenance of soil organic matter level through appropriate practices including ban on burning arable stubble, except for plant health reasons ([2])	Reduced GHG emissions from fires and potential to use residues in other way to promote soil carbon
Landscape, minimum level of maintenance	GAEC 7	Retention of landscape features, including where appropriate, hedges, ponds, ditches, trees in line, in group or isolated, field margins and terraces, and including a ban on cutting hedges and trees during the bird breeding and rearing season and, as an option, measures for avoiding invasive plant species	Protection of carbon stores and sequestration potential in woody vegetation, wetlands and soils

Notes
(1) The GAEC buffer strips must respect, both within and outside vulnerable zones designated pursuant to Article 3(2) of Directive 91/676/EEC, at least the requirements relating to the conditions for land application of fertiliser near water courses, referred to in point A.4 of Annex II to Directive 91/676/EEC to be applied in accordance with the action programmes of Member States established under Article 5(4) of Directive 91/676/EEC.
(2) The requirement can be limited to a general ban on burning arable stubble, but a Member State may decide to prescribe further requirements.

Source: IEEP based on Regulation (EU) No 1306/2013, Annex II and Hart et al., 2017

Cross Compliance and LULUCF

Analysis of the LULUCF reports identified 10 Member States who explicitly mentioned cross compliance as of importance to the delivery of LULUCF mitigation. The Member States concerned and the nature of the reference made to Cross Compliance is set out below. Three of these Member States explicitly identified the SMR requirements as of importance. All 10 Member States identified GAEC as explicitly of importance. GAEC 4, 5 and 6 were noted by the majority of Member States as of importance (Table 3).

The Czech Republic and Slovakia provided information on the national definitions of the GAEC standards applied. This is of importance as Member States are required to define GAEC nationally and/or regionally. Therefore, to understand the likely impact on LULUCF emissions it is important not only to know which GAEC requirement is applied and relevant but also what action is required under national or regional definitions of a specific GAEC.

Table 3 Cross-compliance standards identified as relevant in LULUCF reporting

Member State	Nature of Cross Compliance Reference				Comments
	SMR	SMR - Detail	GAEC	GAEC - Detail	
Belgium	Y	Notes importance of other binding regulations	Y	Notes minimum requirements for soil erosion and SOM protection requirements	Measures identified equate to GAEC 5 and 6
Croatia			Y	Notes specifically importance of GAEC 4, 5 and 6	
Czech Republic	Y	Mentioned generically, although noted as importance for reducing emission from fertiliser use and enteric fermentation.	Y	Notes aspects especially soil protection during crop cultivation, bans on erosion 'hazardous' crops and post-harvest soil cover	Measures identified equate to GAEC 4 and 5
France			Y	Specifically notes actions to promote: buffer strips; soil cover; non burning of residues; and maintaining landscape features	Measures identified equate to GAEC 1, 4, 6 and 7
Ireland	Y		Y	Notes specifically GAEC 5 and 6	
Italy			Y	Specifically highlights GAEC relating to soil structure and SOM	Measures identified equate to GAEC 5 and 6
Luxembourg			Y	Specifically highlights GAEC relating to SOM including noting a ban on reversal of permanent grassland on slopes greater than 12%	Measures identified equate to GAEC 6
Slovakia			Y	Provides detail on requirements ie. minimum soil cover applies from 1 Nov to 1 March; notes actions to protect against soil erosion; specific detail on actions to maintain SOM ie crop rotation and stubble burning	Measures identified equate to GAEC 4, 5 and 6
Spain			Y	GAEC mentioned in the context of reduced fertiliser use	Link to GAEC 5
UK	Y	Specifically highlights implementation of the Nitrates Directive as of importance	Y	Specifically notes actions of SOM, minimal soil cover and reducing soil erosion	Measures identified equate to GAEC 4, 5 and 6

Source: IEEP based on Article 10 reports (2017)

National Implementation of GAEC

The parameters for GAEC standards are set out in EU Regulation 1306/2013, with Member States having discretion in how these standards are applied nationally (or in some cases regionally[21]). When looking in detail at the GAEC standards explicitly linked to soil carbon (GAEC 4, 5 and 6) there are variable patterns of implementation, which will potentially impact on emission balances. Given the limited information supplied by Member States on the detail of GAEC requirements within their LULUCF reports, additional information is supplied here on the national and regional implementation of GAEC. The following analysis is based on information in JRC 2015[22].

The definitions of GAEC standard 4 on minimum soil cover among Member States and regions include differing requirements based on season, duration of cover and minimum proportion of soil cover. There is also variation depending on the type of land and crops to which requirements apply. For example figure 6 summarises information on the time of year when soil cover is required across the 32 Member State and regional definitions of GAEC 4. Not all Member States or regions appear to require complete green soil cover on all the relevant land or crops – in seven Member States or regions the minimum percentage green soil cover ranged from 30% to 80%.

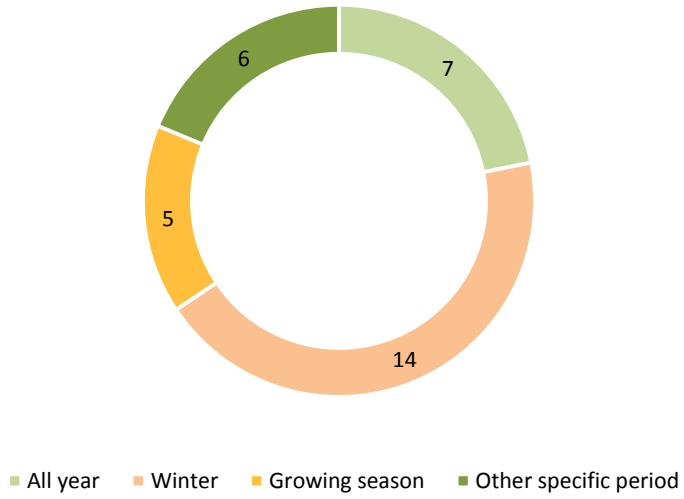
Under GAEC standard 5 - minimum land management reflecting site specific conditions to limit erosion - a range of tools are required by Member States and regions including contour ploughing, ridge planting, reduced and conservation tillage, maintenance of grassland or woody vegetation, green winter cover, and restrictions on growing particular crops. In more than half the Member States or regions slope is used as a criterion to identify the land where specific land management practices are required (i.e. to identify land deemed at risk of erosion and therefore relevant for the application of the measures listed).

GAEC standard 6 – maintenance of soil carbon - determines a minimum baseline for implementation of action, i.e. banning burning of stubble. This minimum was the only requirement adopted in 15 of the 32 Member State and regional definitions of GAEC 6 in 2015. In the other 17, additional requirements were adopted including restrictions on entering land when it is waterlogged or frozen, use of crop rotations (including not growing successive crops with a high soil carbon demand), application of organic matter, soil testing and stubble management.

[21] Most Member States define GAEC standards nationally, but in the case of Belgium and the UK GAEC standards are defined regionally, with separate standards for Flanders, Wallonia, England, Scotland, Wales and Northern Ireland. (The outermost regions are not considered here.)

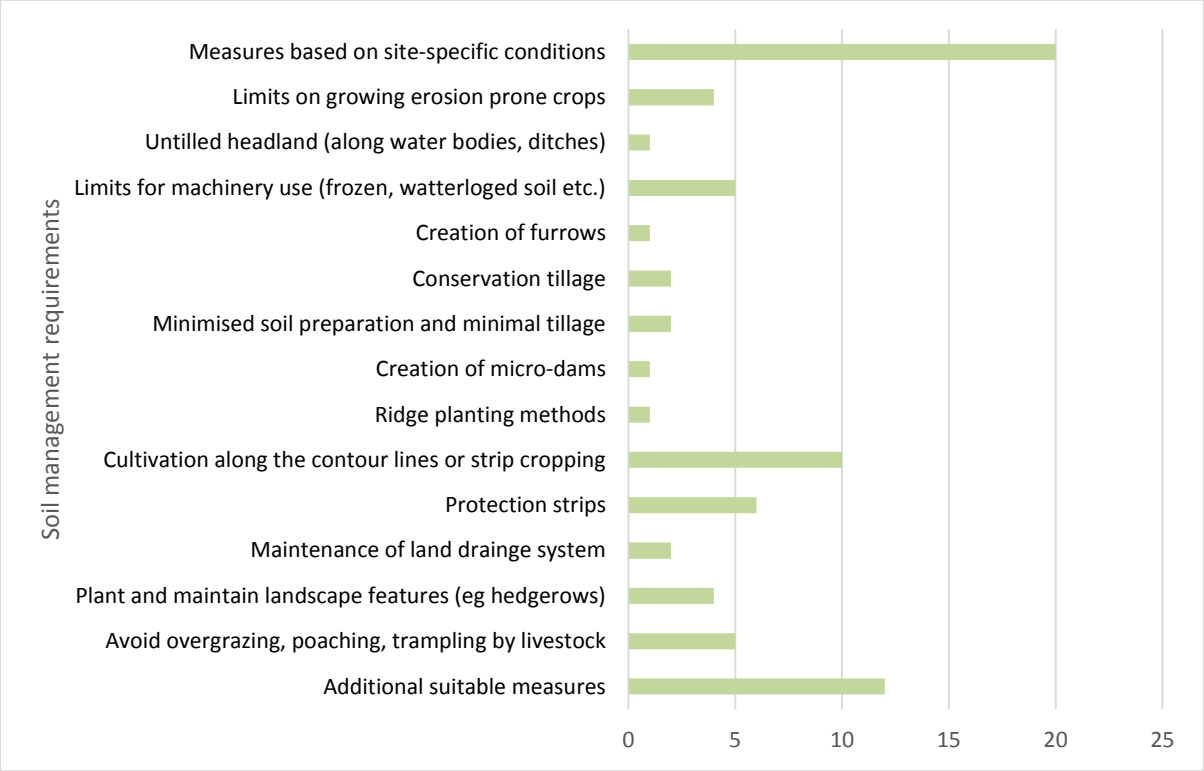
[22] JRC (2015) Translations into English of Member States' GAEC notifications to the European Commission for campaign year 2015 (unpublished)

Figure 6 Time of year soil cover required under GAEC standard 4, by number of the 32 Member States or regions (2015)



Source: Data extracted from JRC, 2015 and figure adapted from analysis Frelih-Larsen, 2016

Figure 7 Management required to limit soil erosion under GAEC standard 5, by number of the 32 Member States or regions (2015)



Source: Data extracted from JRC, 2015 and figure adapted from analysis Frelih-Larsen, 2016

4.1.2 CAP Greening Payments (pillar I)

Introduction

The 2013 reforms of the CAP saw the introduction of mandatory 'greening' measures to 'support agricultural practices beneficial for the climate and the environment' (Regulation (EU) No 1307/2013). These practices take the form of simple, generalised, non-contractual and annual actions that go beyond cross compliance and are linked to agriculture.

Under the greening rules Member States must use 30 per cent of their national ceilings for direct payments to grant an annual payment, on top of the basic payment, for compulsory practices to be followed by farmers. The three Pillar I greening measures are set out below. Detail of the action required and the link to climate mitigation are presented in Box 2.

- crop diversification – rules requiring a minimum number of crops to be grown on arable farms above certain farm size thresholds;
- the maintenance of permanent grasslands – that the ratio between the area of permanent grassland and total utilised agricultural area does not decline by more than 5% at a national or regional level, and that environmentally sensitive permanent grassland (ESPG) areas are designated and protected from ploughing and conversion;
- Ecological Focus Areas – Regulation 1307/2013 defines 10 types of ecological focus area (EFA) which can be established to safeguard and improve biodiversity on farms.

The rationale behind the introduction of these greening measures was to provide a substantial funding resource (30% of Pillar I correspond to approximately €12 billion/year) to support basic environmental management and climate action on all agricultural land in the EU-28 (Hart, Baldock and Buckwell, 2016). The Ecological Focus Areas (EFAs) and the permanent grassland obligations, particularly the ban on ploughing of permanent grasslands designated as environmentally sensitive, have been noted as having the highest potential for climate mitigation. However, the nature and extent will depend on Member States' and farmers choices regarding implementation (Hart et al., 2017).

Box 2 Greening requirements and climate

The three elements of greening are set out below in order of their relevance to climate mitigation and the delivery of LULUCF related emission reductions / removals increases.

Protection of Permanent Grassland	
Requirements - Member States must ensure that the ratio of the area of permanent grassland to the total utilised agricultural area does not decline by more than 5%, they can choose the geographic scale at which this is assessed ie national, regional etc - Member States must designate environmentally sensitive permanent grassland (ESPG) in areas covered by the Birds and Habitats Directives - Converting or ploughing the ESPG is prohibited at the farm level	*Climate mitigation opportunities* Strong potential depending on area of land designated - This measure is aimed specifically at carbon sequestration through the retention of permanent pasture and the specific protection from conversion and ploughing on certain types of 'sensitive' pastures particularly inside Natura 2000 sites. Permanent pasture is known to retain and sequester carbon and (unlike in forest systems) the majority of carbon stored is held in the soil.

- Member States have the option to designate further ESPG areas elsewhere, offering the opportunity to protect significant soil carbon stocks outside Natura 2000 areas	
Ecological Focus Areas	
Requirements The EU Regulation defines 10 types of EFA, Member States must choose a list of one or more EFAs to offer farmers. • Land lying fallow; • Terraces; • Landscape features; • Buffer strips; • Areas of agro-forestry; • Strips of eligible hectares along forest edges; • Areas with short rotation coppice with no use of mineral fertilizer and/or plant protection products; • Afforested areas eligible for direct payments; • Areas with catch crops, or green cover established by the planting and germination of seeds; • Areas with nitrogen fixing crops. Farmers with more than 15hectares of arable land, must ensure that an area corresponding to at least 5% of their arable land is an EFA. Farms with a large proportion of grassland are not required to meet the EFA requirements, and there are other exceptions, including organic farms.	*Climate mitigation opportunities* Strong potential depending on the EFA options selected - EFAs stated aim is to safeguard and improve biodiversity but many options also have potential climate benefits. Permanent field margins, buffer strips, landscape features and trees help to protect carbon stores and the sequestration potential of the soil beneath them. Individual trees, agroforestry and woodlands can store carbon. Climate benefits of EFAs on which agricultural production is allowed will mainly be in reducing the risk of losing soil (and organic matter) through erosion, although N-fixing crops have potential to reduce NO2 emissions from soils (through reduced demand for nitrate fertilisers). However, for nitrogen fixing crops, catch crops/green cover and short rotation coppice, Member States can choose whether fertilisers and pesticides are permitted and when the crops must be in the ground. In addition farmers can choose the EFA type and location. These decisions will affect the extent to which the climate mitigation potential is realised.
Crop Diversification	
Requirements - applies only to farms with more than 10 hectares of arable land - farms with up to 30 ha of arable land have to grow at least two different crops on their arable land - farmers with more than 30 hectares of arable land have to grow at least three crops - the main crop cannot cover more than 75% of the arable land - fallow land, grass and other herbaceous forage count as crops	*Climate mitigation opportunities* Limited: the stated aim of the crop diversification requirement is soil quality (EU 1307/2013, Recital (41)), there are limited but possible links to improved crop rotation hence soil organic matter retention and reductions in nitrogen based fertilised inputs. However, in practice any benefits depend entirely on the way in which individual farmers implement the requirements i.e. what land, which crops, which crop combinations and whether rotation is employed.

Source: IEEP compilation based on EU Regulation 1307/2013, Frelih-Larsen et al. 2016, Martineau et al. 2016, and Hart et al, 2017.

LULUCF Reporting and Greening

As part of their LULUCF reporting (either within their initial or progress reports) 11 Member States noted the importance of greening of Pillar I as a policy relevant to LULUCF and the reduction of GHG emissions associated with land management. A summary of references made to greening by Member States is set out in Table 4.

Of those Member States one (Croatia) referred only generically to the importance of greening, while other Member States also highlighted specific elements of greening. 7 Member States highlighted all three aspects of Greening as being relevant. EFAs and permanent pasture measures were both highlighted by a total of 9 Member States. Most Member States simply stated the relevant EU rules and requirements relating to greening, while a limited number ie Flanders (BE), Netherlands, Spain and Wales (UK) commented specifically on national implementation or the rules applied.

Table 4 Summary of Member State References within Article 10 Initial and Progress Reports to Greening in the Context of LULUCF Emission Reduction

Member State	General reference to greening	Specific elements of greening		
		Crop Diversification	Permanent Pasture	EFAs
Belgium				Y – specific detail provided on cover crop use in Flanders
Croatia	Y – general note flagging greening as relevant			
Estonia	Y – provided general information on the importance of each greening measure; specify it as a policy of importance	Y	Y	Y
Finland		Y	Y	Y
Italy	Y – notes importance as a general policy and that the scope of action covers 7 million ha in Italy	Y	Y	Y
Malta		Y	Y	Y
Netherlands		Y – noted only a small number of farmers needed to change their practices	Y – specifically highlights no tillage requirements and notes that areas to which this applies is small	Y – notes that most farmers selected legumes or catch crops despite other options being offered
Poland		Y	Y	Y
Slovenia	Y – notes greening generally as a policy of importance		Y – specifically notes permanent pasture aspects	
Spain	Y – highlights greening generically as of importance	Y	Y	Y – highlights EFAs deemed relevant ie fallow, N-fixing crops, forested areas, agroforestry

UK	Y – notes the importance of greening	Y – notes specific examples of requiring consent to improve grassland and in Wales to improve grassland with less than 25% rye grass	Y

Source: IEEP (2017) based on Article 10 reports

Delivering Greening and LULUCF Mitigation Potential

As noted in a number of Article 10 reports (Netherlands, Spain, UK, Belgium) both Member States and individual farmers have considerable flexibility in choosing how to implement their Pillar I greening obligations. In addition some farmers are exempt from the Pillar I greening requirement. For example, farmers with an arable area below a certain size threshold, organic farms, those growing permanent crops beneficiaries of the Pillar I Small Farmers Scheme, and farms where Pillar I greening requirements are not compatible with a Natura 2000 management plan (Frelih-Larsen et al., 2016).

Analysis shows that 72% of the total agricultural area in the EU and 36% of the beneficiaries of Pillar I direct payments are subject to at least one Pillar I greening obligation (EC, SWD/2016/218). However, the actual change delivered on this land depends on the measure in question. For example, analysis by the European Commission indicated that for 8% of the arable land in the EU farmers have had to adjust part of their crop production pattern to comply with the thresholds for crop diversification, but that the area on which farmers have actually had to introduce a different crop to meet their diversification obligations is estimated to be only around 1% of EU arable land (EC, SWD/2016/218).

In terms of climate mitigation the measures to safeguard permanent grassland have been highlighted in the literature (Martineau et al., 2016; Hart et al., 2016) as having the greatest potential. However, it is primarily the areas designated as environmentally sensitive permanent grassland (ESPG), either in Natura 2000 sites or (on a voluntary basis) outside Natura, that are noted as of importance. This is due to the farm level restriction on conversion and the requirement to avoid ploughing. The area designated as ESPG varies considerably between Member States, along with the proportion of permanent pasture within Natura 2000 sites defined as ESPG. As noted in the Netherlands Article 10 report, these areas can be relatively small. In addition, only five Member States/regions had taken the decision to designate ESPG outside of Natura 2000 sites (Flanders, Czech Republic, Latvia, Luxembourg and Wales) as of 2015 (EC, SWD/2016/218).

EFAs have also been noted as important in terms of their potential climate mitigation impact. Not all EFA options are equal, however; specifically the following have been identified in the literature as relevant: fallow land, landscape features, buffer strips, afforestation, agro-forestry, strips along forest edges, short rotation coppice, catch crops and green cover, N-fixing crops. The climate mitigation benefits of many of these options available to Member States will, however, depend on the specific rules adopted in relation to management (e.g. whether use of fertilizers is permitted or not) (Martineau et al., 2016).

Each Member State is free to choose the list of EFA measures it can offer to its farmers; farmers in a given Member State are then free to choose from this EFA list to ensure that they

meet the EFA area requirement for their farm holding. Table 5 presents the list of EFA options made available by each Member States in 2015. This demonstrates that there is a high degree of variability across the EU 28 in EFA options offered to farmers relevant to emission reductions in the LULUCF sector. Analysis by the European Commission (EC, SWD/2016/218) identified that in 2015 more than 73% of the total EFA area declared by famers (before weighting factors are applied) is linked to agricultural production, in the form of nitrogen-fixing crops (45.5%) and catch crops (27.7%). Landscape features (including, but not necessarily limited to, those already protected under GAEC) accounted for 4.26%, and fallow land without production accounts for a further 21.2%.

Table 5 Number and type of elements considered to be EFA, in 32 Member States or regions

MS	Fallow	Landscape Features	Buffer Strips	Agroforestry	Forest edges - with production	Forest edges - without production	Short Rotation Coppice	Afforested areas	Catch crops etc.	N fixing crops	Total EFA types by MS (max=11)
EU 28	**30**	**24**	**19**	**12**	**6**	**10**	**22**	**15**	**21**	**31**	
AT	√	√					√		√	√	5
BE - Fl	√	√	√	√	√	√	√	√	√	√	10
BE - Wa	√	√	√	√		√	√		√	√	8
BG	√	√	√			√	√		√	√	8
HR	√	√	√			√	√		√	√	7
CY	√		√	√				√		√	5
CZ	√	√					√	√	√	√	7
DE	√	√	√	√		√	√	√	√	√	10
DK	√	√	√				√		√		5
EE	√	√					√			√	4
EL	√	√	√							√	4
ES	√			√				√		√	4
FI	√	√					√			√	4
FR	√	√	√	√	√	√	√	√	√	√	10
HU	√	√	√	√	√	√	√	√	√	√	11
IE	√	√	√				√	√	√	√	7
IT	√	√	√	√	√	√	√	√		√	10
LT	√									√	2
LU	√	√	√	√	√	√	√	√	√	√	10
LV	√	√	√						√	√	5
MT	√	√								√	3

NL		√					√		√	√	4
PL	√	√	√		√	√	√	√	√	√	9
PT	√	√		√				√		√	5
RO		√	√				√	√	√	√	7
SE	√	√		√			√		√	√	6
SI	√								√	√	3
SK	√	√	√				√		√	√	7
UK - EN	√	√	√						√	√	5
UK - NI	√	√		√			√	√		√	6
UK - SC	√	√	√						√	√	5
UK - W	√	√					√	√		√	5

Source: EC, 2016 adapted from Frelih-Larsen et al., 2016

4.1.3 CAP Rural development (pillar II)

The EAFRD Regulation (Regulation (EU) No 1305/2013) establishes both objectives and EU priorities to which rural development under the CAP should contribute, and sets out the detailed parameters for individual measures. The following objectives have been put in place (Article 4 of the EAFRD Regulation, own emphasis):

- fostering the competitiveness of agriculture;
- ensuring the sustainable management of natural resources, and **climate action**;
- achieving a balanced territorial development of rural economies and communities including the creation and maintenance of employment.

The objectives are pursued through six priorities (Article 5 of the EAFRD Regulation), namely:

1) fostering knowledge transfer and innovation in agriculture, forestry and rural areas
2) enhancing the viability and competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management
3) promoting food chain organisation, animal welfare and risk management in agriculture
4) restoring, preserving and enhancing ecosystems related to agriculture and forestry
5) promoting resource efficiency and supporting the shift toward a **low-carbon and climate-resilient economy** in the agriculture, food and forestry sectors
6) promoting social inclusion, poverty reduction and economic development in rural areas

As highlighted above, the objectives as well as the priorities refer to climate action in a number of places. Both lists show, however, that climate aspects are just a part of a broader direction agreed for the rural development in the 2014-2020 programming period. Climate action, and the pursuit of LULUCF mitigation in particular, therefore has to **compete for support under the CAP pillar II** with other priorities such as agricultural competitiveness, rural economic development, and knowledge transfer; nevertheless, climate and environment relevant measures are required to comprise a minimum of 30% of each programme's EAFRD contribution[23]. The choices of measures and allocations, possibly selected to maximize **synergies** between the rural development priorities but also to reflect the particular **needs** of the Member States, are made by the RDP authorities, within the framework set by the CAP legislation. Then, further choices are made by the potential beneficiaries, who choose whether to apply for support, and from which measures among the portfolio of available RDP measures.

Overall, the six priorities are pursued through a wide range of measures identified by Member States as being LULUCF-relevant in programmes adopted for the 2014-2020 period (in all Member States who submitted Article 10 reports). Table 6 below lists the measures mentioned by Member States in their reports under Article 10 of the LULUCF Decision, showing their RDP measure code and sub-measure code (wherever sufficient information is

[23] Article 59 (6) of Regulation 1305/2013, discussed further below.

provided by the Member State to identify the measure and sub-measure). The list and numbering of measures and sub-measures is based on the Commission's Implementing Regulation No 808/2014[24].

Agri-environment-climate commitments

"Agri-environment-climate" (M-10) is the biggest 2014-2020 rural development measure in budgetary terms. Its sub-measure 10.1 "Agri-environment-climate commitments" is by far the most frequently reported RDP sub-measure code in article 10 reports. This may be explained partly by the fact that agri-environment-climate payments are compulsory for the Member States to include in their RDPs under the EAFRD Regulation. Defined under Article 28 of the EAFRD Regulation, the agri-environment-climate payments support measures are selected by the Member States and aim to "preserve and promote the necessary changes to agricultural practices that make a positive contribution to the environment and climate". Climate action is therefore not the only dimension of the payments, as there may be other environmental objectives that Member States choose to pursue that way (e.g. biodiversity). The Member States have therefore relative freedom in choosing the measures that they deem most appropriate. As a result, agri-environment-climate commitments include a **wide spectrum of LULUCF actions** such as integrated horticulture or peatland conservation. The **yearly compensation payments** are provided to farmers or other land managers, compensating them for all or part of the additional costs and income foregone resulting from the commitments, as well as covering part of the transaction costs where necessary.

Apart from the **compulsory** element, the "agri-environment-climate" measures have an in-built **additionality** component as they have to go beyond: the cross-compliance requirements referred to in section 4.1.1[25]; certain basic rules (including the greening requirements mentioned in section 4.1.2) for direct payments[26]; and minimum requirements for use of fertilizer and plant protection products; as well as any relevant mandatory requirements established at national level.

Linking agricultural policy to policies on land use, land use change and forestry may seem appropriate, but it should be done with due consideration of the sector's specificities, notably when it comes to timescales for policy programming. The CAP programming period span is currently 7 years, and the commitments under the relevant RDP measures may be shorter (e.g. agri-environment-climate commitments shall be undertaken for a period of 5 to 7 years); and it is often the case that Member States enter into commitments with land managers

[24] Commission Implementing Regulation (EU) No 808/2014 of 17 July 2014 laying down rules for the application of Regulation (EU) No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), OJ L 227, 31.7.2014, p. 18–68, http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32014R0808

[25] Set out in Title VI of Regulation (EU) No 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Council Regulations (EEC) No 352/78, (EC) No 165/94, (EC) No 2799/98, (EC) No 814/2000, (EC) No 1290/2005 and (EC) No 485/2008, OJ L 347, 20.12.2013, p. 549–607, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013R1306

[26] Rules relevant to "maintaining an agricultural area in a state which makes it suitable for grazing or cultivation without preparatory action going beyond usual agricultural methods and machineries" or "carrying out a minimum activity, defined by Member States, on agricultural areas naturally kept in a state suitable for grazing or cultivation" set out in Article 4 of Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009, OJ L 347, 20.12.2013, p. 608–670

which begin in one programming period and continue into the next. The EAFRD regulation allows however the Member States to determine a longer period for some of their agri-environment-climate commitments in order to "achieve or maintain the environmental benefits sought". This flexibility is particularly justified from a climate change mitigation perspective: the potential contribution of LULUCF actions is limited if these actions are maintained for only 5 or 7 years with a significant risk of **reversibility** of any GHG emission impacts occurring during this period and then cease. In practice however, extension of the RDP measures beyond the frames of the programming period and the Multiannual Financial Framework is problematic, as there is no guarantee of the availability of EAFRD support after the end of the current programming period. Although there is no sign of Member States opting for such long agri-environment-climate commitment spans based on information in the Article 10 reports, they would not be a novelty to CAP. In 1992, as part of the MacSharry reforms, a scheme for long-term set-aside of agricultural land for environmental reasons and for the protection of natural resources was introduced, with a time span of (at least) 20 years[27]. It is therefore important to ensure that coherent policy direction and explore ways that the related financial support are continuously provided over **longer periods of time** (e.g. reflecting the estimated longevity of carbon pools and their stability over time[28]). A longer time horizon is therefore key to **climate integrity** of the LULUCF measures.

Forest measures

Forest measures supported under 2014-2020 RDPs are mainly covered by two measure categories. The first category, "Investments in forest area development and improvement of the viability of forests" (M-08) supports actions such as afforestation, establishment of agro-forestry systems, the prevention of fires and other catastrophic events in forests, improvement of the resilience and economic value of forests, and investment in forestry technologies such as soil-friendly and resource-friendly harvesting machinery and practices. Support under this category takes form of compensation payments, premiums, as well as investment support, depending on particular measures.

The second category, "Forest-environmental and climate services and forest conservation" (M-15) supports forest-environment commitments (e.g. the maintenance of a diverse forest edge or second crown layer to preserve forest microclimate and prevent loss of the carbon content of the forest soil) and conservation of forest genetic resources (e.g. characterisation, collection and utilisation of genetic resources in forestry). Support is provided in the form of compensation payments per hectare for operations consisting of one or more forest-environment and climate commitments.

For holdings above certain size (decided at RDP level), support under both categories (M-08 and M-015) is conditional on the presentation by the beneficiary of a relevant part of the

[27] Article 2 of Council Regulation (EEC) No 2078/92 of 30 June 1992 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside, OJ L 215, 30.7.1992, p. 85–90, http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1506589658678&uri=CELEX:31992R2078

[28] For instance the accumulation of carbon from zero-tillage practices may lead to soil organic carbon levels reaching a steady state after approximately twenty years, WRI (2006), The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting, and IPCC (2003), Good Practice Guidance for Land Use, Land-Use Change and Forestry, http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

forest management plan adopted in line with the **sustainable forest management** (SFM) definition established by the Ministerial Conference on the Protection of Forests in Europe of 1993[29] (for SFM related analysis see section 4.2). Just like in the case of the agri-environment-climate payments, M-08 commitments should go **beyond the minimum national requirements** established by the relevant legislation (in this case the forestry acts) and shall be undertaken for **5 to 7 years**, but **longer periods** may be determined by the Member States (see above for the implications of longer period RDP commitments).

Other measures focused on climate and environmental issues

One of the important factors in Member State allocation to climate and environmental measures is the EU's commitment to **mainstream climate change into the EU's sectoral policies** and funds. The overall aim of the EU to dedicate at least 20% of its budget for 2014-2020 on climate change-related action was reflected in the recitals of the EAFRD Regulation:

> "The Member States should provide information on the support for climate change objectives in line with the ambition to devote at least 20 % of the Union budget to this end using a methodology adopted by the Commission."

To reflect that ambition, the EAFRD includes the following commitment put into effect by article 59 (6) (own emphasis):

> "Member States (…) should be required to spend a **minimum of 30%** of the total contribution from the EAFRD to each rural development programme on **climate change mitigation and adaptation as well as environmental issues**. Such spending should be made through agri-environment-climate and organic farming payments and payments to areas facing natural or other specific constraints, through payments for forestry, payments for Natura 2000 areas and climate and environment-related investment support."

This 30% minimum contribution refers to climate *and* environment issues, which means that its scope is wider than the Council's pledge to spend 20% of the EU budget on climate objectives, particularly given the longstanding relevance of EAFRD measures to the delivery of biodiversity objectives. It nevertheless narrows the Member States' choices between the competing rural development priorities, while allowing freedom in deciding on how to meet the 30% requirement. The measures which are the subject of the 30% requirement include (beside the already mentioned Investments in forest area development and improvement of the viability of forests (M-08) and Agri-environment-climate (M-10)): Organic farming (M-11), Natura 2000 payments (M-12), Payments to areas facing natural or other specific constraints (M-13), and Forest-environmental and climate services and forest conservation (M-15).

More details on specific agri-environment-climate, organic farming, Natura 2000, and forestry measures supported under RDPs and included in Article 10 reports are provided in table 6 below and Annex 1 to this study.

[29] More information on Forest Europe website : Sustainable Forest Management Implementation , http://foresteurope.org/sustainable-forest-management-implementation/

Moreover, the EAFRD regulation [Article 28 (4)] links the agri-environment-climate payments to (i) knowledge and information measure (M-01) such as expert advice or training, and (ii) physical investment required to introduce particular measures (M-04).

Other measures referred to by Member States

The Article 10 reports go beyond the measures identified by the EAFRD Regulation as being directly relevant to the 30% commitment in the areas of climate and the environment (or as laid down in the regulation "of particular relevance to (…) promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors"[30]). Six additional measures are mentioned in the reports, specifically: Knowledge transfer and information (M-01), Advisory services, farm management and relief services (M-02), Investments in physical assets (M-04), Farm and business development (M-06), Basic services and village renewal in rural areas (M-07), and Animal welfare (M-14). However, these measures are often referred to by one Member State or only a small number of them.

In total, the Member States article 10 reports **connect 12 (out of 20) RDP measure codes to climate mitigation** and adaptation in LULUCF sector (see Table 6 below).

[30] Annex VI of the EAFRD regulation

Table 6 Reported LULUCF actions per RDP measure and sub-measures codes

Measure code	Programming sub-measure	Reported measures per Member State
8. Investments in forest area development and improvement of the viability of forests	8.1 afforestation/creation of woodland	**AT** : afforestation activities using tree species based on natural forest communities, **BG**: afforestation of abandoned land, barren and deforested areas, eroded and threatened by erosion land outside forest areas, **CY**: Reforestation/ afforestation, **EL**: support for afforestation/creation of forested areas, **ES**: this measure is in 13 out of 18 RDPs, **LV**: Afforestation and improvement of stand quality in naturally afforested areas, **LT**: Afforestation on private-owned unused land that is barely suitable for agriculture, **PL**: Afforestation actions, **UK**: woodland creation
	8.2 establishment and maintenance of agro-forestry systems	**EL, FR**: agroforestry systems, **ES**: this sub-measure is in 5 out of 18 RDPs
	8.3 prevention of damage to forests from forest fires and natural disasters and catastrophic events	**AT**: preventive actions to protect forests from forest fires, natural disasters and catastrophic events, **CY**: the prevention of damages from forest fires, natural disturbances and catastrophic events, **EL**: prevention of damages to forests from forest fires, natural disasters and catastrophic events, **ES**: this sub-measure is in all 18 RDPs, **LV**: Preventive measures of forest damages, **BG**: Restoration and maintenance of protective forest belts and new anti-erosion afforestation, **SK**: Protection of existing forests against natural disturbances (as an integral part of sustainable forest management)
	8.4 restoration of damage to forests from forest fires and natural disasters and catastrophic events	**AT**: actions to restore forest ecosystems after those events, with the aim to avoid subsequent pest outbreaks, **CY**: restoration of damages from forest fires, natural disturbances and catastrophic events, **EL**: forest restoration caused by forest fires, natural disasters and catastrophic events, **ES**: this sub-measure is in 15 out 18 RDPs, **LV**: Regeneration of forest stands after forest fires and other natural damages
	8.5 investments improving the resilience and environmental value of forest ecosystems	**AT**: increasing the resilience and environmental value of forest ecosystems, by i.a. promoting the establishment of protective infrastructure measures and silvicultural measures focussing on biodiversity, **CY**: thinning of trees in dense areas of reforested/ afforested woods in order to increase resistance of forests, **ES**: this sub-measure is in 16 out 18 RDPs, **LV**: Improvement of ecological value and sustainability of forest ecosystems, **EE**: Improvement of forest economic and ecological vitality, **MT**: creation and sustainable management of woodlands
	8.6 investments in forestry technologies and in processing, mobilising and marketing of forest	**AT**: investments in forestry technologies and in processing, mobilising and marketing of forest products with the aim to support forest cooperatives to jointly mobilise and market timber and

	products	forest biomass., **EL**: investment in forestry technologies and in processing, distribution and marketing of forest products, **ES**: this sub-measure is in 14 out of 18 RDPs
10. Agri-environment-climate	10.1 agri-environment-climate commitments	**BE**: production of (crop/ grain) legumes, cultivation of fibre flax and fibre hemp using reduced fertilization, agreements for the conservation of small landscape elements, water quality agreements (farming of low risk of nitrate leaching crops on at least 90% of the farm's cultivated area, agreements for reduced fertilizer use in and in the vicinity of Natura 2000-areas, non-productive investments (investments targeted at soil or water management or at increased biodiversity or landscape value), agreements on grassland or grass strips, **LU**: improvement of fertilizer application techniques, maintenance of landscape features, grass strips, extensification of fertilization and use of meadows, land use conversion from arable land to meadows and grasslands and maintenance of such land use conversion, extensification of nitrate fertilization in selected crops, prevention of erosion and leeching of nitrates. **AT**: environmentally sound and biodiversity promoting management: indirect impact on soil carbon conservation and sequestration, which is addressed e.g. by preventing conversion of grassland, preserving landscape elements, install biodiversity sites, specific crop rotations), limitation of yield-increasing inputs by e.g. renunciation of mineral fertilizers, renouncement of fungicides and growth regulators on areas dedicated to cereal cropping by renunciation and therefore necessary reduced N-fertilisation, greening of arable land – intermediate crops by the active greening of land between two main crops and renunciation of mineral N-fertilizers and pesticides and tillage operations throughout the greening period, greening of arable land – "evergreen" system by all-season greening of at least 85% of arable land (by growing main and intermediate crops)and renunciation of mineral N-fertilizer and pesticides and tillage operations throughout the greening period, direct seeding and seeding on mulch (incl. strip-till) by direct seeding and seeding on mulch or strip-till-seeding, renunciation of ploughing tillage., Low emission slurry and biogas spreading techniques: surface-near spreading of at least 50 % of the liquid farm manure on arable land and grassland, e.g. by using trailing hose spreaders or liquid manure injection techniques, erosion protection in fruit, vine and hop production by active area-wide greening of all machine tracks in vineyards, fruits and hops. Preventative ground water protection, arable land: reduced use of fertilizers, renouncement of selected pesticides; documentation on the use of nitrogen fertilizer, specific consultation and training, grassland: preventing the conversion of grassland (ban on the ploughing up or renewal). Management of arable areas particularly threatened by leaching by the establishment of a permanent green cover mixture on arabe land at risk of

	leaching, renunciation of fertiliser and pesticides on these area and conversion, preventative surface water protection on arable land by land set aside by establishing a minimum 12-metre buffer strip adjacent to rivers or streams or by preserving existing, greened buffer strips along rivers or streams, nature conservation by extensive, near-to nature management e.g. fertilizer reduction and renunciation, fallow land, preservation of landscape elements, soil preserving tillage systems, and others. **CZ**: afforestation and grass planting, suitable treatment of grassland in wetland locations which have considerably higher potential to fix C and N, maintenance of stabile ecosystems in areas suffering from deteriorating moisture conditions which minimises negative impact of wind erosion and threatened increased C and N loss; Sustaining increased C sequestration and N retention at waterlogged locations; management of steppe locations minimises negative impacts of certain specific climate effects, appropriate management on organic soil prevents increased greenhouse gas emissions, general management approaches supporting development of specific ecosystems with high adaptation potential to specific effects in their environment; maintenance of existing high-quality ecosystems leading to maintenance or strengthening of increased sequestration potential; reducing nitrogen emissions consequences; maintenance of strengthening of N retention capacity by implementing of appropriate soil management practices, respectively transition to cultures with higher potential; strengthening of anti-erosion measures with high sequestering effect especially in vulnerable locations, land areas endangered by erosion and in protective zones around water sources; supporting sequestering potential of arable land temporarily influenced by water logging. **EE**: growing plants of local varieties, environmentally friendly management, maintenance of semi-natural habitats, environmentally friendly horticulture, soil protection **FR**: maintenace of the extensive herbaceous systems/limiting intesification and returning organic matter to soil, maintenance and change of practice towards systems of poly-cultures and breeding/ limitation of agricultural inputs, improvement of carbon storage capacity in soils., **HR** : tilling and sowing on the terrain with slope for arable annual plants, grassing of permanent crops, preservation of high nature value grasslands, pilot measure for protection of corncrake (lat. Crex crex), pilot measure for protection butterflies, establishment of field strips, maintaining of extensive orchards, maintaining extensive olive groves , **IE**: Green Low-carbon Agri-environmental Scheme: an agri-environmental scheme that applies agricultural production methods to address issues of climate change, water quality and biodiversity loss. Specific actions within the scheme relate environmental management activities on grassland (low-input permanent pasture, species rich grassland, traditional hay meadows), to reducing soil erosion and nutrient leaching on cropland

		(min-till establishment practices, winter cover crops). Minimum tillage, cover crops, low-input permanent pasture, Traditional Hay Meadow, Commonage Management Plan (CMP) and Commonage Farm Plan (CFP) Use of Low Emissions Spreading Systems (LESS), Environmental management of set aside, arable grass margins, **IT**: soil management to improve crop adaptation, improve the efficient use of nutrients, keeping soil in good condition preventing erosion, improve fertility naturally, avoid synthetic inputs, promote crop diversification, maintaining and improving the surface of grazing land, maintain habitats in backward areas and subject to specific constraints, **LV**: introduction and promotion of integrated horticulture, growing of legumes, maintenance of biodiversity in grasslands **MT**: use of environmentally friendly plant protection products in vineyards, support for the traditional cultivation of sulla through crop rotation, low input farming, suppress the use of herbicides in vineyards and fruit orchards, establishment and maintenance of conservation buffer strips, conservation of rural structures providing a natural habitat for fauna and flora, **NL**: meadow bird management to raise the groundwater level in peat pasture areas, **PL**: sustainable agriculture, protection of soil and water, valuable habitats and endangered bird species in Natura 2000 sites and Valuable habitats outside of Natura 2000, **SE**: grass production in intensive grain producing areas and the inclusion of catch crops in the crop rotation, management of pasture land, creating wetlands on agricultural soils and management of wetlands, **SK**: Integrated farming, integrated farming in vineyards, Protection of biotopes of natural and non-natural grassland, Multifunctional field edges, protection of water resources, protection of endangered species of animals, **UK**: peat restoration measures, Countryside Stewardship (environmental management of land including moorland habitats), **DK**: conversion of arable land on organic soils to natural habitats: The areas under the subsidy scheme are registered with a ban on cultivation, fertilisation and pesticide application.
	10.2 conservation and sustainable use and development of genetic resources in agriculture	**MT**: Conservation of species in danger of genetic erosion.
11. Organic farming	11.1 payment to convert to organic farming practices and methods, 11.2 payment to maintain organic farming	**BE**: organic farming leads to climate change mitigation by reducing the use of fossil fuels (for fertiliser and pesticides production) and by increasing the organic carbon content of farmed soils, **AT**: organic farming measures like the renouncement of mineral fertilisers and chemical synthetical pesticides, preservation of landscape elements and the maintenance of grassland, conservation and partial build-up of soil organic carbon by manure management, the greening

	practices and methods	of arable land and humus promoting crop rotations (e.g. fodder cropping/leguminous crops), **MT**: organic farming – legumes, **IT**: organic farming: management of waste crop, organic manure, extended crop rotation, selection of better crop varieties, cover crops **CZ, EE, IE, MT, FR, PL, SK, HR, IE**: organic farming
12. Natura 2000 and Water Framework Directive payments	12.1 compensation payment for Natura 2000 agricultural areas 12.2 compensation payment for Natura 2000 forest areas 12.3 compensation payment for agricultural areas included in river basin management plans	**EE**: Natura 2000 support for agricultural land, Natura 2000 support for private forest land **EL**: 12.2 «compensation for forest areas of Natura 2000 network, **SK**: Protection of Natura 2000 areas
13. Payments to areas facing natural or other specific constraints	13.2 compensation payment for other areas facing significant natural constraints	**IE**: Area of Natural Constraints (ANC)
15. Forest-environmental and climate services and forest conservation	15.1 payment for forest-environmental and climate commitments	**ES**: this sub-measure is in 3 out of 18 RDPs, **CZ**: Stabilisation of carbon volumes bound in forest ecosystems, **AT**: improving the environmental conditions of forest ecosystems
	15.2 the conservation and promotion of forest genetic resources	**ES**: this sub-measure is in 5 out of 18 RDPs, **AT**: conservation and promotion of forest genetic resources

1. Knowledge transfer and information	1.1 vocational training and skills acquisition actions 1.2 demonstration activities and information actions1.3 short-term farm and forest management exchange as well as farm and forest visits	**AT**: Knowledge Transfer and Information as an important basis for raising awareness concerning energy and resource efficiency as well as environment and climate policy, **EE**: Support for advisory systems and services, **IE**: Knowledge Transfer Groups, **MT**: enhanced understanding of ecological systems, biodiversity, nutrient budgeting, marketing and promotion of products, and quality assurance systems
2. Advisory services, farm management and relief services	2.1 to help benefiting from the use of advisory services 2.2 the setting up of farm management, farm relief and farm advisory services as well as forestry advisory services 2.3 training of advisors	**BE**: Advisory services for specific themes: cross compliance, greening, biodiversity, climate, water, and soil, **SE**: advising program "Focus on Nutrients"
4. Investments in physical assets	4.1 investments in agricultural holdings	**AT**: investment in agricultural holdings to improve the overall performance by i.a. increasing resource and energy efficiency (and reduce demand for fossil fuels) thus contributing to promoting renewable energy, **MT**: addressing soil sealing with investments in more efficient water-saving devices and systems on all farms but particularly cropping farms, also enhanced water and waste storage; and better waste handling and collection facilities and processes
	4.3 investments in infrastructure related to development, modernisation or adaptation of agriculture and forestry	**AT**: infrastructure related to development of agriculture and forestry to support sustainable management by adaptation to climate change, **EE**: Development and maintenance of infrastructure for agriculture and forest management, **EL**: Opening and improvement of forest road network, **LV**: Development and adaptation of drainage systems in cropland, Development and adaptation of drainage systems in forest land
	4.4 non-productive investments linked to the achievement of agri-environment-climate objectives	**AT**: Support for non-productive investments linked to the achievement of agri-environment-climate objectives aims to improve the ecological conditions of wetlands, thus contributing to soil carbon conservation and sequestration.

6. Farm and business development	6.1business start up aid for young farmers	**AT**: business start-up aid for young farmers and investments in creation and development of non-agricultural activities.
	6.4 investments in creation and development of non-agricultural activities	**AT**: development of energy services based on renewable energy sources and reducing demand for fossil fuels and strengthening local energy supply
7. Basic services and village renewal in rural areas	7.2 investments in creation, improvement or expansion of all types of small scale infrastructure, including investments in renewable energy and energy saving	**AT**: investments in renewable energy (biomass-heating systems, local heat grids, replacement of old heating systems by biomass district heating systems, CHP-installations, digesters and installations for the production of methane and o in dedicated climate and energy projects on community level)
	7.6 studies/investments for the maintenance, restoration and upgrading of the cultural and natural heritage of villages, rural landscapes and high nature value sites including related socioeconomic aspects and environmental awareness actions	**AT**: activities to identify potential for torrent and avalanche control, and is thereby directed towards introducing preventive measures for the protection and stabilisation of ecosystems and their carbon stocks
14. Animal welfare	Payment for animal welfare	**SK**: animal welfare[31]

[31] Slovakia reports that "Animal welfare" measure is expected to contribute to "lower emissions N_2O and CH_4 [thanks to] reducing or optimising use of fertiliser, plant protection products.", Slovakia Article 10 progress report, p. 14.

4.2 Forestry policies

Most Member States see forestry policies as a key driver of their LULUCF mitigation actions. This section provides a more in-depth description and analysis of the national policies shaping forestry sectors, embedded in a wider context of the strategic direction set out at EU level.

Article 10 reports refer frequently to sustainable forest management (SFM, mentioned explicitly by 24 out of 27 reporting Member States, see figure 8 below), as well as to the concept of multifunctional forests (mentioned also among the LULUCF priorities at national level, see section 3.1). This reference to SFM and multifunctional forests links to the 2013 revision of the EU's forest strategy[32]. The New EU Forest Strategy (COM/2013/659) recognises both the multi-functionality of Europe's forests and that there are aspects of the forest value chain (i.e. the way forest resources are used to produce goods and services) that have a strong influence on forest management decisions. The growing bioeconomy and bioenergy sectors are two such examples. The EU Forest Strategy promotes the concept of SFM as defined by the Ministerial Conference on the Protection of Forests in Europe[33] (Forest Europe):

> "The stewardship and use of forest lands in a way and at a rate that maintains their productivity, biodiversity, 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 assesses and measures SFM through a set of criteria and indicators and reports through State of Europe's Forest reports (Forest Europe, 2015). Criterion 1 addresses global carbon cycles and covers the main elements of LULUCF activities of the EU's climate accounting framework (Table 7). Its prominence in the SFM criteria should not be overlooked, yet through implementation Member States need to balance commitments to the other SFM criteria in the management of forests.

[32] The EU Forest Strategy makes explicit reference to climate action for adaptation (internal and external) and mitigation. Member States action on LULUCF is mentioned explicitly with the strategy suggesting that Member States should demonstrate "how they intend to increase their forests' mitigation potential through increased removals and reduced emissions, including by cascading use of wood, taking into account that the new LIFE+ subprogram for Climate action and Rural Development funding can promote and support new or existing forest management practices that limit emissions or increase net biological productivity (i.e. CO2 removal). They should do this by mid-2014 and in the context of their information on LULUCF actions". Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A new EU Forest Strategy: for forests and the forest-based sector, COM(2013) 659 final, http://eur-lex.europa.eu/resource.html?uri=cellar:21b27c38-21fb-11e3-8d1c-01aa75ed71a1.0022.01/DOC_1&format=PDF

[33] 1993 pan-European Ministerial Conference on the Protection of Forests in Europe

Table 7 Forest Europe SFM Criterion 1 and its associated indicators

Criterion 1: Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles	
C.1 Policies, institutions and instruments to maintain and appropriately enhance forest resources and their contribution to global carbon cycles	
1.1 Forest area	Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area.
1.2 Growing Stock	Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply.
1.3 Age structure and/or diameter distribution	Age structure and/or diameter distribution of forest and other wooded land, classified by availability for wood supply.
1.4 Forest carbon	Carbon stock and carbon stock changes in forest biomass, forest soils and in harvested wood products

Source: ForestEurope

National forest policies have traditionally focused on supporting the management and growth of forests in a way that satisfies the **productive and economic functions** of the forest resource. In many cases the forest policies and measures listed in Article 10 reports are likely to have been in place for reasons other than climate mitigation or specific LULUCF activities, such as improving the viability and resilience of forests to climate or contributing to the bioeconomy. Healthy and resilient forests, for the most part, can benefit climate mitigation both within LULUCF and beyond through long-term carbon sequestration, stabilisation of forest soils and providing wood resources to substitute fossil or high-GHG intensity materials (such as steel or concrete in construction). It is therefore logical for Member States to list forest management and afforestation activities as part of their LULUCF commitments.

However it is far less clear to what extent 'additional' action is being taken in the EU-28 to secure the carbon sink potential of forests; to increase the substitution of GHG-intensive materials; or to follow resource efficiency principles in order to use forest resources in a way that minimises the impact on the environment and climate whilst prioritising the forest products with higher added-value, creates more jobs and contributes to a better carbon balance. There are however signs that some Member States are testing such additional actions, as in the case of Polish "Forest Carbon Farms" pilot initiative. The aim of the forest carbon farms is to improve the know-how and scientific certainty related to the increases of carbon stock in Polish forest through enhanced forest management (the measure is described in detail in Box 7 in Annex I of this study).

Forest management for increased replacement of GHG intensive feedstocks with biomass

The production and use of energy biomass from forests to replace fossil sources receives particular attention in Member State action on LULUCF activities (use of forest biomass for energy was mentioned in 19 out of 27 reporting Member States). Forest biomass has always been used as a source of heat and power in Member States, with some rural areas still reliant on woody biomass for this purpose both domestically and in central installations. With the introduction of EU renewable energy targets, many Member States (namely Spain, Slovenia, Romania, Lithuania, and Estonia) highlighted their intention to meet these targets through the use of biomass to replace coal and gas sources, as illustrated in Member State National Renewable Energy Action Plans (NREAPs, see section 4.4.1 on Renewable Energy Directive).

Whilst the production of renewable energy can help to decarbonise the economy as a whole, through reducing emissions in the energy sector, there is a risk that it undermines the sink potential of forests through lack of replacement within policy relevant timescales (2030) necessary to address climate mitigation needs, i.e. the carbon debt issue (Bowyer et al, 2012). In this way, the forest carbon sink might cease to be available for offsetting emissions in other sectors, such as agriculture. To address these issues, the Commission has proposed a new sustainability criterion for forest biomass with the view to avoid the risk of forest biomass overharvesting and biodiversity loss (recast of the Renewable Energy Directive[34]). Moreover, emissions from forest biomass conversion to energy will be accounted as part of the LULUCF emissions.

Furthermore, the carbon sink of forests is projected to decline. As noted in the EU's impact assessment on the proposed LULUCF Regulation[35], forest harvest is projected to increase over time by 49 million m^3 to 2030 compared to 2005 levels due to growing demand for wood for energy production but also material use up to 2050. With the forest increment also set to decrease as a result of aging stands the overall carbon sink in managed forests is anticipated to decline by 32% by 2030. The GHG impact of these changes is partially compensated by a rising carbon sink from afforestation and decreasing emissions from deforestation, not all of which is an active choice by Member States[36].

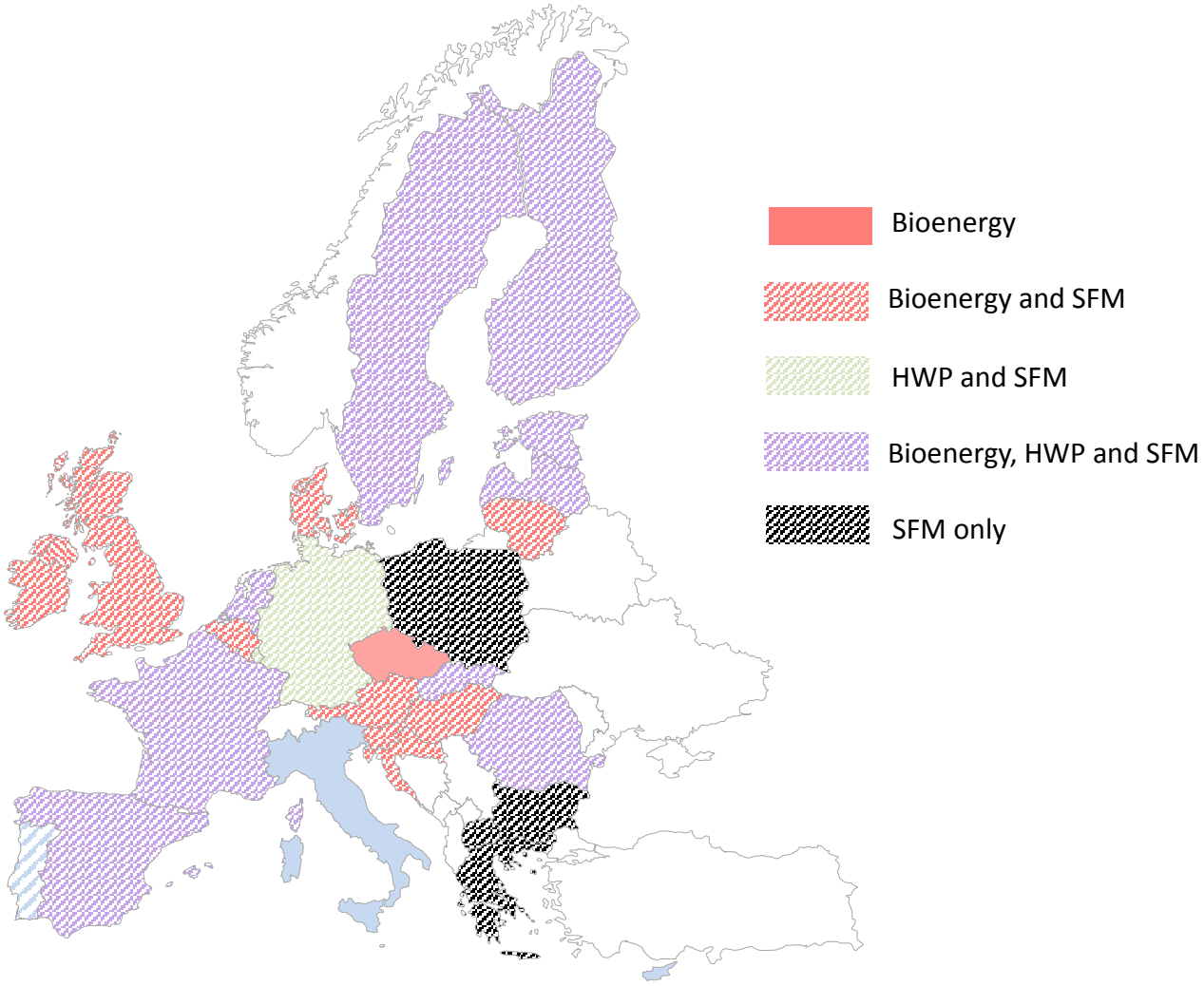
Member States that have implemented policies and measures aimed at **increasing the harvested wood products (HWP) pool (11 out of 27 reporting Member States) are likely to have a more positive impact on climate mitigation than those that have focused on the use of biomass for energy**, particularly over the longer term. In some cases, Member States are opting for both strategies (9 out of 27, see figure 8 below and Annex 1). The real impact of policies and measures will depend on the maintenance of the carbon sink in managed forests, particularly where increment is declining and harvest increasing.

[34] Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast), COM(2016) 0767 final, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016PC0767

[35] Commission Staff Working Document Accompanying the document Proposal for a Regulation of the European Parliament and of the Council on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry into the 2030 climate and energy framework and amending Regulation No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and other information relevant to climate change.

[36] For example, increases in forest area can occur as part of natural regeneration on abandoned farm-land.

Figure 8 Member States reporting on sustainable forest management (SFM), bioenergy, and harvested wood products (HWP) in their Article 10 reports*.



*Portugal did not submit a report

Source: IEEP based on Article 10 reports

Permanence of mitigation effort

The dynamics of carbon stocks in forests are important to consider in relation to the long-term impact of climate action chosen by Member States in their Article 10 reporting. For example, almost all Member States[37] (26 out of 27 reporting Member States) have chosen to count **afforestation** programmes in their policies and measures contributing towards the LULUCF accounts. For the period of the establishment of these new forests, and as the forests remain *in situ,* the contribution to climate mitigation can be positive through increased removals and as a growing sink, providing that the resulting vegetation and soil structure

[37] For example, in UK(S) there is a target to plant 10,000 ha/yr of new conifer plantations and native woodland, aimed at meeting climate mitigation targets and supplying the wood processing and bioenergy sectors.

contains a greater and more stable carbon pool than the land use it replaces[38]. However, as soon as the forest becomes harvested, the sink and sequestration potential are affected. In some cases forest thinning can help forests to establish better and can improve the resilience of forests to environmental and climate risks, such as forest fires. Remaining trees can increase their carbon stocks, but harvesting temporarily depletes the carbon in the forest, both from the removal of standing biomass and any disturbance impacts through harvest. The re-establishment of the carbon sink requires the regrowth of the trees over a period of years and thus there is a payback or debt period. The continued climate relevance of the harvested biomass then depends on whether it is retained in HWP, combusted or disposed of, i.e. whether it is released to the atmosphere or not. The detail of the intricate dynamics of biogenic carbon sources and sinks in forests is set out clearly in Matthews et al. (2014)[39].

In this context, four factors are important from a climate mitigation perspective: the previous land use and carbon content of the land being afforested; the period for which the afforested land remains forest; the management of that forest including the harvesting of biomass; and the end use of the biomass after harvest. There are a number of mechanisms in the EU to help ensure that forests are managed sustainably, in addition to MS legislation, the rules and requirements surrounding the CAP forest measures (see section 4.1), the abovementioned EU forest strategy and the principle of SFM and other mechanisms such as voluntary certification schemes (FSC and PEFC). However, these requirements do not guarantee that forest activities listed in Article 10 reports are contributing effectively to the achievement of long-term climate goals.

Forms of support

The above considerations suggest that the impact of climate action in forests depends in part on how Member States design and implement national policies, and in part on the choices of individual forest owners and managers. Based on Article 10 reports, in most cases where Member States identify forest-related policies and measures, they rely on the use of financial and facilitation[40] support provided under the CAP Rural Development Programmes, in particular the Forest Measures. Revisions to the CAP for the 2014-2020 programming period allow EU public money to support the management of forests and afforestation for both private and public beneficiaries[41] (see more in section 4.1).

In some cases, such as Finland[42], Ireland, France, Greece, Germany and Lithuania, Member States state in their Article 10 reports that they have chosen to use national State-Aid[43]

[38] The environmental compliance requirements for CAP supported afforestation under Article 6 of the Delegated Regulation (807/2104) help to ensure coherence with climate objectives in this regard. Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009, OJ L 347, 20.12.2013, p. 608–670, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1307

[39] Forest Research (2014), Review of literature on biogenic carbon and life cycle assessment of forest bioenergy, https://ec.europa.eu/energy/sites/ener/files/2014_biomass_forest_research_report_.pdf

[40] Such as capacity building, advice and training

[41] With different conditions of support between public and private beneficiaries.

[42] Finland which has two national schemes, supporting forestry heath and climate mitigation (KEMERA) and forest nature conservation and biodiversity (METSO).

[43] State-aid is support provided from national or regional funds, as opposed to EU public money.

support for action on forests. The rationale for choosing to use state-aid over that EU public support varies between specific actions, such as establishment of forests versus their on-going maintenance. The Guidelines for state aid in the agriculture and forestry sectors[44] set out the minimal environmental requirements for receipt of such aid. For example, §509 of the guidelines sets out the requirements for afforestation which include a number of provisions for climate action, such as: (i) avoiding afforestation on peat lands and wetlands, (ii) ensuring resilience to climate change and natural disasters, and (iii) setting requirements for harvesting rotations for fast-growing species (>8 and <20 years). Specific aid for improving the resilience and environmental value of forest ecosystems is only eligible if the investments are aimed at commitments for environmental aims, enhancement of public amenity value or the improvement of climate mitigation potential (§531). Importantly these are not to be exclusive of economic benefits in the long term.

4.3 Cross-cutting measures to protect soil

The primary goal in the context of LULUCF relating to soils is the retention and accumulation of soil carbon. This acts as a sink for GHG emissions but also increases the resilience of soils, promoting their fertility, health, structure and offering potential to support not just mitigation but also climate adaption. The interconnected nature of soil functionally means that to protect soil organic matter actions of relevance will be diverse. These include activity intended to protect soil by: covering with plants or organic mulches; reducing erosion; changing approach to fertilisation; altering methods of tillage and sowing; promoting different forms of land use including afforestation, conversion to grassland or establishment of permanent grasslands. As such there is an equal diversity of policy actions and measures set out in the Member State LULUCF reports to address the question of soils both on agricultural and forest land.

In total 131 policies and measures were explicitly noted by 26 Member States in their Article 10 reports to protect or alter the management of soils. Soil related interventions were most commonly noted in relation to rural development programmes with 18 Member States making explicit reference to soil protection in their measure descriptions (other measures will also likely have implicit impacts but this is not calculated here). In addition, in relation to the CAP both greening measures and cross compliance actions (in particular GAEC) were highlighted by multiple Member States. Beyond the CAP actions across spheres of forest policy, climate mitigation and adaptation action plans and strategies, land use and spatial planning, biodiversity protection, water policy (specifically the implementation of the Nitrates Directive), monitoring, reporting, modelling and research and development were also explicitly linked by Member States to soil management. A summary of the types of intervention with examples is provided in Table 8 below.

[44] European Union Guidelines for State aid in the agricultural and forestry sectors and in rural areas 2014 to 2020, OJ C 204, 1.7.2014, p. 1–97, http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52014XC0701%2801%29

Table 8 Examples of interventions identified in Article 10 reports that highlight the importance of soil protection and management

Category of Action	Description	Examples of Actions Noted by Member States in Article 10 reporting
CAP – Pillar I Cross Compliance	Cross compliance under CAP relating to GAEC and Statutory Management Requirements	Noted in relation to minimum soil cover and agricultural management practices based on soil type – IE, SI, HR Measures on organic soils e.g. ban on reversal of pasture
CAP – Pillar I Greening	Greening measures including Protection of Permanent Grassland and Ecological Focus Areas	Limited references explicitly to soil protection although EFAs and Protection of Permanent Grassland noted e.g. by EE
CAP – Pillar II – Rural Development Programme	Actions adopted under a number of different measures within the RDP, particularly relevant agri-environment climate	Different types of intervention noted as relevant to soils including: - Reduced tillage, reducing erosion, direct sowing e.g. AT, CZ, LU - Support for organic farming e.g. CZ - Support for non-productive investments including landscape elements, tree rows, grass strips e.g. BE, SE - Change of land use from arable to forest land/permanent pasture e.g. CZ, IT, MT - Protecting wetland soils and peat soils e.g. CZ, EE - Reverting organic soils to natural habitat e.g. DK or grassland e.g. LV - Establishment of small 'protective' forests groves to protect water and soils e.g. EE - Improving management of grassland e.g. FI via promoting grass based biogas, Ireland via support for sheep farming - Forest management e.g. HU - Soil analysis and links to on farm nutrient planning e.g. PL, SK - Incorporation of pruning residues and burning ban e.g. ES
Forest Management	Forest management designed to promote soil protection through eg Forest Strategies	There are number of practices, in addition to afforestation, flagged as improving forest soils including: - Protecting soils during forest extraction/haulage/harvest e.g. AT, LU - Protecting forest soil inputs i.e. needles, litter e.g. AT - Prohibiting clear felling due to link with soil erosion and permanent loss of soil productivity e.g. AT, CZ - Permanent soil cover of forest soils e.g. CZ - Emphasising soil protection within forest management e.g. PL - Optimising forest roads e.g. SI
Climate adaptation	Actions noted specifically in the context of climate adaptation actions, strategies	Noted by a number of Member States (AT, BG, CZ) of the importance of soil fertility, structure and stability when dealing with climate change and that this is complementary to LULUCF action
Climate mitigation	Actions noted specifically in the context of climate mitigation	Several Member States noted 'Climate Programmes for Agriculture' e.g. FI aimed at increasing the energy and material efficiency agricultural production and reducing emissions per unit produced. In this context soil protection and actions were noted as important often cross referring to other specific actions e.g. those listed

		under RDPs. For example the Finnish Programme contains 76 different measures for action in agriculture. ES noted its Roadmap for dispersed (ESD) Sectors including specific actions focused on soil protection e.g. legume use, direct sowing, use of residues. Specifically the protection of peat or organic soils was noted in the context of climate mitigation plans by multiple Member States including RO, FI, DK, CZ
Land use and Urban planning	Actions limiting development and taking into account soil conditions	Several Member States noted the importance of considering LULUCF and soil protection in urban planning and land use planning to ensure 'rational management by property owners' and protect key soils from development e.g. CY, CZ
Biodiversity protection	Protection of biodiversity linked to soil protection or rehabilitation	Several Member States noted the importance link soil protection and biodiversity actions linked specifically to the rewetting of organic soils, the rehabilitation of wetland and/or organic soils and the conversion of organic soils to grassland (e.g. DK, SE, LV); support for semi natural habitat maintenance linked to reducing SOM loss (e.g. EE); and protection of less favoured areas
Water quality – Nitrate Directive Implementation	Implementation of water protection measures	The implementation of the nitrates Directive was explicitly referenced in the context of soil protection and LULUCF by a number of Member States. This was noted in terms of reducing fertiliser inputs but also more importantly in shifting attitudes for soil and nutrient management (CZ, LT) and the development of crop management and fertiliser plans (MT)
Monitoring	Monitoring of soils to establish information on soil carbon and climate mitigation	Various Member States identified monitoring efforts including: - Monitoring of forest soils to establish carbon fluxes – EE - Understanding material flows in soils by ADEME to increase modelling certainty – FR - Monitoring of soil agrochemical properties to improve efforts to minimise the loss of the soil layer as part of interinstitutional planning to deliver the National Climate Change Management Policy - LT

Source: IEEP (2017) based on Article 10 reports

4.4 Other policy instruments

4.4.1 EU legislation

One striking observation based on the overview of the measures reported by the Member States under Article 10 of the LULUCF decision is that a great number of the reported measures are required by binding legislation at EU level.

The key EU legislation framing measures reported by the Member States (apart from CAP relevant legal requirements presented under section 4.1 of this study) is set out in the following acts:

- **Natura 2000 legislation** (Birds[45] and Habitats[46] Directives) establishing a pan-EU network of protected areas with an aim to ensure the long-term survival of Europe's most valuable and threatened species and habitats.
- **Nitrates Directive**[47] one of the key instruments in the protection of waters against agricultural pressures by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. It is an integral part of the Water Framework Directive.
- **Water Framework Directive**[48] establishing a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater.
- **INSPIRE Directive**[49] with an aim to create an EU spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment.
- **Renewable Energy Directive**[50] establishing an overall policy for the production and promotion of energy from renewable sources in the EU including a binding target of 20% renewable energy in the overall EU energy mix, broken down into national binding percentage targets.
- **Common Provisions Regulation**[51] laying down the common rules applicable to the European Structural and Investment Funds (ESI Funds) consisting of: the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund, the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF), which operate under a common framework.

The Member States reported these acts as policy tools to implement the LULUCF measures. Nevertheless in cases where the compliance with EU law is ensured without an attempt to maximize LULUCF mitigation action, such measures are relevant but not additional to the overall climate action effort undertaken by the Member State. In other terms, compliance with the EU law does not always mean that Member States pursue additional, enhanced

[45] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds, OJ L 20, 26.1.2010, p. 7–25, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147

[46] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206, 22.7.1992, p. 7–50, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043

[47] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, OJ L 375, 31.12.1991, p. 1–8, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0676

[48] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, 22.12.2000, p. 1–73, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060

[49] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), OJ L 108, 25.4.2007, p. 1–14, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32007L0002

[50] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028

[51] Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006, OJ L 347, 20.12.2013, p. 320–469, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1303

climate action in LULUCF sector. The instances where Member States try to design their EU law implementation in a way that enhances climate benefits of LULUCF action deserve therefore to be treated separately from other ways of ensuring compliance. In the following paragraphs, a short summary of the reported measures implementing the key legislation listed above is presented. The summaries note any signs of enhanced compliance with a view of maximizing LULUCF climate mitigation impacts that could be identified based on Article 10 reports.

Natura 2000 legislation

Several Member States report actions required under Natura 2000 legislation as LULUCF and climate change mitigation relevant. It should be noted that LULUCF actions may have both positive and negative impacts on fauna and flora. Inversely – biodiversity protection measures such as Natura 2000 requirements are more often than not supportive of LULUCF mitigation actions. While it is true that "any major land-use change will change the types of habitats and species, irrespective of any change in diversity", tradeoffs between carbon sequestration and maintenance of biodiversity can occur in the creation of productive managed forest for example (IPCC, 2000)[52]. A win-win situation takes place when LULUCF mitigation potential is pursued by avoidance of deforestation, or land or soil degradation, which is also good for biodiversity (although conversely, there are cases where restoration of habitats such as heathland or sand dunes requires felling of pine stands – a major driver of deforestation in the Netherlands). Member States are legally bound to implement Natura 2000 directives. Article 10 reports include measures that are in vast majority (a few exceptions noted below) an outcome of that legal obligation, but do not seem to reveal a strategic approach to encourage synergies between biodiversity protection and climate mitigation.

For instance Slovakia lists "Protection of Natura 2000" as a measure under its RDP for the 2014-2020 period. The stated objective of the measures is "no application of plant protection products, no fertilisers except by freely grazed animals, no buildings on permanent grasslands" and the impact on emissions: "lower emissions of N_2O and CH_4". In a similar way, Estonia mentions "Natura 2000 support for private forest land" and "Natura 2000 support for agricultural land" as Article 10 relevant measures included in its RDP for the period 2014-2020. Both reports did not provide enough detail to allow determination whether or not they are designed to enhance the LULUCF mitigation action.

Lithuania reports "Prioritised Action Frameworks (PAFs) as required under Article 8 of the Habitats Directive" as one of the measures with a general description of Article 8 of the Habitats Directive requirement and an increasing uptake of the relevant activities by Lithuanian farmers. In 2017, in Lithuania's progress report under Article 10 a note on additional initiative was added: an approval of a Landscape and Biodiversity Conservation Programme for 2015-2020 including Natura 2000 site "management measures related to climate mitigation and adaptation activities in grasslands, wetlands, and forests". The climate components of the programme indicated an **enhanced compliance approach**, enabling maximizing the potential of LULUCF mitigation actions framed initially by the Natura 2000 legislation.

[52] IPCC (2000), Land use, land use change and forestry, Special Report, https://www.ipcc.ch/pdf/special-reports/spm/srl-en.pdf

In Belgium (Flanders), as part of the **agri-environment-climate measure** (RDP, M10) fertilizers cannot be applied in any form in the vicinity of Natura 2000 croplands and grasslands. This rule is subject to agreements over a 5 year period applicable to designated plots. This is a new measure with the aim to cover an area of 500 ha of grassland and 500 ha of cropland in Flanders by the end of 2020. In Wallonia, similar support is proposed by the RDP 2014-2020: for grasslands under Natura 2000 with "strong constraints", including reduced use of fertiliser, an annual area of over 6 thousand ha is foreseen for the period 2014-2020. Flanders supports also afforestation aiming at meeting Natura 2000 conservation targets. A plant subsidy, a maintenance subsidy and a compensation for income losses are provided to farmers for afforestation using indigenous species or poplars with an indigenous understory. For twelve years after the conversion farmers receive a compensation for their income losses due to the conversion of agricultural land into forest land as well as a subsidy for the maintenance of forest land. The measure includes also compensations for wildlife protection such as construction of game fences or individual shelters. In the case of reforestation, the use of seedlings from recommended species is also compensated. The measure aims at **minimising the impact of the Natura 2000 conservation targets on the agricultural sector**. Belgium notes also that "stimulating these good forestry practices (including wood production) has **beneficial effects on carbon sequestration**".

Apart from Slovakia, Estonia, Lithuania, and Belgium, other Member States mention Natura 2000 measures in the context of their RDPs are: Greece, Luxembourg, and Poland. Additionally, Luxembourg reports **advisory support** to farmers applying the measure consisting on extensification of fertilizer use in Natura 2000 sites to maximize the achievement of its objectives (water protection from nitrates leeching as a primary objective, and GHG emission reduction as a secondary objective). Hungary mentions "Protection of Natura 2000 areas and other natural values" as part of its New Hungary Rural Development Strategic Plan (2007–2013), and Bulgaria reports "Preservation and restoration of 11 habitat types rivers and wetlands in the 10 Natura 2000 sites in Bulgarian forests" as one of its LIFE+ supported measure.

Wetland protection under Natura 2000 network is also included in Article 10 reports (e.g. by Malta, Bulgaria, and Belgium).

Nitrates Directive

EU's agriculture is an important source of nitrate pollution. Two main sources of agricultural N emissions: intensive livestock systems and excess of use of nitrous fertilizer lead to N leaching and run off, but also other N losses through volatilization of NH_3, N_2O, NO_x to atmosphere, due to nitrification and denitrification processes[53]. The EU Nitrates Directive is dealing with nitrate concentration levels in waters, with a direct impact on GHG emissions (namely N_2O). It should be noted however that a large number of measures tackling nitrogen compounds emissions (e.g. changing livestock diet) are not directly affecting land use and are

[53] Velthof G.L., J.P. Lesschen, J. Webb, S. Pietrzak, Z. Miatkowski, J. Kros, M. Pinto, and O. Oenema (2011), The impact of the Nitrates Directive on gaseous N emissions, Final Report for the DG ENV of the European Commission under contract no ENV.B.1/ETU/2010/0009, http://ec.europa.eu/environment/water/water-nitrates/pdf/Final_report_impact_Nitrates_Directive_def.pdf

regulated under **the Effort Sharing Decision** (Decision No 406/2009/EC)[54] rather than the LULUCF Decision.

Croatia reports for instance "Standards for nitrates", describing them as mandatory for farmers whose agricultural holdings are located within the so called nitrate vulnerable zones (NVZ)[55]. The farmers have to limit their nitrogen input to soil and conduct soil analysis. According to the report, the prohibition of deposit of manure in the winter as well as a mandatory requirement to store its surplus in a specific way reduce N volatile compound emissions. Cyprus mentions a similar measure.

Ireland lists the Nitrates Directive as a driver behind nutrient management in both cropland and grassland. The Czech Republic mentions Good Agricultural Practices applied in organic farms that include best available techniques such as: reduction of waste nitrogen by phase diets in feed, reduction of ammonia emission by adding enzyme substances to feed, partly grated floor, plastic and concrete grids with vacuum system removes manure, or steel manure storage tanks.

Finland, the Netherlands ("obligation to use an N catch crop after maize"), Malta, Spain, the UK ("implementation of EU Nitrates Directive under CAP cross compliance"), Luxembourg, and Hungary also refer to the Nitrate Directive obligation in their reports, but without any sign of practices increasing their usual contribution to climate change mitigation through LULUCF sector.

Lithuania's "Nitrate Action Plans under the Nitrates Directive" requires livestock farmers not only to store manure and slurry in special storage vessels but "in order to reduce GHG emission, also there are established requirements for slurry storage covering and slurry speeding technology".

Many other Member States who did not explicitly report on the Nitrous Directive relevance, have referred to the standards set in the directive such as the limit on use of livestock manure to 170 kg N per hectare per year.

Water Framework Directive

The Water Framework Directive was mentioned among others by Lithuania ("Programmes of measures within River Basin Management Plans, as required under the Water Framework Directive") with relevance to water protection measures and strong links to the Nitrates Directive presented above. Apart from pollution reducing measures a link to climate mitigation can be made when the role of the Water Framework Directive in protecting wetlands and general flood and drought prevention are considered. In general, river basin management is linked to climate adaptation activities to minimize direct and indirect pressures of climate change on Europe's water bodies (EC, 2009)[56].

[54] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, OJ L 140, 5.6.2009, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009D0406

[55] Nitrate-vulnerable zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution

[56] EC (2009) Common Implementation Strategy - Guidance document No. 24 River basin management in a changing climate, http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

INSPIRE Directive

Lithuania and Spain mentioned the INSPIRE directive among the policies reported under Article 10. While Spain did not provide further details, Lithuania described its ways of implementing the directive, although with no sign of going beyond the minimum legal requirement. It should be noted however that INSPIRE directive has a potential to improve LULUCF data accuracy and availability, and therefore help to pursue the LULUCF mitigation potential (the importance of alignment of the existing spatial data source in this respect is addressed in section 5.1).

Renewable Energy Directive

Article 4 of the Renewable Energy Directive (2009/28/EC) puts an obligation on the EU Member States to draw up National Renewable Energy Action Plans setting out their respective national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, taking into account, among others, national policies to develop existing biomass resources and mobilise new biomass resources for different uses. For their bioenergy components, the National Renewable Energy Action Plans are therefore considered among LULUCF relevant policies by several Member States, namely Austria, Estonia, Lithuania, Romania, Slovenia, and Spain.

The action plans do not guarantee that the predicted use of biomass will take place within the time given, and quickly become outdated. They do however increase transparency of Member States actions in the area of renewable energy. Transparency, together with more clarity on practicalities of the actions (e.g. sources of funding) facilitate monitoring of Member States' progress to meet the national targets set in the Renewable Energy Directive, and create a positive signal for investors (Kampman et al., 2015)[57].

Bioenergy is now one of the most important sources of renewable energy in the EU, accounting for around 50% of the total renewable energy generated. However, there have been concerns raised over the sustainability (from a GHG perspective) of using this biomass to produce energy, particularly as a result of the delay in re-sequestering the carbon emitted through combustion. This has led the Commission (in 2016) to propose sustainability criteria for the use of biomass in generating heat and power under the proposed revised renewable energy Directive (COM/2016/0767)[58].

Common Provision Regulation

The so called Common Provision Regulation (Regulation No 1303/2013)[59] was reported among the policies supporting the LULUCF measures by Estonia and Lithuania. The reports indicate that the thematic objectives to which the European Structural Investment (ESI) Funds

[57] Kampman, B., Sina, S. et al. (2015), Mid-term evaluation of the Renewable Energy Directive A study in the context of the REFIT programme, CE Delft, https://ec.europa.eu/energy/sites/ener/files/documents/CE_Delft_3D59_Mid_term_evaluation_of_The_RED_DEF.PDF

[58] Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast), COM(2016) 0767 final, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016PC0767

[59] Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006, OJ L 347, 20.12.2013, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1303

support should be directed, and climate relevant thematic objectives in particular, contribute to LULUCF actions. This contribution is described in a context of a wider EU policy goal of mainstreaming 20% of EU budget to climate action in the 2014-2020 programming period. Estonia, for instance, uses the Cohesion Fund support available for restoration of contaminated sites and water bodies to restore its exhausted and abandoned peatlands as well as drained peatlands (Box 3). It should be noted that the climate mainstreaming goal pursued through, among others, the thematic objectives applies also to the EAFRD (one of the five ESI Funds).

Box 3 Cohesion Fund and LIFE programme support to restoration of water regime on abandoned and exhausted peatlands in Estonia

In Estonia, there are some 2000 ha of exhausted and abandoned peat extraction sites from Soviet times. Cut off from water sources and deprived of vegetation layer, such sites emit GHG. With the support of the EU Cohesion Fund (over 5 mln € between 2014 and 2017), Estonia has undertaken an effort to restore the water regime in all the exhausted and abandoned peat extraction sites so that they can be replaced with bogs or forest. Deposition of peat has stopped due to drainage in two thirds of the nearly one million hectares of Estonian mires. When organic matter in these drained areas decomposes, it emits GHG. Such drained mires represent the second most important source of CO_2 emissions in Estonia (industry is first). The actual annual increment of peat is so small that peat is regarded in Estonia as a non-renewable resource. Despite this, cut off peatlands with exhausted peat reserves require restoration as the processes of self-recovery through paludification are very slow. Estonia mentions however that the existing methods of restoration through paludification are time-consuming and expensive, and could be improved.

Apart from the Cohesion Fund, the peatland restoration initiatives in Estonia are supported also through the LIFE programme which supports the LIFE Peat Restore project (Figure 1)[60].

Figure 1 Open fen area with moderate drainage impact in the northern part of the Läänemaa Suursoo mire complex in Estonia.

photo Raimo Pajula (LIFE Peat Restore project)

[60] Life Peat Restore project website: https://life-peat-restore.eu/en/

4.4.2 LIFE

Apart from the EAGF and EAFRD, LIFE is mentioned in Article 10 reports as an EU programme supporting LULUCF actions in the Member States. The LIFE programme supports environmental, nature conservation and climate action projects throughout the EU.

According to the LIFE Regulation, LIFE Environment (LIFE's sub-programme) supports among others "activities for forest monitoring and information systems, and to prevent forest fires" under its Priority area "Environment and Resource Efficiency"[61]. Under the Priority area "Climate Change Mitigation", LIFE contributes among others to the development and implementation of policies related to LULUCF, including conservation of natural carbon sinks.

LIFE-supported measures have been reported by Greece, Bulgaria and Lithuania. Greece refers to the two ongoing and one recently ended projects: "Olive-Clima", "Climatree", and "FoResMit"[62]. The "Climatree" project for instance, led by Institute of Urban Environment and Human Resources at the Panteion University in Athens aims to contribute towards the development of a novel methodology for CO_2 balance of tree cultivation and creation of an innovative tool for the quantification of carbon storage in permanent tree-crops"[63]. The project's main outputs will include a "software permitting estimates of CO_2 balance under different conditions (land use scenarios, cultivation methods etc.)"[64]. The project was launched in 2015 and will be running until 2019; its developers hope it will provide "substantial contribution towards more informative agriculture and climate policies at the regional, national and EU level, maximize mitigation potential of the agricultural sector by identifying best tree-crop management practices, and attempt an ecosystemic approach to tree crop cultivation".

Bulgaria notes the use of both LIFE and LIFE+ (LIFE predecessor, operating between 2007 and 2013) funds to support its biodiversity-related LULUCF actions, dedicated mostly to the preservation of forested habitat including wetland.

4.4.3 Other policy instruments

National legislation

The reported national legislation other than EU law implementation measures, is predominantly concentrated on forestry sector. For instance, the UK has adopted a new forestry standard defined as a "revised national standard for sustainable forest management to include a new guideline on climate change, covering both adaptation and mitigation". In agriculture, CAP regulations prevail indicating that national LULUCF actions are defined and often limited to the rules (and budget) established at the EU level. Regulatory approach at national level reaching beyond CAP ambitions remain therefore an option for the Member States willing to increase the GHG emission reduction and carbon sequestration from LULUCF sector.

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[61] Annex III Regulation (EU) No 1293/2013 of the European Parliament and of the Council of 11 December 2013 on the establishment of a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EC) No 614/2007, OJ L 347, 20.12.2013, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2013.347.01.0185.01.ENG

[62] Olive-Clima LIFE11 ENV/GR/000942, Climatree - LIFE14 CCM/CG/000635, and Foresmit LIFE14 CCM/IT/000905

[63] Climatree project website: https://www.lifeclimatree.eu/english/the-project/

[64] Bithas, K. Climatree project PPT presentation at the Workshop on "Climate Action in Agriculture and Forestry" taking place on 01.06.2017, https://ec.europa.eu/clima/events/articles/0116_en

Fiscal instruments

Fiscal and other market-based instruments are reported by several Member States. France for instance introduced a "Forest investment tax incentive scheme" that encourages forest owners to adopt a sustainable management approach, including grouping of the owners into producer organizations to become eligible to a higher tax reduction rate. The objective of the scheme is to improve forest management, with "multiple benefits such as reduced under-exploitation of certain forests, better resilience to storm risk, but also greater mobilization of timber".

Bulgaria works on developing financial incentives for activities to establish new forests through tax incentives. It is a part of Bulgaria's Third National Action Plan on Climate Change for the period 2013-2020 implementation.

Sweden's carbon dioxide tax and energy tax are considered by Sweden to influence demand for forest raw materials for energy supply and construction purposes, and indirectly impact forestry's fluxes of GHG gases. Ireland also applies a carbon tax on gas and liquid fossil fuels.

The examples presented here show how taxation can promote afforestation and demand for biomass to replace emission-intensive resources. It is widely recognized that fiscal instruments can be an important driver of climate action (IMF, 2011)[65], including measures pursuing LULUCF mitigation potential. Their potential seems however still underexploited as they focus almost exclusively on carbon taxes incentivizing substitution of fossil fuels by biomass.

Voluntary initiatives

Member States report the use of diverse voluntary activities pursuing the LULUCF mitigation potential. These activities range from information campaigns, stakeholder coordination, sustainable forest certification, to good practice codes and carbon registries.

The UK reports an implementation of a Voluntary Code and an associated carbon registry for UK domestic woodland carbon schemes to encourage private sector funding for woodland creation projects.

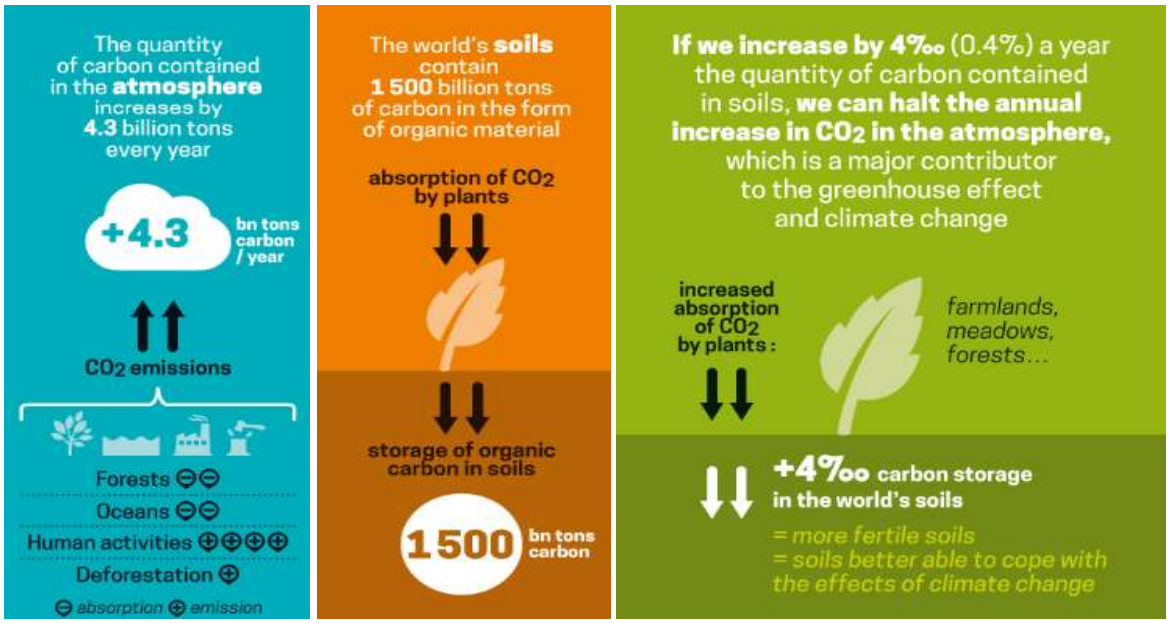
Sweden mentions the voluntary third-party certification schemes: the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC), relevant to the sustainable forest management and the associated carbon sequestration and GHG emission reduction impacts.

Spain and France refer to the "4 for 1000" initiative that aims to demonstrate that agricultural soils are crucial to food security and climate change. The initiative achieves its aim through research and stakeholder engagement in a "transition towards a productive, resilient agriculture, based on a sustainable soil management"[66]. Figure 9 below is the initiative's presentation of links between soils and CO_2 emissions.

[65] IMF (2011), "Promising Domestic Fiscal Instruments for Climate Finance", Background Paper for the Report to the G20 on—Mobilizing Sources of Climate Finance, https://www.imf.org/external/np/g20/pdf/110411b.pdf

[66] More about "4 per 1000" initiative can be found on the official 4‰ website: http://4p1000.org/understand

Figure 9 "Carbon sequestration in soils for food security and the climate", 4 per 1000 initiative infographic



Source: 4 per 1000

5 Methods to determine land use and GHG emission estimates

The overview of Article 10 reports showed very little information regarding the methodologies for land use and GHG emissions determination applied by the Member States. In order to respond to the research questions guiding this study, other sources of information have been consulted, namely the most recent metadata based on the 2016 National Inventory Reports submitted under the UNFCCC.

5.1 Land use determination

A recent study by Schmid et al. (2017)[67] examined the quality and quantity of information sources that EU Member States use to compile their land area information for cropland management and grazing land management under the UNFCCC reporting. These findings are relevant only to a part of the LULUCF land use accounting categories, yet they offer a good insight into the approaches taken by the Member States to land use determination.

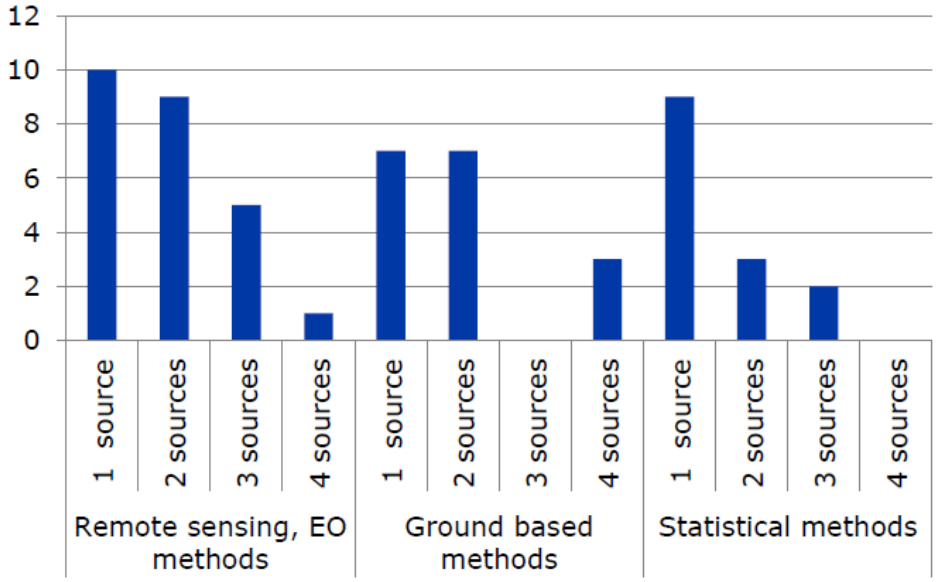
Schmid et al. (2017) notes that:

> "many Member States use not only different methods, but also they combine several sources. Remote sensing/Earth observation (EO) methods (e.g. satellite images, orthophotos) are the most frequently used when it comes to derive land area information, for both cropland management and grazing land management, followed by ground based methods (e.g. field inventories and surveys). This information is often complemented with additional statistical information (e.g. national agricultural statistics) and sometimes even with expert judgments (used in two Member States)."

Figures 10 and 11 below show the distribution of the methods used by the EU Member States to collect land area information relevant to cropland and grazing land management as reported in the 2016 NIRs. This combination of data sources and types serves to illustrate that there are few if any single dataset/sources that can provide the information needed to accurately report on changes in land use and management relevant to LULUCF reporting obligations.

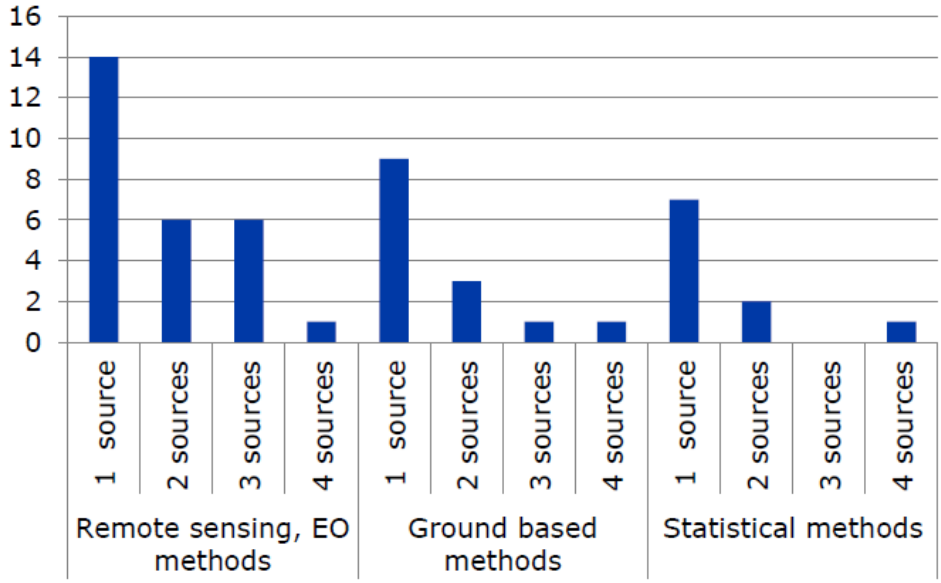
[67] Schmid et al. (2017), Aggregated results of the evaluation of Member State reporting systems for cropland and grazing land management, prepared for DG CLIMA of the European Commission+

Figure 10 Sources of land area information relevant to cropland management



Source: Schmid et al. (2017)

Figure 11 Sources of land area information relevant to grazing land management



Source: Schmid et al. (2017)

These findings show that 26 Member States mention the use of spatially explicit (geographic) data in their NIRs[68]. This number is limited to reporting on cropland and grazing land management activities, and includes a range of sources such as CORINE land cover data, maps

[68] (with the exception of Greece, and possibly also Poland – as the latter country did not provide the relevant information)

based on aerial photos, satellite images, orthophotos[69], military topographic maps, cadaster, and IACS/LPIS.

An overview of monitoring approaches for representing land use and land use change used by the Member States is also examined in a study by ICF published in 2016[70]. This study takes 2015 NIR submissions into account and notes:

> "Usually data used for estimating land use changes are statistics from *in situ* surveys, especially for forests (i.e. data from the National Forest Inventory), but some MS also use remote sensing based techniques, such as aerial photographs and satellite images. For grassland and cropland, many Member States use data from the Farm Structure Survey (FSS) and the EU Land Parcel Identification System (LPIS), as well other agricultural data collected in the framework of the CAP [ ]. The CORINE land cover database is used by several Member States. Most Member States have used an approach based on land use sampling, in which fixed points are revisited (in the field, as done in the LUCAS survey) or using aerial photographs, and changes in land use can be determined. Often the National Forest Inventory sample points are used. The benefit of the approach is that the observed land use change has a low uncertainty, which in a grid based approach is not always the case, as grids might have been classified differently among two maps in time. However, for a good coverage of the total area of a country, many sample points are required."

Both the Schmid et al. (2017) and Olesen et al. (2016) studies point to the application of Land Parcel Identification System (LPIS) in LULUCF reporting. Member States have been required to develop a LPIS to support the Integrated Administration and Control System (IACS) for the management and control of CAP payments to farmers operated by the EU Member States; regulatory requirements on it have been in place since 1992. Member State LPISs are IT systems recording all agricultural parcels in the Member States declared by farmers for CAP payments. As a spatially explicit tool for land use data collection, LPIS represents an advanced source of information as compared to the statistical or other not-spatially explicit sources such as expert judgment.

A study by Weiss et al. (2015) identified 8 Member States using information from IACS/LPIS for cropland and grazing land reporting purposes in 2014. For 2016 Kyoto reporting, Schmid et al. (2017) found out that 16 Member States (AT, BE, BG, CZ, DK, ES, FI, FR, IE, LU, MT, NL, PT, SE, SI, UK) use LPIS for at least one of their land use activities relevant to cropland and grassland management. This suggests that **the number of Member State using LPIS for LULUCF reporting (relevant to cropland and grazing land) doubled in the space of two years**. This is a positive development, reflecting the opportunities for improved and more accurate reporting thanks to the use of relevant IACS/LPIS data, but it also shows that the use of this tool is not yet EU-wide, and that its use therefore appears to encounter some barriers.

Several studies address the potential of using IACS/LPIS - a critical CAP data source, for the purposes of developing and implementing climate mitigation policies, not just for cropland

[69] Ortho-rectified (corrected for distortion) images taken from airborne devices or satellites.
[70] Olesen, A.S., Lesschen, J.P. et al. (2016), op. cit.

and grazing management reporting. Based on Weiss et al. (2015) [71], Martineau et al. (2016) [72], JRC (2016)[73], and also (to a limited extent) ECA[74] (2015), a set of opportunities and challenges related to IACS/LPIS use for LULUCF reporting purposes have been found (Table 9).

Table 9 Opportunities and challenges of using IACS/LPIS for LULUCF reporting

Opportunities	Challenges
• Fine-grained spatially explicit land use data • Annual updates of the data • Relatively wide use by the Member States and familiarity with the system • Scalability (high level of semantic correspondence between the IPCC land use categories and LPIS land cover classes at an aggregated level) • Flexibility (different set ups depending on the Member State) • Cost-effectiveness gains as compared to (setting up of) a standalone system for LULUCF accounting	• Restricted access and sharing of IACS data (in some Member States LPIS data are not made public) • Long time series data (e.g. >10 years) may not be available in all Member States • IACS and LPIS systems have been developed for the purposes of managing CAP payments; and relevant agencies in some Member States may not be aware of the potential to exploit them for wider policy purposes • LPIS usually covers land eligible for CAP payments, and often only parcels for which CAP payments are claimed; gaps exist particularly in extensive grassland coverage and other parcels under Pillar I greening measures • Technical deficiencies in tracking land-use changes over time • Complexity of certain current rules/administrative burden for the Member States • Organisational barriers (some Member State paying agencies do not regard climate mitigation, and hence cooperation with authorities responsible for climate mitigation, as as a priority; some climate bodies do not regard land use as a priority area for mitigation policy)

Source: IEEP based on Weiss et al. (2015), Martineau et al. (2016), JRC (2016), and ECA (2015)

JRC (2016) provides a more in depth review of the opportunities to use LPIS for LULUCF reporting as compared to other spatially explicit land use data tools such as Land Use/Cover Area Frame Survey (LUCAS) and CORINE Land Cover. It also analyses the remaining challenges

[71] Weiss, P., Freibauer, A., et al. Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/EU, Task 3 of a study for DG Climate Action: 'LULUCF implementation guidelines and policy options', Contract No CLIMA.A2/2013/AF3338, Institute for European Environmental Policy, London.
[72] Martineau, H., Wiltshire, J. et al. (2016), op. cit.
[73] Bertaglia, M., Milenov, P., et al. (2016), Cropland and grassland management data needs from existing IACS sources, contract no 071201/2013/664026/CLIMA.A.2, JRC - Ispra
[74] ECA (2016), The Land Parcel Identification System: a useful tool to determine the eligibility of agricultural land – but its management could be further improved, http://www.eca.europ a.eu/Lists/ECADocuments/SR16_25/SR_LPIS_EN.pdf

to improve and adapt the LPIS for the purposes of LULUCF accounting, noting that technical issues are easier to address than legal or other implementation challenges. In this review JRC found that while IACS/LPIS does not offer "off-the-shelf data availability for the purposes of LULUCF accounting" it is "the best option to cater for UNFCCC and KP reporting and accounting data needs" provided the scope of data collected through LPIS is widened and is complemented with other datasets in order to ensure the full scope of LULUCF reporting is covered.

Based on the four studies mentioned above, the following recommendations for a more effective use of LPIS in contributing to LULUCF reporting and decision-making, consistent with its primary purpose of ensuring the regularity of CAP payments, can be formulated:

- Member States should be encouraged and allowed to consider broadening the scope of information collected under LPIS to integrate other Earth Observation system information necessary for LULUCF reporting; and to allow more consistent time series, particularly where this represents a cost-efficient means of meeting CAP needs and climate policy needs simultaneously;
- LPIS/IACS time series updating should be designed so as to facilitate data transfer to NIR reporting;
- LPIS data allow for the identification and registration, and then effective monitoring, of ecological focus areas, permanent grassland and other categories of land; the potential benefit for LULUCF reporting should be more effectively exploited;
- Member States should consider broadening the scope of LPIS recorded data beyond the parcels relevant to CAP payments (enabling the evolution of LPIS into a new land monitoring system with new functionalities);
- As noted above, 16 Member States now make use of at least some LPIS data for LULUCF reporting purposes. Access to and sharing of the LPIS data should be further improved, e.g. access granted to the inventory agencies, RDP evaluators, and LULUCF reporting bodies, or open public access to key geospatial data. Where barriers are identified, appropriate legal changes (see last bullet point) should be considered, in line with the INSPIRE Directive, while bearing in mind the impact of data protection requirements on implementation of the CAP.
- Competent authorities should be encouraged to archive LPIS geospatial data for longer periods, beyond the current minimum requirement, in the light of potential benefits in understanding changes in LULUCF sinks and emissions;
- While the CAP legal basis and objective of the LPIS remains relevant, where Member States identify any legal constraints to wider use and functionality of LPIS data, relevant changes should be considered in CAP legislation; and Member States should be encouraged to make use of the resulting flexibilities.

The above mentioned recommendations could be implemented, to a large extent under the remit of the INSPIRE Directive at the EU level, with support provided to Member States for implementation. This may necessitate a more fundamental change in the way land use information is reported and collected within Member States, combining existing inventory and geospatial sources to facilitate such a change, including other Earth Observation tools

and programmes such as Copernicus or LUCAS[75]. The role of such tools and programmes would not be to replace LPIS, which has a specific function in support of CAP payments, but to ensure its better integration into a more holistic mechanism to track and report land use information at the Member State level.

Copernicus is an EU programme managed by the European Commission with a "full, free, and open" data policy aimed at developing European information services based on satellite Earth Observation and in situ (non-space) data[76]. The potential use of Copernicus "Sentinels" (high resolution image time series) offering "unprecedented" frequency and capacity of land use monitoring, are particularly promising in terms of adding or enhancing LPIS functionalities. Additionally, LPIS could benefit from the products of LUCAS which is an in situ observation survey managed by Eurostat aimed at providing harmonised and comparable statistics on land use and land cover across the whole of the EU's territory[77]. One recent inclusion into the LUCAS survey is data on top soil characteristics, which could help to monitor better the change in soil carbon and structure from a climate change perspective.

An alignment of the three systems granting wider (possibly public) access to spatial data would be a step towards a better implementation of the INSPIRE directive[78] that aims at consolidating EU's spatial data infrastructure for the purpose of EU environmental and related policies. It would also be in line with the European Commission's Better Regulation guidelines[79], thanks to avoiding duplication and unnecessary data collection burden. The proposed LULUCF Regulation recognizes this opportunity for the post 2020 period, but technical and legal barriers remain to be addressed before improved data collection and methodologies can be put in place. Member States should be therefore encouraged and supported so that the synergic potential of the existing land use databases is exploited to the greatest possible extent.

5.2 GHG emissions and removals estimates

A vast majority of Article 10 reports do not include any information about the methodologies applied to estimate GHG emissions and removals by LULUCF. This information should be provided in the NIRs submitted by the EU Member States under the UNFCCC, although in practice this is not always done in fully transparent and comprehensive ways[80].

The UNFCCC submissions, based on IPCC guidance, distinguish between three different approaches ("tiers") to estimating GHG emissions from LULUCF sector (see Box 4 below). As set out in the LULUCF Decision, the use of Tier 1 is a minimum requirement, and the Member

[75] JRC (2016), Towards Future Copernicus Service Components in support to Agriculture? Concept note. https://ec.europa.eu/jrc/sites/jrcsh/files/Copernicus_concept_note_agriculture.pdf
[76] Copernicus website: http://www.copernicus.eu/main/overview
[77] Eurostat website:
LUCAS - Land use and land cover survey: http://ec.europa.eu/eurostat/statistics-explained/index.php/LUCAS_-_Land_use_and_land_cover_survey
[78] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), OJ L 108, 25.4.2007, p. 1–14
[79] EC (2017), Better Regulation Guidelines – Commission's Staff Working Document SWD(2017)350, https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines.pdf
[80] Schmid et al. (2017), op.cit.

States are encouraged to apply higher tiers (Tier 2 and Tier 3) which are more country-specific, and considered to provide more robust and accurate estimates than Tier 1.

Box 4 IPCC's three-tier approach to estimating LULUCF GHG emissions and removals

In the Guidelines for National Greenhouse Gas Inventories (2006)[81], IPCC explains its framework of tier structure in following terms:

"**Tier 1** methods are designed to be the simplest to use, for which equations and default parameter values (e.g., emission and stock change factors) are provided in this volume. Country-specific activity data are needed, but for Tier 1 there are often globally available sources of activity data estimates (e.g., deforestation rates, agricultural production statistics, global land cover maps, fertilizer use, livestock population data, etc.), although these data are usually spatially coarse.

Tier 2 can use the same methodological approach as Tier 1 but applies emission and stock change factors that are based on country- or region-specific data, for the most important land-use or livestock categories. Country-defined emission factors are more appropriate for the climatic regions, land-use systems and livestock categories in that country. Higher temporal and spatial resolution and more disaggregated activity data are typically used in Tier 2 to correspond with country-defined coefficients for specific regions and specialized land-use or livestock categories.

At **Tier 3**, higher order methods are used, including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national level. These higher order methods provide estimates of greater certainty than lower tiers. Such systems may include comprehensive field sampling repeated at regular time intervals and/or GIS-based systems of age, class/production data, soils data, and land-use and management activity data, integrating several types of monitoring. Pieces of land where a land-use change occurs can usually be tracked over time, at least statistically. In most cases these systems have a climate dependency, and thus provide source estimates with inter-annual variability. Detailed disaggregation of livestock population according to animal type, age, body weight etc., can be used. Models should undergo quality checks, audits, and validations and be thoroughly documented."

The analysis of the 2016 NIRs conducted by Schmid et al. (2017) shows a distribution of the tiers reported for all mandatory pools in cropland management (CM) and grazing land management (GM) (Table 10 and 11).

[81] IPCC (2006), IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4 Agriculture, Forestry and Other Land Use, chapter 1, http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

Table 10 Number of Member States reporting Tier 1, 2, or 3 or a combination of thereof per UNFCCC carbon pool categories in cropland management

Tier / Pool	T1	T2	T3	T1&T2	T1&T3	T2&T3
Above ground biomass	7	9	1	5	0	0
Below ground biomass	2	7	1	1	0	0
Litter	9	2	0	0	0	1
Dead wood	4	2	1	0	0	0
Mineral soil	4	6	4	5	1	2
Organic soil	11	4	0	0	0	0

Source: Schmid et al. (2017)

Regarding tier information under cropland management category Schmid et al. (2017) notes:

> "It can be seen that Tier 1 is still widely applied in litter, dead wood and organic soils. For litter and dead wood Tier 1 means in general that "NO" [not occurring] was reported, as this is the IPCC default assumption (no change in carbon stocks). Litter and dead wood play a rather minor role in CM/GM systems and we therefore did not put emphasis on these pools. On the other hand, organic soils can be a significant pool and so the application of a Tier 1 method can be seen as problematic. However, the use of Tier 1 is often a result of lacking information on organic soils (areas and emission factors). For mineral soils Tier 1 is only applied in 4 Member States, so in most Member States there is already some country specific information available (e.g. country specific soil carbon stocks). The majority of Member States apply higher Tiers for carbon stock changes for above and below ground biomass. This includes mainly perennial biomass, for which many Member States have gathered detailed information through national studies or statistics. For below ground biomass the picture given below might be a bit misleading, as it is often reported as IE (included in above ground biomass)."

A similar picture has been observed in grassland management accounting category (Table 11).

Table 11 Number of Member States reporting Tier 1, 2, or 3 or a combination of thereof per UNFCCC carbon pool categories in grazing land management

Tier / Pool	T1	T2	T3	T1&T2	T1&T3	T2&T3
Above ground biomass	12	6	1	3	1	0
Below ground biomass	3	5	2	2	0	0
Litter	7	2	0	1	0	1
Dead wood	1	3	0	0	0	1
Mineral soil	6	10	3	2	1	2
Organic soil	7	5	0	0	0	0

Source: Schmid et al. (2017)

Overall, Schmid et al. (2017) findings show that at EU-28 level, agricultural land reporting is still mainly driven by the most basic, Tier 1, method consisting on a multiplication of rough activity data by a default emission factor. The same tendency, just with a wider scope i.e. covering all main land accounting categories, has been observed by Martineau et al. (2016), based on the 2014 NIRs. Moreover, Schmid et al. notes that the NIRs do not provide sufficiently transparent information to explain the choice of the applied tiers.

As explained in Box 4 above, Tier 2 and Tier 3 methods are more complex than Tier 1 as they require more detailed information and relevant expertise of those who apply them; for this reason they are also more costly than Tier 1. The Member States tend to use higher tiers when reporting on pools for which there is some country-specific information available. The **availability of accurate and up-to-date information seems therefore critical for improving technical accuracy of LULUCF GHG emissions and removals estimates**. This observation has been already made in previous studies; Martineau et al. (2016) note for instance:

> "(…) it is not only the methodology tier, and/or the availability and accuracy of emission factors that influence the ability to account for mitigation, but also the availability and accuracy of activity data. For example, data on land use may be collected infrequently (perhaps at 5 or 10 year intervals), but there may be good methods and emission factors for estimating GHG emissions from some types of land use change. The methods may be Tier 3 methods and the category of emissions may be a key category, but there will be poor emissions estimates if the activity data is incorrect."

This conclusion naturally links to the opportunities presented by the **use of spatially explicit land use information tools, such as IACS/LPIS and Copernicus** (addressed in section 5.1 of this study). The vast potential for improved data collection and use in this area should however be considered together with the high level of uncertainty inherent to LULUCF emission and removal estimates. As noted by Olesen et al. (2016), with regards to highly uncertain pools like soils:

> "LULUCF uncertainty cannot necessarily be circumvented by using higher Tier methods, because it is inherent in the nature of some pools as well as the limited possibilities of assessing their C stock changes. The application of three independent Tier 3 methods in Sweden and Finland (two models and a country-wide soil monitoring project) did not provide clear results for the short-term soil C stock changes (Rantakari et al. 2012, Ortiz et al. 2013). Outputs of all three methods included both emissions and removals across time, but country-wide soil C stock changes cannot be measured in the short term due to the destructive nature of soil sampling (preventing reassessment of the same soil cores) and to the high variability of the C stocks per site. A distinct and accurate result for soil needs a few decades of time between the reassessments, as well as an extremely high number of samples."

The negative impacts of uncertainty on the robustness and accuracy of GHG emissions and removals estimates for LULUCF sector may be therefore addressed to some extent by **frequent data collection and monitoring over long time periods.** This does not necessarily imply annual reporting and accounting of LULUCF GHG impacts, nor close-to-the-reported year submissions (Olesen et al., 2016). This means however that some initial investment in the data collection and management methods (including improvements of accuracy, access

to and availability of spatially explicit land use data, see section 5.1), as well as continuous and consistent application of such methods in the long term should be put in place in order to minimize the uncertainty added by inventory methodologies to the inherent uncertainty of the GHG emissions and removals by LULUCF.

6 Mitigation potential, cost-effectiveness and possible enhancement of the reported LULUCF actions

6.1 Mitigation potential

Most Member States did not provide any quantitative estimates of their LULUCF measures' impacts on GHG emissions and removals. They justified this in most cases by reference to a lack of robust data and/or the high variability of conditions influencing the measures' overall impacts. It is therefore impossible, based on Article 10 reports, to provide an aggregated EU-28 impact of the reported measures in terms of the GHG removals and emissions. The main reason behind the lack of GHG emission impacts of the measures included in Article 10 reports may stem from the fact that the mitigation potential within the LULUCF sector is generally not well known. As a sector with both emissions and removals, with many different stakeholders and land owners, and where activity is influenced by many policy fields (e.g. agriculture, environmental, land use planning) and market developments, the estimates of mitigation potentials are very uncertain, especially due to the uncertainty in the uptake of the measures. Several studies have made estimates of the mitigation potential at EU level for the entire LULUCF sector for the agriculture and forestry sectors.

The EUCLIMIT modelling work, which was used for the impact assessment of the LULUCF proposal, estimates the mitigation potential for afforestation and agricultural land, including additional mitigation enhanced at a carbon price of €20/ton, at 95 Mton CO_2-eq/year for the period 2021-2030. This is without any credits from forest management.

The meta-review study of the potential mainstreaming of climate action in the current Common Agricultural Policy (CAP) framework (Martineau et al., 2016) examined a broad range of existing literature, particularly studies and scientific articles. Of the 22 mitigation actions it assessed, 11 showed significant mitigation potential (each at least 500 kt CO_2eq/yr at EU level). Of these, eight were related to land use, land use change or crop production, and were focused on carbon sequestration. The CO_2 related feasible additional mitigation potential of these eight actions at EU level in 2030 was estimated to lie within the range of 26-56 Mt CO_2eq/yr.

In this chapter we estimate mitigation potentials for the LULUCF sector, based on a top-down approach, for which we use current reported emissions in GHG inventories, and estimates of mitigation potential from individual countries or EU wide studies. This top-down analysis will consider EU-wide parameters for the sequestration potentially attributable to action in: reducing emissions from organic soils; mineral soils; forest management; afforestation; and avoiding deforestation. For each of these areas, we will identify the categories of actions mentioned in Member State Article 10 reports which appear to be most relevant, based on the list identified in the synthesis report (see Annex 1), and identify to the extent possible a bottom-up view on the available evidence of the mitigation potential per hectare from the Member State policies and measures. Table 12 below shows how the broad mitigation categories , for which we have identified top-down mitigation potential, relate to the policy and measure categories, for which we have tried to identify bottom-up sources for estimating mitigation potential.

Table 12 Categories of mitigation actions for which mitigation potential could be estimated (based on literature review)

Type of emissions mitigation	Relevant categories of policy and measure
Reducing emissions from organic soils	Biodiversity/nature conservation measures Nutrient, tillage, and **water** management Grassland, grazing land and/or pasture management
Carbon sequestration mineral soils	Biodiversity/nature conservation measures **Nutrient, tillage,** and water management Organic farming (Restoration of degraded land)
Forest management	Forest management Protection against natural disturbances/fire Conservation of carbon in existing forests Biomass for energy use Substitution of GHG intensive materials by HWP
Afforestation	Afforestation and reforestation Biomass for energy use
Avoiding deforestation	Conservation of carbon in existing forests Protection against natural disturbances/fire

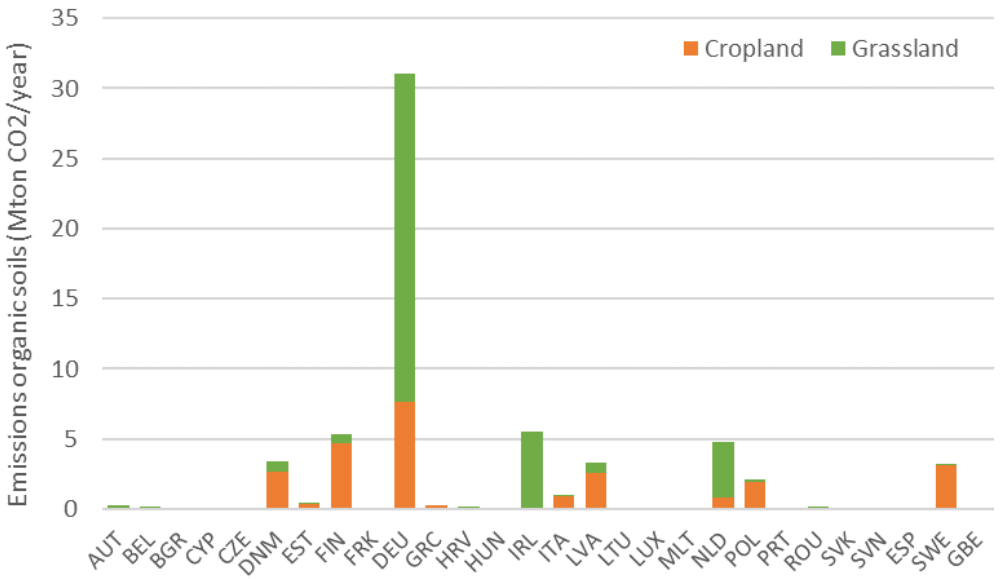
Source: WUR and IEEP, 2017

6.1.1 Reducing emissions from organic soils

For cropland and grassland the emissions from organic soils are the main emission source. Based on the latest reported GHG emissions (NIR, 2017[82]) the total emissions from organic soils under cropland (CRF Table 4B) amount 31 Mton CO_2 in 2015 (18.3 ton CO_2/ha/year) and under grassland (CRF Table 4C) 38 Mton CO_2 (16 ton CO_2/ha/year). These emissions are mainly occurring in Member States with large peat areas, which are located in North and NorthWest Europe (Figure 12).

[82] Countries annual inventory submissions to the UNFCCC include a national inventory report (NIR) and common reporting format (CRF). The NIRs contain detailed descriptive and numerical information and the CRF tables contain all greenhouse gas (GHG) emissions and removals, implied emission factors and activity data. As a party to the UNFCCC the EU also submits a NIR and CRF table, based on aggregated information and data from the NIRs and CRFs of its member states.

Figure 12 Emissions from organic soils under cropland (only cropland remaining cropland) and grassland (only grassland remaining grassland) per Member State in 2015



Source: EU NIR 2017

The main option to reduce these emissions is **to elevate the groundwater level in order to reduce the oxidation of the organic material**. This can be done either by technical measures or through increasing the water level and extensification[83] of the land use. One of the technical options is the use of submerged drainage, which still allows for agricultural activities, but reduces emissions. The conversion of agricultural into nature or paludiculture is a more effective option, but also has a larger impact and might be more appropriate in areas where land is cheaper and less intensively used.

As mentioned in the synthesis report, several Member States consider or have already policies for the conversion of arable land on organic soils to nature or grassland, e.g. Denmark, Luxembourg, Latvia, and Germany. However, a quantification of the mitigation potential is mostly not provided. Latvia reported for instance that "conversion of 1 ha of cropland to grassland considering 5.2% share of organic soils [in Latvia] would reduce CO_2 emissions by 0.3 tonnes CO_2 ha^{-1} annually".

For cropland on organic soils a land use conversion to extensive grassland or nature would be the most relevant option, as the cropland area on organic soils is relatively small, only about 1.3% of the total cropland area, whereas emissions from that land are very high. We assumed that half of this land could be taken out of production or converted to more extensive grassland use. This could result in an emission reduction of about 12 Mton CO_2-eq per year (assuming emissions are reduced by 75% after conversion). A first analysis for the Netherlands[84] shows that the use of submerged drains and raising water levels for grassland

[83] Extensification of land use is the opposite of intensification. It is the process of decreasing the use of capital and inputs such us fertilisers, stocking densityor mechanic interventions relative to land area.

[84] Van den Born et al., 2016, Dalende bodems, stijgende kosten. Planbureau voor de Leefomgeving. Den Haag (http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2016-dalende-bodems-stijgende-kosten-1064.pdf)

areas with deep drainage could reduce emissions from organic soils by 1-2 Mton CO_2 per year, which would be a reduction of about 35%. Extrapolating this reduction to all grassland under organic soils in the EU would lead to a potential mitigation of about 13 Mton CO_2 per year.

In addition N_2O emissions from cultivated organic soils, which are reported under the sector Agriculture, will be reduced as well if measures are taken. These emissions are currently reported at 13 Mton CO_2-eq per year (EU NIR 2017) and could be reduced by 4.7 Mton CO_2-eq (36%, which is the same reduction percentage as for CO_2). Consequently a total mitigation potential of about **30 Mton CO_2-eq/year** would be possible for organic soils under grassland and cropland.

Detailed assessment of relevant policies and measures

Biodiversity and nature conservation			
Activities reported	GHG Impact –based on literature review	Abatement/Sequestration	NIR category
Subsidies for the conversion of arable land on organic soils to nature	Restoration of wetlands helps to reduce GHG emissions from decomposition of peat and restoring the natural water table of drained wetlands. With an increased water table in organic, carbon-rich soils, accumulation of organic substances is greater than the decomposition, which facilitates the conservation and accumulation of peat and reduces the carbon release from these soils (Frelih-Larsen *et al.,* 2014)	Large potential in the correct circumstances with a mitigation potential range for restoration of wetlands is 3.1 to 7.8 t CO_2eq/ha/yr (Frelih-Larsen et al., 2014)	Cropland converted to Wetland
Rehabilitation of moorland and restoration of wetlands, protection of bogs	The relationship between wetlands/peatlands and GHG emissions is complex. The fluxes of CO_2, CH_4 and N_2O vary depending on the condition and hydrological status of the wetland. The amount and type of GHG emissions depend on the water saturation in the soil, climatic conditions and the nutrient availability. The drainage of wetlands and peatlands exposes organic carbon to the air, decomposition of the organic material occurs and emits CO_2.	Restoration of wetlands helps to reduce GHG emissions from decomposition of peat and restoring the natural water table of drained wetlands. With an increased water table in organic, carbon-rich soils, accumulation of organic substances is greater than the decomposition, which facilitates the conservation and accumulation of peat and reduces the carbon release from these soils	Wetlands remaining Wetlands

	Drained organic soils with low water tables continue to degrade and to emit CO_2, until either drainage is reversed or all peat is lost. Saturated soils however create anaerobic conditions and can release CH_4 (Martineau et al., 2014).	(Frelih-Larsen et al., 2014).	
Initiatives to limit consumption of peat in horticulture	Indirect – it is not clear how this demand based initiative will reduce the impact on peat extraction	Conservation of existing carbon stock	Wetlands
Protection and management of the Natura 2000 network	Indirect - Protection is likely to preserve carbon stocks that might otherwise be lost	Conservation of existing Carbon Stock	Wetlands, Grassland, Forest Land, Cropland
Maintenance of biodiversity in grasslands	Reduced CO_2 and N_2O emissions (LV Article 10 report)	Conversion of 1 ha of cropland to grassland considering 5.18% share of organic soils would reduce CO_2 emissions by 0.3 t/CO_2/ha/yr (LV Article 10 report)	Cropland converted to grassland

Nutrient, tillage, and water management[85]			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Converting cropland from annual tillage crops to perennial crops	Converting cropland to perennial crops such as grass can sequester and retain carbon	Martineau et al., estimated the range as 0.6 – 2.0 t/ha/yr of carbon sequestered	Crop land converted to Grass land
Development and adaptation of drainage systems in cropland	More studies are necessary to evaluate impacts,	Implementation of the measure in Latvia according to the tier 1 method will contribute to the net CO2 removals in soil –1.32 tCO_2/ha/yr	Cropland remaining cropland

[85] There is a wide range of activities reported under this heading with some having a direct effect and others with different primary objectives. Activities have multiple benefits for soil, nutrient and water management including reduced erosion, diffuse pollution and improving soil structure.

	particularly on non-CO2 gases, of the measure on the basis of scientific results	during 20 years' period after implementation (article 10 report)	

Grassland, grazing land and/or pasture management[86]			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Pasture Suitable for carbon storage	The prevention of cultivation on high Organic matter soil will maintain the carbon stock more effectively.	This activity reduced losses.	Grassland remaining Grassland
Preservation of HNV grassland	Prevention of grassland (without cultivation) will preserve the carbon stock.	Reduces carbon losses through cultivation.	Grassland remaining Grassland

[86] The article 10 reports describe a range of measures relating to grassland management and grazing. For the purposes of this assessment, intensification and grassland improvement measurers have been grouped together

6.1.2 Carbon sequestration in mineral soils

A range of mitigation measures exist to increase the carbon stocks in mineral soils. These measures can be categorised in three main groups:

1. Restrict the breakdown of organic matter (e.g. zero or reduced tillage)
2. Ensure supply of organic matter on the field (e.g. cover crops, incorporate crop residues)
3. Ensure supply of external organic matter (e.g. manure, compost and other organic material)

In the Article 10 reports many measures are mentioned, which were mainly clustered in the category Nutrient, tillage, and water management. However, hardly any quantification of the mitigation potentials is provided in these reports. A good overall study quantifying the potential for carbon sequestration in agricultural soils in the EU is still missing. There are several studies with some scenarios or estimates for individual management practices that provide some data. Lugato et al. (2014) came up with an estimate between 23.1 and 57.9 Mt CO_2eq per year by 2050 for arable land. Frank et al. (2015) estimated a soil organic carbon mitigation potential for European cropland between 9 and 38 MtCO_2 per year until 2050 for carbon prices between 10 and 100 USD/tCO_2.

According to the most recent data reported to the UNFCCC, mineral soils under cropland are a net source of 24 Mton CO_2 and grassland a net sink of 41 Mton CO_2eq. These emissions and sequestration are mainly related with land use changes, of which grassland to cropland and vice versa is the main land use change. Based on above mentioned literature, earlier work (PICCMAT project[87]) and modelling work with the RothC model (WUR, unpublished), the realistic maximum C sequestration potential for mineral agricultural soils is estimated at roughly **50 Mton CO_2/year** in the EU (excl. land use change and mitigation options for organic soils). Compared to other world regions, e.g. Africa, the potential is rather limited, as agriculture in Europe is already intensive with relatively high inputs from crop residues and manure. In addition, soils in North-West Europe are relatively high in C content, which makes it difficult to increase the sequestration effect.

Many biodiversity and conservation activities have a direct and positive impact on the protection of land based carbon stock or increasing sequestration,despite this not being the primary objective of the measures in most cases. The table below details the measures identified through the Article 10 reports and GHG impacts.

It should be noted that organic farming is included in 25 Article 10 reports. However, there is not enough detail to determine or quantify any mitigation effect resulting from this activity. Organic Farming in itself is not a mitigation activity although it is accepted that practices involved with organic farming may have GHG benefits.

Detailed assessment of relevant policies and measures

Biodiversity and nature conservation			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category

[87] PICCMAT (2008) Final Report - PICCMAT (Policy Incentives for climate change mitigation techniques). http://cordis.europa.eu/result/rcn/47726_en.html

Subsidies for the conversion of arable land on organic soils to nature	Restoration of wetlands help to reduce GHG emissions from decomposition of peat and restoring the natural water table of drained wetlands. With an increased water table in organic, carbon-rich soils, accumulation of organic substances is greater than the decomposition, which facilitates the conservation and accumulation of peat and reduces the carbon release from these soils (Frelih-Larsen *et al.,* 20	Large potential in the correct circumstances with a mitigation potential range for restoration of wetlands is 3.1 to 7.8 t CO_2eq/ha/yr Frelih-Larsen et al., (2014)	Cropland converted to Wetland
Shelter belt restoration	See Sustainable forest management		
Agroforestry measures	Agroforestry is the inclusion of trees with crop and/or livestock production systems. Good potential to sequester C in the soil and biomass produced.	There is a large range of sequestration potential reported ranging from 138kg C/ha/yr (Frelih-Larsen et al., 2014) to 6.5t C/ha/yr[88] (Aertsens *et al.,* 2013). ('the type of agroforestry systems and their capacity to sequester C vary globally' (Oelbermann *et al.,* 2004)	Cropland remaining Cropland and Grassland remaining Grassland
Support for the maintenance of pasture land	Retains carbon stock in grass. Younger grass swards will sequester carbon more rapidly, while stock change factors are reduced in grasses over 5 years.	Carbon stocks in grass vary significantly depending on climate, soil and management practice. Range between 50-175t/ha C at 30cm depth (Rees et al,. 2017 (unpublished)	Grassland remaining Grassland
Rehabilitation of moorland and restoration of wetlands,	The relationship between wetlands/ peatlands and GHG emissions is complex. The fluxes of CO_2, CH_4 and N_2O vary depending on the	Restoration of wetlands help to reduce GHG emissions from decomposition of peat and restoring the natural	Wetlands remaining Wetlands

[88] Experiments in Vézénobres (France, Mediterranean climate, sandy loam soil) indicate that poplars (140 trees/ha) of 13 years old have on average sequestered 540 kg C/tree in the trunk and 60 kg C/tree in the root system. This parcel has a potential of sequestering 6.5 tonnes C/(ha year) in the trees itself' (Aertsens *et al.,* 2013).

protection of bogs	condition and hydrological status of the wetland. The amount and type of GHG emissions depend on the water saturation in the soil, climatic conditions and the nutrient availability. The drainage of wetlands and peatlands exposes organic carbon to the air, decomposition of the organic material occurs and emits CO2. Drained organic soils with low water tables continue to degrade and to emit CO_2, until either drainage is reversed or all peat is lost. Saturated soils however create anaerobic conditions and can release CH_4 and N_2O. (Martineau et al., 2014)	water table of drained wetlands. With an increased water table in organic, carbon-rich soils, accumulation of organic substances is greater than the decomposition, which facilitates the conservation and accumulation of peat and reduces the carbon release from these soils (Frelih-Larsen et al., 2014).	
Sustainable forest management	See Forest Management Section		
Initiatives to limit consumption of peat in horticulture	Indirect – it is not clear how this demand based initiative will reduce the impact on peat extraction	Conservation of existing carbon stock	Wetlands
Protection and management of the Natura 2000 network	Indirect - Protection is likely to preserve carbon stocks that might otherwise be lost	Conservation of existing Carbon Stock	Wetlands, Grassland, Forest Land, Cropland

Nutrient, tillage, and water management			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Minimum or zero tillage systems	Where zero tillage does sequester C, the practice needs to be maintained as even	An area of some debate. Manley et al., (2005): 'Our statistical analyses of more than 100 studies and some 900 estimates suggest that, compared to CT (conventional till), ZT (zero tillage) seems to	Crop land remaining Crop land

	occasional cultivation can release the C sequestered in previous years.	sequester too little carbon at too high a cost to make this means of mitigating climate change an attractive alternative to emissions reduction. However, there are some exceptions where an effort to switch from CT to no till agriculture does lead to a low-cost carbon benefit'. The recent review by Buckingham et al., (2014) concluded that ZT will only sequester C in soils when crop yields are increased, e.g. by eliminating the need for fallow to conserve moisture and hence enabling a crop to be grown every year.	
Protecting arable mineral soils – essentially through intercropping, reduced till, no till systems	See reference to zero tillage systems above	See zero tillage. Minimum tillage and zero tillage systems may have some benefit in terms of reducing fuel usage in plough based systems	Crop land remaining crop land
Extensification of nitrogen fertilizing of selected arable crops	Reduce N_2O emissions. Activity mainly focused on water protection areas.	No firm evidence for C sequestration or reduced losses from information provided. No indication of the reduction in N application thresholds.	Agricultural Soils
Leaving crop residues in field and/or banning stubble/residue burning	Carbon will increase due to the addition of residues	Very difficult to quantify and wide ranging depending on the crop. Estimates between 0.03 and 0.6 t/yr/ha carbon sequestered were used (Martineau et al., 2014)	Crop land remaining crop land
Converting cropland from annual tillage crops to perennial crops	Converting cropland to perennial crops such as grass can sequester and retain carbon	Martineau et al., estimated the range as 0.6 – 2.0 t/ha/yr Carbon sequestered	Crop land converted to Grass land

Support to introduction and promotion of integrated horticulture	More studies are necessary to evaluate the impact on emissions of the non-CO2 gases and carbon stock change in soil due to change of the management system	Implementation of the measure in Latvia according to the tier 1 method will contribute to the net CO2 removals in soil –8.9 t/CO_2/ha/yr during 30 years' period. (Article 10 report)	Cropland remaining copland

6.1.3 Forest management

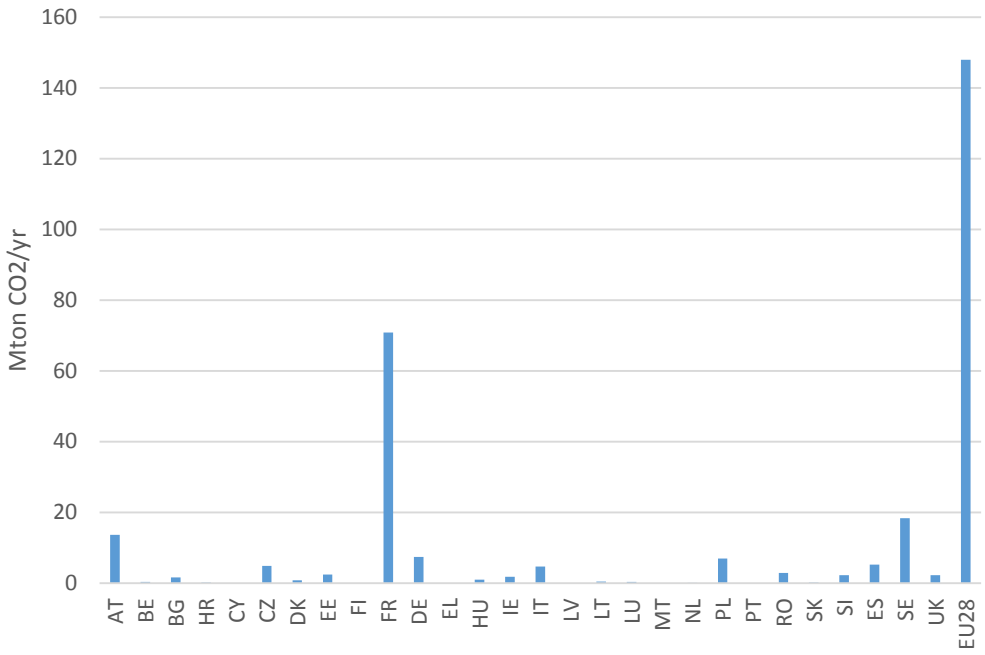
The Art 10 reports include little quantification of mitigation potentials, while also published studies with quantified mitigation potentials are scarce. A recent mitigation potential study for Spain shows that adopting a forest management regime oriented towards carbon sequestration, i.e. changing the spacing, rotation and thinning of stands, can reach a mitigation potential of 7 Mton CO_2 per year in Spain without costs (Albiac et al. 2017).

Additionally mitigation potential for forest management was assessed using carbon stock information for European forests from the European Forest Sector Outlook Study 2 (UNECE/FAO 2012). Using its supporting data[89] the carbon stocks in total living forest biomass per unit area was calculated for the EU28 and separate Member States (except Malta, as no output for Malta was available) for a reference scenario and a scenario with forest management aimed at optimising carbon stocks in the forest. In this carbon scenario total annual harvests were the same as under the reference scenario, but thinning intensities and management cycles were changed (see UNECE/FAO 2012). Based on the carbon stocks in the output files annual carbon stock changes were calculated for the reference and carbon scenarios. Subsequently the mitigation potential was determined as the difference in the annual carbon stock changes between the scenarios.

At EU28 level by 2030 the additional carbon stock changes were 40 Mton C per year, corresponding to a mitigation of **148 Mton CO_2 emissions per year** (Figure 13). On an area basis this corresponded with 0.36 Mg C per ha per year, or 1.33 Mg CO_2 per ha per year. The mitigation potential for Spain with this approach was estimated at 5.2 Mton per year (Figure 14) which is similar to the 7 Mton per year estimated by Albiac et al. (2017).

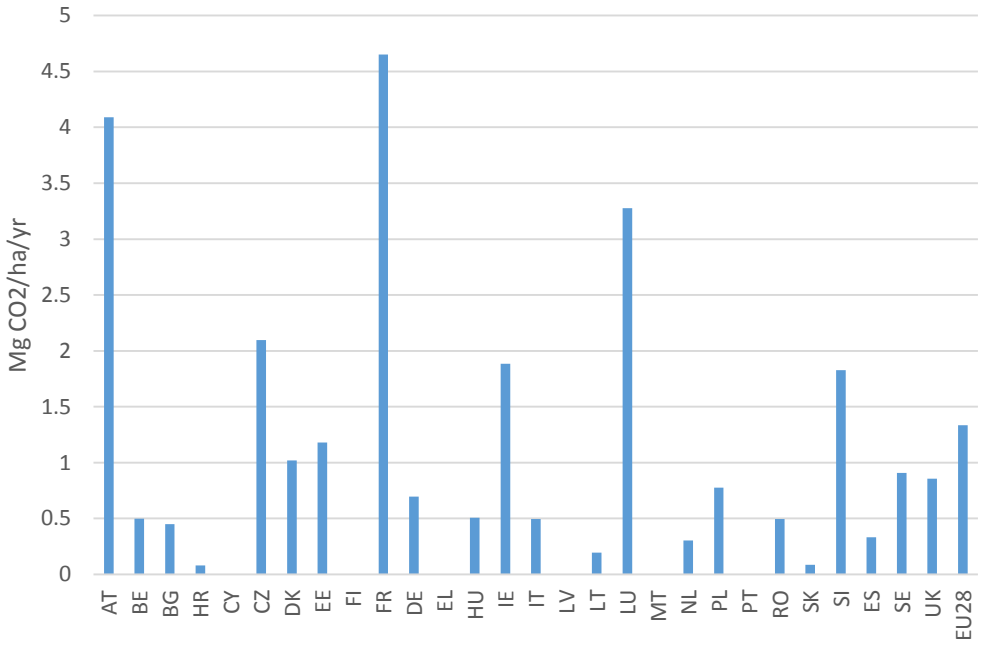
[89] UNECE/FAO (2012) EFISCEN results supporting data: https://www.unece.org/fileadmin/DAM/timber/efsos/data/efsos2-efiscen-results-2011-12.xls

Figure 13 Mitigation potential (Mton CO_2/yr) based on a scenario aimed at optimising carbon stocks in forests, compared to a reference



Source: WUR based on UNECE/FAO 2012

Figure 14 Mitigation potential (Mton CO_2/yr) per ha based on a scenario aimed at optimising carbon stocks in forests, compared to a reference



Source: WUR based on UNECE/FAO 2012

A recent study by Nabuurs et al. (2013) indicates the first signs of a saturation of the carbon sink in European forest biomass. Reasons for this saturation were found in a decline of the stem volume increment in European forests, which was attributed to a combination of

developments in older age classes and high growing stocks, i.e. forests getting increasingly mature, slowing down its increment. Additionally they observed a slowing down of forest area increase, which is also supported by analysis further on in this report. They proposed a number of measures to improve carbon sequestration in European forests. These measures included for instance conserving high carbon stock densities in old growth forests that are not at high risk of disturbances, while harvesting mature stands with low productivity that are at high risk of disturbance, but also other measures for conserving high carbon stocks on sensitive sites while improving and intensifying management in other sites suitable for such measures. They also indicated that due to the current situation with a lot of old forests could imply that for some MS an implementation of forest management measures aimed at a sustained forest carbon sink in the future could result in a decreased sink on the shorter term. If also the carbon in harvested wood products and substitution effects for wood replacing energy intensive materials or fossil fuel sources is considered, this transition is expected to be smoother, and potentially event at no additional emissions[90].

In assessing the mitigation potential for **protecting against natural disasters**, quantification of the mitigation impact is extremely challenging, as we do not know what proportion of the forest area would be lost without protection. However, we can demonstrate the value by quantifying the carbon stock in protected areas. Standard figures (IPCC) for above ground biomass in European temperate continental forest for trees over 20 years old is 120 tonnes dry matter /ha with a range of (20 -320). Using a carbon fraction of 0.47 this equates to 56.4 t/carbon/ha above ground biomass. The annual additional sequestration can be also calculated using standard figures (IPCC) at 4t dm/ha/yr equating to 1.88 t/c/ha additional annual sequestration. However, in the event of fire, it is not the case that all the carbon is lost or that it happens immediately. Conversion of biomass to atmospheric carbon continues for a long period (~100 years) after fires that cause extensive tree mortality as standing dead trees fall and decompose (Kashian et al., 2006). Regeneration and replanting may also occur over this time compensating to some extent the loss of enhancing sequestration by the previous crop.

Substitute of GHG intensive materials with harvested wood products are targeted at using more forest products affecting the demand and carbon fluxes. These activities could have a positive or negative impact on C stock in Forest. The main benefit of these activities is likely to be in the other sectors.

92 measures and policies relating to **biomass for energy purposes**, including many referring to forest management were included in the Article 10 reports. Many of the measures described provide an indirect stimulus in the form of economic incentives to produce heat using biomass fuel or other forms of promotion. The measures also include training, research and advisory activities. While these activities act as a catalysts or stimulus to produce biomass crops, providing quantitative estimates of the actions taken and changes in land use and the benefits is not possible. The activity resulting from changes in biomass demand has led to a wide range of potential impacts. Examples of negative impacts include the removal of crop residues that might have otherwise been incorporated and cultivation of land for crops such

[90] http://www.efi.int/files/attachments/thinkforest/nabuurs_thinkforest_30_may_2017.pdf

as maize. The benefit of this activity is not exclusive to the LULUCF sector; in most cases the benefits are secondary and indirect with the focus being on the energy sector.

Detailed assessment of relevant policies and measures

Forestry Management			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Construction of roads and other forest infrastructure	Indirect – the impact of this activity is not clear or quantifiable	Not applicable	Not applicable
Forest certification	Indirect - impact not quantifiable based on information provided in the article 10 reports	conservation of carbon in existing forest	Forest land remaining forestland
Enhancing production in forests	Activities influence on-site carbon stores, fluxes, and sequestration	Generally positive but very difficult to estimate.	Forestland remaining Forestland
Data banks/inventories	Indirect – Useful for measuring and monitoring stocks but not a sequestration activity in its own right	Not Applicable	Forest land remaining Forest land
Guidance and advisory services	Indirect but essential in encouraging uptake of positive activity that can preserve and sequester carbon	Not applicable - this is a secondary activity to promote action	Multiple
Stakeholder engagement	Indirect – can lead to positive collaborative activities to preserve and sequester carbon	Not applicable – this is a secondary activity to promote action	Multiple
Sustainable t forest management activities	See Enhancing Production in forests.		
Development and adaptation of drainage systems in forest land	Direct and indirect impact on GHG emissions in short and in long term. Living and dead biomass carbon pool is highly affected and can be quantified following existing forest management models. Impact on the non-CO2 GHG (CH4 and N2O) cannot be evaluated at reasonable level of uncertainty due to lack	Average annual GHG reduction potential per area unit 1.3 tCO_2/ha/yr (LV Art. 10 report)	

	of reliable research data. (LV Art. 10 report)		

Protection against natural disturbances in forests and conservation of carbon in existing forests			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Thinning and sustainable forest management	Management including thinning has proven effective in reducing Fire risk (Prevosto et al, FUME FP7), and increasing the growth of remaining trees	Reduced risk of fire leading to avoidance of emissions.	Forest Land remaining Forest Land
Insurance support	Indirect – Insufficient information. May provide funding for re-establishing forest areas	Not applicable	Not applicable.
Deforestation Prevention	Conserving carbon in existing forests	Standard figures (IPCC) for above ground biomass in European temperate continental forest for trees over 20 years old is 120 tonnes dry matter /ha with a range of (20 - 320). Using a carbon fraction of 0.47 this equates to 56.4 t/carbon/ha above ground biomass. The annual additional sequestration can be also calculated using standard figures (IPCC) at 4t d.m/ha/yr equating to 1.88 t/c/ha additional annual sequestration.	

Natural Regeneration	Increased Sequestration through accrued above ground biomass	Sequestration estimates - 1.88t/c/Ha annually	Forest Land remaining Forest Land
Dialogue with stakeholders	Indirect – Unclear on activities it will lead to	Not applicable – likely to encourage positive activity	Not applicable

Substitute of GHG intensive materials with harvested wood products			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Increasing Timber production	Potentially a positive impact through reforestation and afforestation	Increasing timber production through increased harvesting of managed forest land will have first a negative impact as the tree biomass (and carbon) is removed)m but this is compensated by growth in other areas of managed forest land. Newly planted trees will initially have a smaller annual growth rate (in m3/ha or tC/ha). Later growth will pick up and be higher than in old growth forests. Afforestation and reforestation will be additional to this, but unless it concerns very fast growing timber species that are managed in short rotations, afforestation or reforestation will only contribute to additional timber production once far over 20 years (the transition period form land converted to FL to FL-FL), often while reaching over 60-80 years.	Forest Land Remaining Forest land or Land converted to forest land[91]
Strategic contract for the timber sector	Indirect – Contract encourages use of harvested wood products – demand led activity	Abatement potential depends on the impact on existing standing crop of trees. Policies are required to maintain carbon stock to avoid a negative impact on LULUCF inventory from forest harvesting	Forest Land

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Improvement in technologies for forest products	Indirect	N/A		N/A

Biomass for Energy Use			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Favouring grass crops on organic soils for biogas production	Reduces potential losses of organic carbon through cultivations.	This activity relates to the protection of existing carbon stock as having permanent cover may reduce the SOC losses. This is not as effective as rewetting areas high in SOC	Grassland remaining Grassland
Energy advisory and training services	Indirect - No direct activity explicitly relating to LULUCF	Not applicable	Not applicable
Task Force Renewable Energy	Indirect - No direct activity explicitly relating to LULUCF	Not applicable	Not applicable
Sustainable forest management	See Forest Management		
Energy accord between the National Government and social and private partners	Indirect - No direct activity explicitly relating to LULUCF	Not applicable	Not applicable
Heat Fund, renewable energy feed-in tariffs, green certificates and other economic incentives to drive bioenergy demand	Indirect - Uncertain impacts and and no direct link to activities explicitly relating to LULUCF	Not applicable	Not applicable
Research activities	Indirect – no direct link to activities impacting LULUCF	Not applicable	Not applicable
Focus on farm or groups of farms capacity to generate and use biofuels and biogas	Indirect - Uncertainty on what the primary activities that are being encouraged	Not applicable	Not applicable

6.1.4 Afforestation

According to IPCC definitions, afforestation describes forest planting activities on sites that have not been forested within the last 50 years, while reforestation refers to sites that have been stocked by forest plants within the last 50 years (SFC, 2010).

The synthesis of the Art 10 reports shows that the majority of the MS (26) considers measures and policies related to afforestation and reforestation. The mentioned activities include afforestation in more general terms or more specifically increasing agro-forestry or afforestation on abandoned or degraded lands. In this assessment of mitigation potential we do not make a specific distinction between afforestation and reforestation and will refer to this only in terms of afforestation.

Bulgaria provides specific targets and estimates for a number of afforestation activities. Total area involved is 2240 ha resulting in a total estimated mitigation of 56.9 Gg of CO_2 emissions.

The Netherlands mentions an action plan for forest and wood in the Netherlands[92], which calls for an additional afforestation of 100,000 ha of forest by 2050 in this country. The Netherlands further estimates the mitigation potential of afforestation at 0.4 Gg CO_2 per ha over a period of 30 years (i.e. on average 13 ton CO_2 per ha per year). Realisation of the afforestation activities, however, is largely foreseen after 2020.

Latvia's estimates of the measures are presented in detail in Box 5 below.

Box 5 Afforestation and improvement of stand quality in naturally afforested areas in Latvia

Latvia's Article 10 progress report include the following estimates of the country's afforestation measure (supported under Latvia's 2014-2020 RDP):

The scope of afforestation is economically and environmentally efficient utilization of former farmlands (mainly land with low fertility), which are not any more used for food or fodder production.

Afforestation secures accumulation of CO_2 in living and dead biomass, litter and soil. The growth conditions in afforested lands usually are similar to fertile forest stand types on drained or naturally dry mineral soils; therefore, the calculation of impact of afforestation on carbon stock in living and dead biomass is done on the basis of average values in *Hylocomiosa* stand type (Table A), estimating the carbon stock in these pools at the end of rotation period (101 years for pine, 81 – spruce, 71 – birch and 51 years for aspen). Carbon stock changes in litter are 0.37 tonnes CO_2 ha^{-1} annually during 150 years period, according to the calculation method applied in the GHG inventory.

Reduction of CO_2 and N_2O emissions from soil due to land use change from cropland or grassland to forest land is not accounted, considering that there are no benefits proposed in the RDP for afforestation of organic soil.

[92] In Dutch: http://edepot.wur.nl/394083

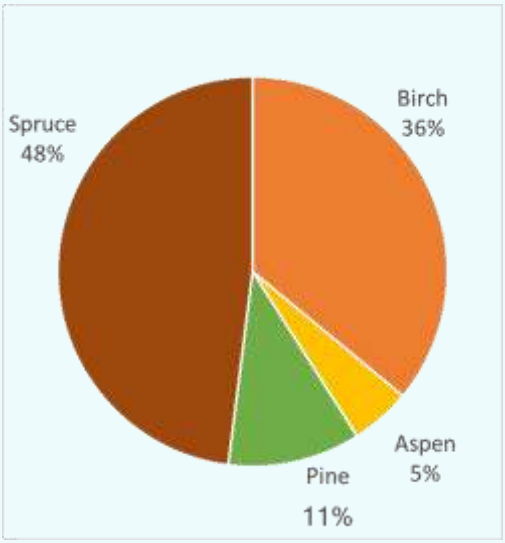
Table A: Average annual net CO_2 removal in living and dead biomass in *Hylocomiosa* stand type

Dominant species	Average annual net removal of CO_2 in living biomass, tonnes of CO_2	Average annual net removal of CO_2 in dead biomass, tonnes of CO_2
Aspen	5.78	0.42
Birch	7.53	0.77
Spruce	5.87	0.53
Pine	5.29	0.47

The distribution of tree species in afforested areas in the impact calculation is adopted according to the average historical values published by the State Forest Service (see figure A below).

On average, afforestation of 1 ha will contribute to removal of 596 tonnes of CO_2 during the rotation or 7.4 tonnes of CO_2 annually.

Figure A: Dominant species in afforested lands



A summary of the impact of the measure is provided in Table B. The total reduction impact of the measure will be nearly 4 million tonnes of CO_2 or 0.05 million tonnes of CO_2 in average annually.

Table B: Summary of the impact of the measure

Parameter	Measurement unit	Value
Total potentially affected area according to projections of MoA	ha	6 600
Total GHG reduction potential	tonnes CO_2eq.	3 935 472
Average annual GHG reduction potential per area unit	tonnes CO_2eq. year^{-1}	48 666
	tonnes CO_2eq. year^{-1} ha^{-1}	7.4

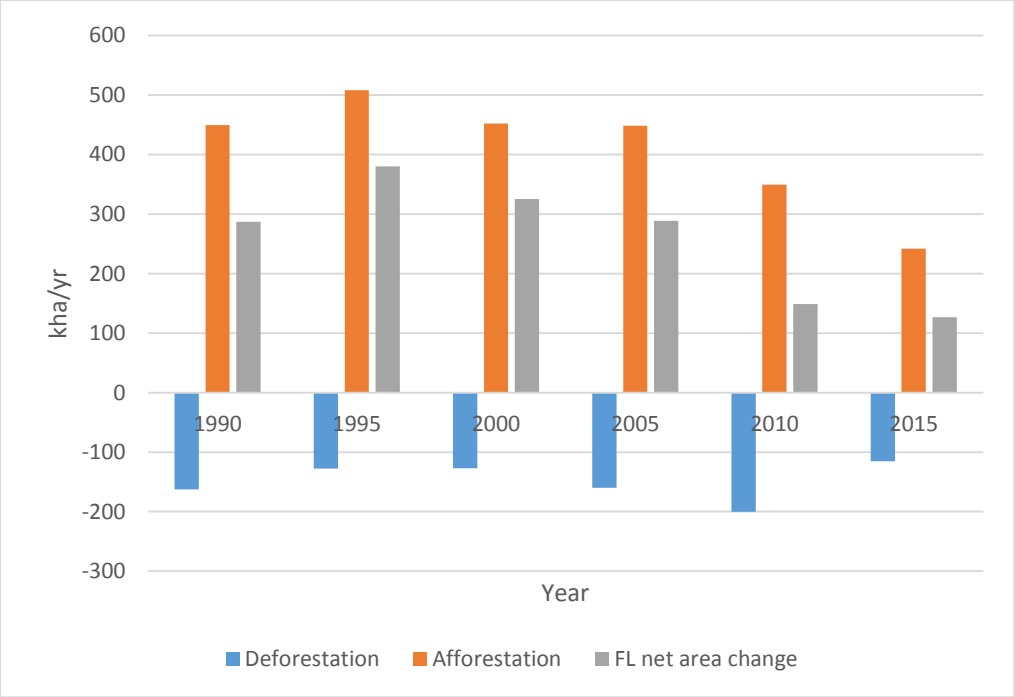
Source: Latvia's Progress report under Article 10 of the LULUCF Decision, Riga 2017

Due to a lack of mitigation potential provided by all reporting Member States in a comparable manner, we also used information from the CRF tables of the EU NIR 2017 to estimate mitigation potential from afforestation. It was assumed that the UNFCCC category land converted to forest land (CRF table 4A.2) provides a relevant estimate. The category area includes all land converted to forest land since 20 years before. The implied carbon stock change factors (i.e. CSC per ha) for living biomass, dead wood, litter and mineral and organic

soil therefore include afforested land with varying times since afforestation. Since changes in rates of carbon stock changes over these 20 years are expected to be limited, and afforestation anyway is expected to have a mitigation effect over longer time periods, this is considered to be a reasonable assumption. For reporting year 2015 the implied carbon stock change factors for the EU28 for living biomass, dead wood, litter and soil added up to 1.86 ton C/ha (removals of 6.8 ton CO_2/ha) on mineral soils, and 0.90 ton C/ha (removals of 3.3 Gg CO_2/ha) on organic soils. On average this results in a mitigation potential of 1.78 ton C/ha, corresponding to removals of **6.5 ton CO_2/ha/yr**.

Based on the numbers published in the EU NIR 2017 it can be concluded that gross afforestation in the EU decreased from 450 kha/year in 1990 to 242 kha/year in 2015 (Figure 15). With deforestation rates varying over time with no clear trend, the net increase in area of forest land in the EU28 also gradually decreased to 126 kha per year in 2015.

Figure 15 Rates of deforestation, afforestation, and subsequent net change in area of forest land (FL) in the EU28

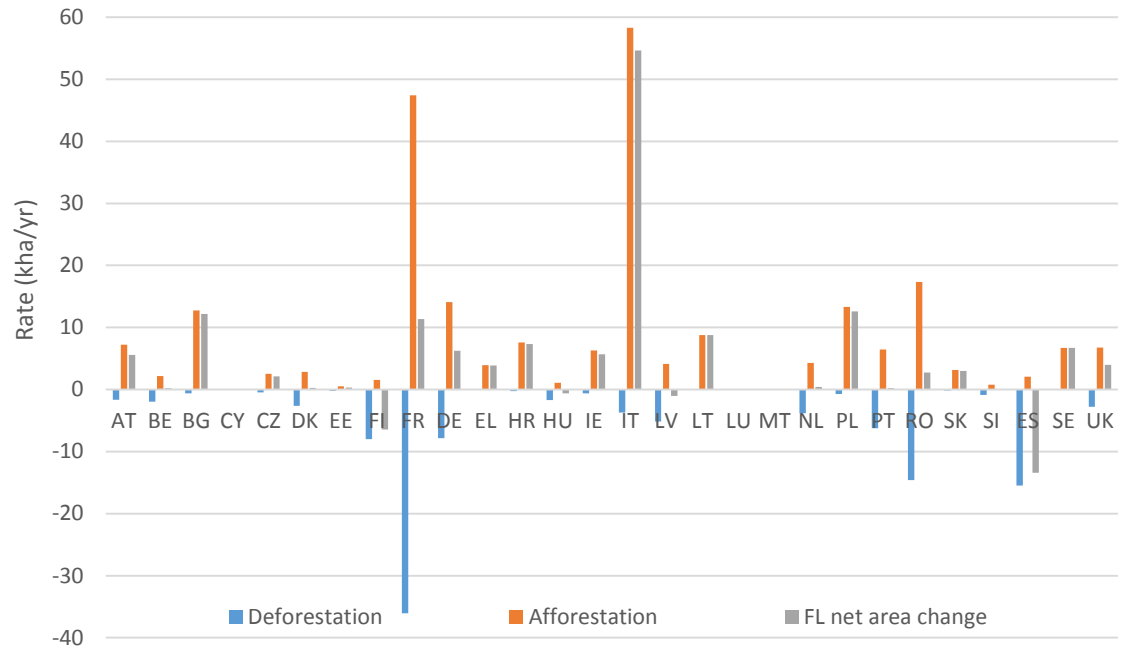


Source: WUR based on the Tables 4.1 (land-use matrix) in the CRF belonging to the EU NIR 2017.

Assuming by 2020 a potential 10% increase in the afforestation rate in the EU28 compared to the rate in 2015, the additional afforestation area could be around 24 kha resulting in an additional mitigation potential of 158 kt (0.158 Mton) CO_2 per year in 2020 which is subsequently continued in the years after afforestation. If this afforestation rate would be maintained until 2030, by 2030 an additional 240 kha would be afforested with a total annual mitigation potential of 1.58 Mton CO_2 per year.

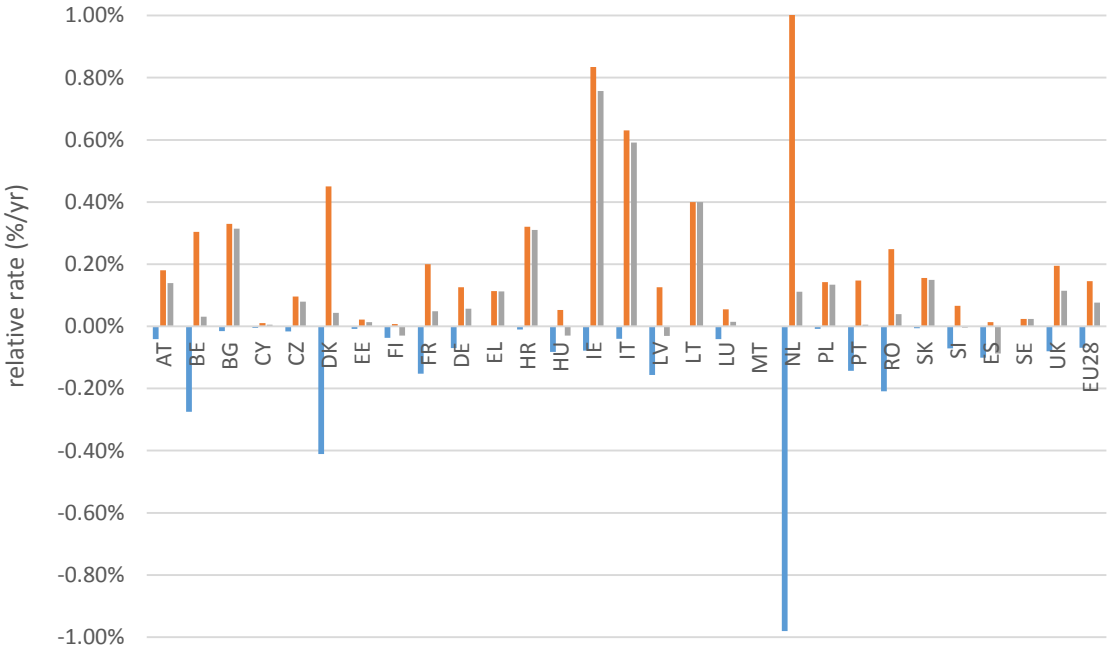
An analysis of changes in forest cover in 2015 for EU28 member states shows a large variation among MS, both in absolute (Figure 16) and relative rates (Figure 17). This would probably influence the possibilities for increasing afforestation over the next years.

Figure 16 Rates (kha/year) of deforestation, afforestation, and subsequent net change in area of forest land (FL) in 2015 in the EU28 member states



Source: WUR based on the Tables 4.1 (land-use matrix) in the CRF belonging to the EU NIR 2017

Figure 17 Relative rates (% of forest area) of deforestation, afforestation, and subsequent net change in area of forest land (FL) in 2015 in the EU28 Member States



Source: WUR based on the Tables 4.1 (land-use matrix) in the CRF belonging to the EU NIR 2017

For this assessment of mitigation potential from afforestation or reforestation potential effects of indirect land-use changes have not been considered. With increasing afforestation

there is a risk that displacement of agricultural land leads to extension of agricultural land and/or increased production elsewhere. This may involve emissions from such land-use changes, particularly if this results in deforestation, or increased emissions per unit of agricultural product.

Detailed assessment of relevant policies and measures

Reforestation and Afforestation			
Activities reported	GHG Impact	Abatement/Sequestration	NIR category
Reforestation	In principle, reforestation is a precondition following harvesting activities replacing formally existing carbon stock. Hence, it is not regarded as providing sequestration potential because it is an integral part of sustainable forest management (SFC, 2010).	See "reduced deforestation"	Forest Land remaining Forest Land
Afforestation	The IPCC estimates that the potential of afforestation in Europe is 115 Mt CO_2e / year under a cost of 100 US $ / t CO_2e (IPCC, 2007). The figure is based on an averaged output from three global forest sector models that provide estimates for all regions of the world (Sohngen and Sedjo, 2006; Sayathe *et al*., 2007; Benitez-Ponce *et al*., 2007).		Land Converted to Forest Land

6.1.5 Avoiding deforestation

Avoiding deforestation will have immediate effects as emissions from loss of total carbon stocks on an area of forest land are avoided. In the Member States Article 10 reports, only the Netherlands provide information on avoided emissions from deforestation, which were estimated at 0.5 Gg per ha of avoided deforestation.

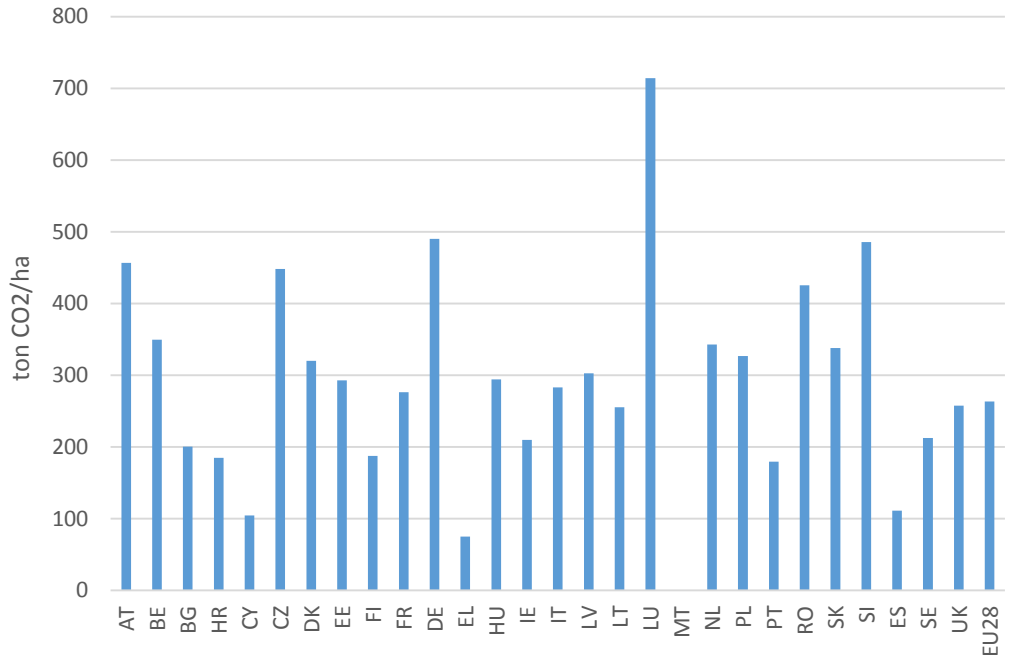
Therefore again we used information from the CRF tables of the EU NIR 2017. The emissions and implied emission factors of the land-use categories involving conversions from forest land to other land useshowever, are not directly suitable for an estimate of mitigation potential. Again these numbers in the CRF tables consider 20 year transition periods. Both emissions and areas provided therefore also include subsequent changes after the actual deforestation occurred. For instance emissions from soil due to cropland management after deforestation are also included in this category.

Therefore for assessing the annual deforestation rates in the EU28 information from CRF table 4.1 (EU NIR 2017, see figures 3, 4 and 5), i.e. the land transition matrix, was used. This table provides the gross annual changes between the different land-use categories.

Then, assuming reported carbon stock changes for biomass and dead organic matter (in CRF tables 4B.2.1, 4C.2.1, 4E.2.1 and 4F.2.1) are on the area deforested in 2015 (i.e. from CRF Table 4.1), the mitigation potential for avoiding deforestation can be calculated at 234.8 ton CO_2/ha/yr for EU28.

Another source providing carbon stock information for European forests is the European Forest Sector Outlook Study 2 (UNECE/FAO 2012). Using its supporting data[93] the carbon stocks in total living forest biomass per unit area was calculated for the EU28 and separate Member States (no output for Malta). Since emissions associated with carbon stock losses in living biomass account for the largest share of the emissions from deforestation it was assumed that this gives a reasonable estimate of mitigation potential of avoiding deforestation. The estimated prevented emissions by avoiding 1 ha deforestation in this case would be 263 ton CO_2/ha/yr for the EU28, but with a large variation in the potentials among the MS (Figure 18).

Figure 18 Prevented emissions from loss of tree biomass resulting from avoiding 1 ha deforestation, calculated using data from EFISCEN output from UNECE/FAO (2012)



Source: UNECE/FAO (2012)

Assuming by 2020 a potential 10% decrease in gross deforestation rate in the EU28 compared to the rate in 2015, the avoided deforestation area could be around 11.5 kha resulting in an additional mitigation potential of between 2.7 and 3 Mton CO_2 per year in 2020.

Detailed assessment of relevant policies and measures

The detailed assessment is as set out above under "Deforestation prevention" in the table in section 6.1.3.

[93] UNECE/FAO (2012) EFISCEN results supporting data: https://www.unece.org/fileadmin/DAM/timber/efsos/data/efsos2-efiscen-results-2011-12.xls

6.1.6 Summary

The table below (Table 13) summarises the estimated mitigation potential by 2030, based on the above presented EU level analysis of emissions analysis of emissions and removals as reported for the EU.

Table 13 Summary of the EU level estimated mitigation potential by 2030 for six selected activities. Numbers are from the calculations in the sections 6.1.1 – 6.1.5 above.

Mitigation action	Mitigation potential (Mton CO_2-eq/year)	Potential area involved (kha)	Mitigation potential per ha (Mg CO_2-eq/ha/year)
Carbon sequestration in mineral soils	50	125,000[1]	0.4
Reducing emissions from organic soils	30	4,000[2]	7.5
Afforestation[3]	1.58	240	6.5
Preventing deforestation[4]	2.7-3	11.5	235 – 263
Forest management	148	138,000[53]	1.1

Source: WUR based on literature review (2017)

1) Based on total cropland area on mineral soils (derived from EU NIR)
2) Based on cropland and grassland area on organic soils (derived from EU NIR)
3) With a rough assumption of 10% additional afforestation in 2020 compared to 2015
4) Assuming a 10% decrease in deforestation rate
5) The exact area on which measures could be applied in the scenarios is not known. This is the total forest area available for wood supply considered in the scenario analysis.

6.2 Cost-effectiveness of the LULUCF measures

The synthesis of the Article 10 reports shows that hardly any information about cost-effectiveness of measures is provided (reporting on such information is also not required under Article 10 of the LULUCF Decision). Some countries do give information on total funding budgets for certain activities, but their cost effectiveness, i.e. euro per ton CO_2, is not provided. In this section cost-effectiveness of selected LULUCF measures relevant to those found in Article 10 reports is presented based on a literature review. Our literature review has not specifically addressed the question of the extent to which mitigation actions which reduce net GHG emissions are, in practice, reflected in national inventories; it should be noted that further effort to improve the accuracy of inventories, and to ensure that they reflect mitigation actions accurately and fully, is itself an important contribution to effective decision-making.

Martineau et al. (2016) assess (i) costs associated with the implementation of mitigation actions by the land managers[94] as well as (ii) administrative costs for public authorities required to introduce new or extending the existing practices into CAP (cross-compliance, greening, RDP). Regarding (i) implementation costs, i.e. capital costs (up front investments), recurring costs (e.g. specific more labour intensive management); and opportunity costs (the income and costs forgone by a farmer), Martineau et al. conclude (own emphasis):

> "The evidence suggests that the majority of climate mitigation actions assessed are likely to have very **low opportunity costs** associated with them, particularly as many of the actions are likely to encourage **more efficient means of production**, particularly in relation to input use. Where high opportunity costs occur, these tend to be associated with actions that require significant land use changes, which could change the nature of the farming enterprise quite significantly depending on the scale at which the action is implemented. These sorts of actions include for example the conversion of arable to grassland, peatland rewetting or restoration and woodland creation. The other main category of costs associated with these actions is the **upfront capital costs required**. These relate to: machinery and equipment costs, for example specialised machinery for zero tillage in order to plant seeds in undisturbed soil and crop residues; (…); and seed or plant costs for habitat creation, for example establishing grassland, tree planting for woodland creation or agroforestry or peatland restoration. An issue that is often raised in relation to actions that require upfront investment in new equipment/machinery (e.g. precision machinery) or infrastructure (e.g. slurry storage) is that **the profit margins of many farming enterprises are too small** to enable the [initial] investment (…)"

Martineau et al. note also that where high costs are identified, further investigation may be needed, and access to funding **incentives** considered, e.g. CAP. In term of administrative

[94] 22 actions assessed in the Martineau et al. review are not exclusively land use based but overlap considerably with the measures identified in Article 10. The action assessed in the review are: Conversion of arable land to grassland to sequester carbon in the soil, New agroforestry, Wetland/peatland conservation/restoration, Woodland planting, Preventing deforestation and removal of farmland trees, Management of existing woodland, hedgerows, woody bufferstrips and trees on agricultural land, Reduced tillage, Zero tillage, Leaving crop residues on the soil surface, Ceasing to burn crop residues and vegetation; Use cover catch crops, a range of livestock production measures, Soil and nutrient management plans, Use of nitrification inhibitors, Improved nitrogen efficiency, Biological N fixation in rotations and in grass mixes, Carbon auditing tools, Increased efficiency.

costs, the findings show that the most significant costs come from the need for new remote sensing data collection (see also section 5.1) and to provide **evidence to justify introducing the measure and inform decisions** about the targeting of the measure (Martineau et al., 2016).

Based on further literature review, one low-cost way of reducing emissions from the LULUCF sector appears to be **improved soil carbon management**. Governments might therefore want to prioritise it over other more expensive ways of addressing climate change. Several analyses of agricultural sectors in different countries have highlighted the potential for relatively low-cost, in some case negative-cost, soil measures (Alexander et al., 2015). Several Member States have made nation-wide marginal abatement cost curves (MACC) for their agricultural sector, which provide information about the mitigation potential and the cost of the measures. However, most of these MACC studies did not include soil carbon sequestration or other land use related measures; and, as with all land use carbon sequestration options, the issue of the permanence of the mitigation benefits (and thus the comparability with mitigation through avoided emissions) needs to be addressed.

In the FP7 SmartSoil project[95], marginal abatement cost curves were developed specifically for soil carbon related measures. The results of the cost-effectiveness analysis indicated that in each of the six case study regions there is potential for the uptake of soil organic carbon (SOC) measures that can produce benefits to farmers in terms of improved gross margins. Although the specific measures and crop combinations varied across the case study regions it was possible to group measures into three broad categories:

1. **Reduced input costs**. Measures such as minimum tillage and use of manures are estimated to be highly cost-effective even where modest reductions in yield occur because of the potential to reduce inputs costs. These input costs include the fuel and time required for cultivation relative to conventional tillage (minimum tillage) and reduced mineral fertiliser costs (manures). Zero tillage performs less well as there is a need for increased pesticide use. The inclusion of legumes and other nitrogen fixing crops in rotations also appears to be cost-effective due to the reduced need for mineral fertiliser input.

2. **Loss of revenue from by-product**. Residue management has a high potential for SOC increase in most case study regions but this could only be achieved at a loss of gross margin due to foregone revenue from selling straw as a by-product.

3. **Increased input costs**. Under the mean yield impact assumption cover crops were estimated to result in a large reduction in gross margin due to the additional costs of seeds and cultivation. However, the cost-effectiveness of this measure was highly sensitive to assumptions about the impact on yield, and under high yield impacts assumptions the cost-effectiveness improved for some crops in some regions.

A report by Daniëls et al. describing the different mitigation measures and costs for the 2020-2030 emission reductions task for the Netherlands, resulting from the recent European proposal for an Effort Sharing Regulation, included several measures for the LULUCF sector

[95] http://smartsoil.eu/

(Daniëls et al., 2016). The cost-effectiveness results show **that management related measures can be cost-neutral**, **whereas measures in which the use of the land is changed can be very costly** (Table 14).

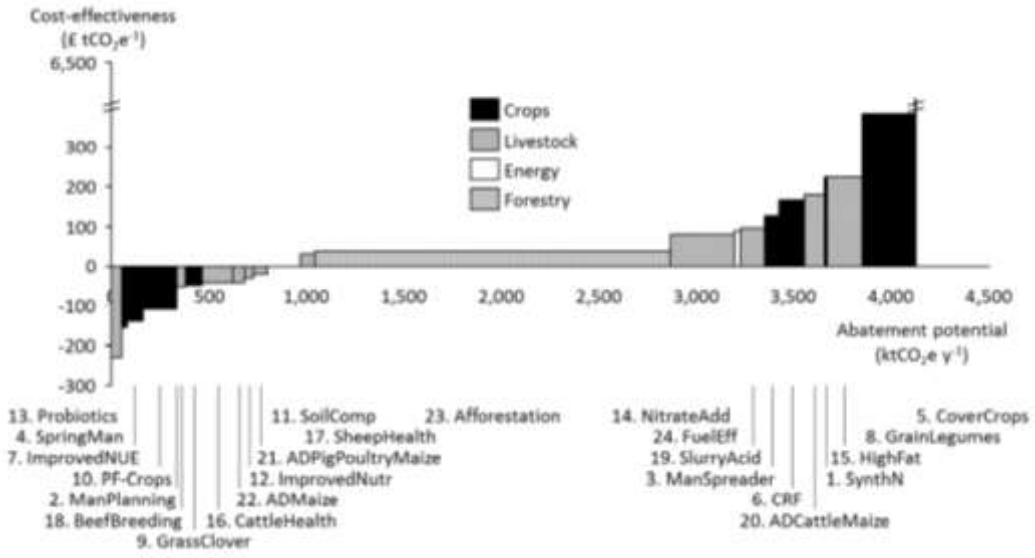
Table 14 Cost-effectiveness of LULUCF measures in the Netherlands by 2030

Measure	Cost-effectiveness (€/ton CO_2)
Forest management: increase harvest for 50% in combination with active forest management	0
Afforestation with 50 kha in 2050	500
Passive rewetting of organic soils	70
Sub merged drainage in organic soils	25
Conversion of agricultural organic soils to nature	140
Conversion of intensive agriculture to paludiculture	70
Land use conversion of peaty soils	150
Increase C sequestration in agricultural soils	0

Source: Daniëls et al., 2016

As presented in Figure 19 below an update of the MACC curve for the UK showed that **afforestation on agricultural land** was the measures with the largest potential (1.8 Mton CO_2 per year in 2030), at a cost of 37£/ton CO_2eq (Eory et al., 2015).

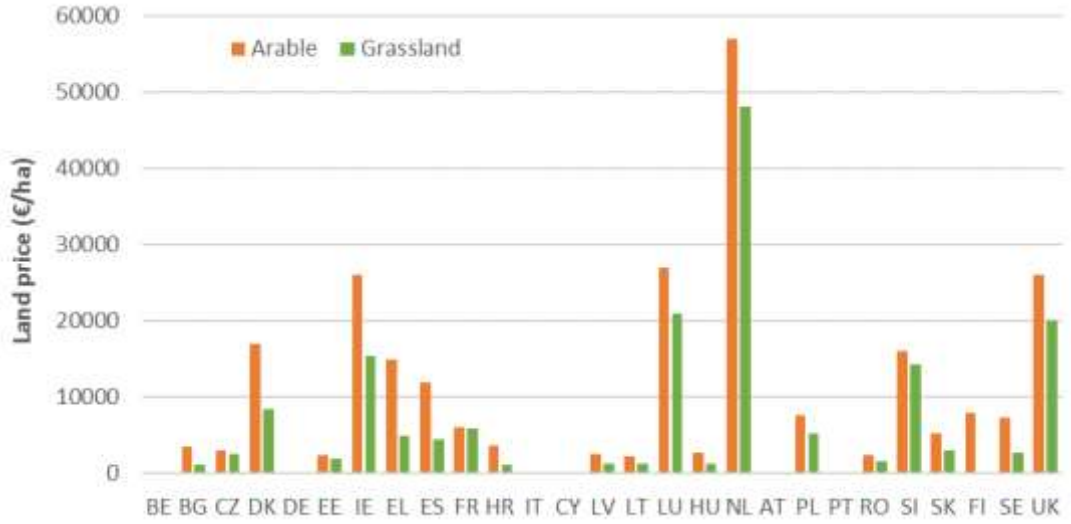
Figure 19 Marginal abatement cost curve for UK agriculture (with interactions, 2030, CFP, d.r. 3.5%)



Source: Eory et al., 2015

For afforestation the price of land will largely determine the cost. This differs largely among EU member states (Figure 20), ranging from €3000/ha for arable land in some Eastern Europe Member States to €57000/ha in the Netherlands. In general permanent grassland is cheaper compared to arable land (on average only 60% of the price of arable land).

Figure 20 Average land prices for arable land and permanent grassland for the year 2014



Source: Eurostat, 2016
Note: not all MS provided data.

Albiac et al. (2017) estimated that **improved forest management** would result in a significant mitigation potential (7 Mton CO_2/year) in Spain at no additional cost, i.e. meaning that cost and revenues from management are in balance. With social cost of Carbon emissions at 40 euros per ton CO_2 the social benefits were estimated at 280 million euros (Albiac et al. 2017).

An action plan for forest and wood in the Netherlands[96] calls for an additional afforestation of 100,000 ha of forest by 2050 in this country and additional implementation of measures for improving productivity in Dutch forests. For **afforestation** the cost was estimated at €412 per ton CO_2 in 2030 and €169 per ton CO2 by 2050, reflecting the relatively high up front cost of land acquisition. Cost for **improved forest management** was estimated at €11 per ton additionally sequestered CO_2 in 2030 and €1.3 per ton CO_2 by 2050.

The above attempt to estimate cost-effectiveness of selected LULUCF actions is based on fragmented evidence that is not suitable for EU-level overview of the cost ranges of LULUCF action identified in Article 10 reports.

6.3 Potential enhanced mitigation actions for the 2021-2030 period

Article 10 reports focus predominantly on 2014-2020 period, with little hint on what types of activities the Member States deem suitable for enhancement (i.e. going beyond the standard practices so far in order to better pursue the LULUCF mitigation potential) after this period.

Next to the measures reported as already adopted or put in place, the synthesis of Article 10 reports identified around 70 potential measures the Member States are considering for adoption in the future. **The potential measures reported by the Member States are not necessarily "enhanced"; rather they are new in terms of the nature or scale of deployment for the Member States who report them**. In the sub-sections below, a sample of the reported

[96] "Actieplan Bose n Hout" (2016) available in Dutch: http://edepot.wur.nl/394083

forestry, agriculture and soils related potential measures, as well as a brief analysis of the future context for their application, is presented.

6.3.1 Forestry measures

The reported potential forestry measures include[97]:

- Increase the potential of forest increment (FR)
- Increase of forests' carbon sink function (FR)
- Taking forest out of production (DE)
- Leaving deadwood in forests (DE)
- Climate change consideration in the forest management guidelines (HU)
- Promoting fast growing plantations (HU)
- Notification of forest cuts (LU)
- Woodland enrichment (UK)
- Sustainable management of forests (RO)
- Subsidy for afforestation (HR)
- Marking stands in forest management plans for improved climate reporting (HR)
- Increased afforestation and reforestation (NL)
- Improved forest management (NL)
- Increase the substitution of energy-intensive products by wood or wood products (FR)
- Increase the substitution of fossil fuels by forest biomass (FR)
- New technologies resulting in more efficient utilization of biomass (LV)
  (indirectly forestry related) reformed EU ETS as a driver for increased biomass consumption (AT)

In Member States in which the forest carbon sink is becoming saturated (more and more mature), **more intensified forest management** with replanting using improved provenances and changing to continuous forest management could increase the forest mitigation potential (Nabuurs et al. 2013). Harvesting mature forests that have a low productivity, however, will only improve the carbon sink on longer time spans. This means that these forest activities result in net emissions on the shorter policy relevant term. As a result of such short term emissions from forest land, many policy makers may be hesitant to consider maintaining a long-term sink in policies. The analysis of afforestation and deforestation further show that there seems to be a large amount of variability in the forest area. Total forest area in the EU-28 still increases, but this is the result of large areas of net afforestation that is partly undone by deforestation elsewhere; however deforestation in Europe generally is characterised by relatively small scale events, mostly for urban development and infrastructure. As a result of the immediate losses of carbon under deforestation and the relatively much slower annual sequestration of carbon under afforestation, **avoiding deforestation** should be considered as a promising LULUCF action..

Further analysis of the potential enhancement of forestry measures requires taking the multi-functionality of the EU's forest resource into account. Multi-functional forests provide a range of ecosystem services to society, not least that of a material resource and the income and jobs in the forest-based industries. **Balancing climate commitments, particularly increasing sequestration potential and carbon sinks with on-going efforts to ensure the continued**

[97] Non exhaustive sample selected to represent the diverse potential measures as reported under Article 10

viability of the EU's forest sector may be a challenge. This challenge is not limited to the decisions and markets with the EU, particularly given that a large proportion of forest biomass and pulp produced in the EU[98] is exported, with growing export markets in China for both pulp and sawn wood.

Article 10 reports show that Member States have approached this implicit challenge through commitments to reinforcing the viability of the forest sectors in an effort to maintain the management of forests and flow of forest biomass resources (for which CAP support under pillar II is available, see section 4.1.3). Climate mitigation benefits appear to have been attached to these efforts as a secondary objective. Going forwards, and to realise a more robust and long-term impact on climate mitigation in the LULUCF sector, **climate mitigation objectives should feature more highly** in Member State decision making process when choosing what to support and promote in forests and the forest sector.

Highlighting the long-term economic potential of climate mitigation action in forests is therefore crucial for "enhancement" of actions in this area. As the EU moves to a more circular and bio-based economy in line with other strategic priorities, **afforestation and the production of HWP to feed the (bio)economy** should be encouraged over those actions that have only shorter-term impacts.

Improving the climate resilience of forests in the EU is going to be increasingly important for both traditional forest sector activities and those associated with emerging markets and economies. Ensuring and demonstrating improved resilience of the EU's primary carbon sink along with its sustainable management from a climate mitigation perspective could be a requirement of LULUCF reporting[99].

Forest management is one of the most referenced LULUCF activities, yet the objectives and practices listed are highly diverse, including some with clear climate benefits (such as creating regulated carbon pools) and others with less certain outcomes (such as improving road infrastructure). When reporting the use of forest management (or afforestation) to meet LULUCF commitments, Member States should **make clearer the intended use of the biomass produced in the forest and how the forests are managed** in order to demonstrate the impact this has on sequestration potential and carbon sink in the medium to long term.

Beyond the management of the EU's forest resources, **the increased production and use of Harvested Wood products** will help to enhance the LULUCF contribution to the EU's climate efforts. Member States should include within their Article 10 reports more explicit information about the aim to substitute GHG-intensive materials in other sectors of society

[98] For example over 20% of sawnwood produced in EU in 2015 was exported to third countries. Eurostat (2017), Sawn wood and panels [for_swpan], http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[99] Demonstration of resilience would need to be defined, but could be reported through reference to the elements of a forest management plan or equivalent instrument citing how forests are supported in their adaptation to future climate change and/or how forest carbon stocks are to be preserved in light of future changes, e.g. extreme events, such as fire or storms, as well as incremental changes such as developments, increased harvesting rates, etc.

and the period over which these materials are expected to last[100]. This would add context to those policies and measures that seek to increase the use of forest biomass resources, which could have both **positive and negative impacts on climate,** depending on the end use.

6.3.2 Agricultural and soils measures

The reported planned agriculture and soils related measures include[101]:

- Innovation in manure management (CZ)
- More efficient manure application (DK)
- Catch crops on additional 240 000 ha (DK)
- Subsidy on conversion of arable land on organic soils to nature (DK)
- Favouring grass crops on organic soils (FI)
- Soil coverage and increase of organic matter in soil (FR)
- Conservation of permanent pastures (FR)
- Purchase of key peatlands by the state (DE)
- Improved rules and reporting on grassland conversion (DE)
- Reduced/no tillage (NL)
- Catch crop/green manure (NL)
- Leave crop residues on fields (NL)
- Raising ground water levels using submerged drains in pastures on peat soils (NL, pilot phase)
- Converting cropland from annual tillage crops to perennial crops, fallow and set aside (UK)
- Intensification of rough grazing on organo-mineral soils (UK)

In agricultural soils the potential for **soil carbon sequestration** is relatively limited, with an estimated average unitary potential of 0.4 ton $CO_{2\text{-eq}}$/ha/year (see section 6.1.6). However, as the **area involved is very large,** this can still have a **significant contribution to the overall GHG emission reduction**. Reducing emissions from organic soils under agriculture has a significant potential with high per hectare emission reductions possible (on average 7.5 ton $CO_{2\text{-eq}}$/ha/year), but the potential area is smaller. However, these measures have much higher cost compared to soil management measures on mineral soils, and require subsidies or stimulating policy to overcome these costs.

Apart from that, many of the Article 10 reported LULUCF actions that reference soil protection relate to existing policies or measures already established (albeit in some instances the area of application and implementation could be extended). There are three areas of action where Member States note in particular potential for future intervention, these relate to: taking forward actions **implementing climate mitigation and adaptation plans** and specifically developing sectoral plans for forestry and agriculture; protecting **organic soils and peatlands**; and developing new tools for **monitoring soil characteristics** and improving modelling to support more effective management of inputs, crop rotation and selection and application of management measures such as reduced tillage.

[100] For example timber used in the construction of buildings can have a lifespan of decades, compared to the relatively short lifespan of paper packaging.

[101] Non exhaustive sample selected to represent the diverse potential measures as reported under Article 10

As seen in the list above, and specifically on organic or peat soils a number of Member States are proposing, trialling or developing tools to support **conversion to grassland, better management of permanent grassland, the promotion of grassland retention, the conversion of arable land to natural habitat or the rewetting of soils and alteration of the groundwater levels.** For example Sweden notes a study underway to assess the feasibility of rewetting organic soils. Several countries are experimenting with policy innovations to promote grassland either through supporting specific livestock (e.g. under the grassland sheep scheme in Ireland) or for example through supporting new markets (e.g. in Finland where there is limited demand for fodder crops in certain regions biogas production using grass is being promoted as a tool to support maintenance of permanent pasture).

Several issues are noted with these approaches that essentially involve land use change. The Netherlands notes that there is some **resistance in particular to rewetting projects** due to the change from a traditional agricultural landscape. Despite this it is noted that pilot projects are underway to increase groundwater levels on peat soils and the Netherlands is also intending to develop policies for a sustainable future of pastures on peat soils. In addition Germany notes that there is a need for better rules on grassland management and conversion especially for peat soils to ensure effective regulation.

Some Member States also note the potential for **additional legislation in the area of soil protection and climate mitigation** in future. France notes a potential future policy action to develop legislation on soil cover and increasing soil organic matter (linked to efforts under the 4 per mille initiative). Spain is also working on a study aimed at identifying the quality, state, status of soils and their potential to capture organic carbon to develop a framework to 2030 (also building on 4 per mille goals).

7 Conclusions

Based on the Article 10 reports reviewed for the purposes of this study, and our literature review, a number of EU wide conclusions can be made.

Firstly, with nearly 680 LULUCF reported policies and measures there are signs of positive actions taken by Member States to pursue LULUCF mitigation potential. The agricultural and forestry policies, as well as wider environment, climate, energy and biodiversity policies, contribute to the increase of GHG sinks and reduction of GHG sources from land use based sectors in many ways. There is little sign however that the actions taken go beyond the necessary compliance with EU law (e.g. the Birds and Habitats Directives or the Nitrates Directive) or that they are devised to exploit mitigation potential from LULUCF sectors in the most effective or feasible way. With the COP21 UNFCCC Paris Climate Agreement and the proposed EU LULUCF Regulation creating greater awareness of the strategic importance of LULUCF action in climate policies post 2020, the mitigation potential should be further pursued, preferably with the use of improved tools and governance solutions.

Secondly, the GHG impacts of the reported measures are rarely quantified in Article 10 reports, mainly due to data and knowledge gaps. Data required to estimate GHG impacts of LULUCF actions include, among other elements: land use information, and the expected level of uptake of measures or actions. There is vast potential for improvement of land use information quality and availability across the EU. As some Member States have already demonstrated, the complementarity between the agricultural database used for CAP implementation (Land Parcel Identification System, which is used by an increasing number of Member States also for climate reporting) with the existing Earth Observation tools available at EU level, such as LUCAS and Copernicus, could be exploited. This would strengthen the environmental integrity of LULUCF accounting by improving its accuracy, completeness, transparency, consistency and comparability (five core objective of reporting established in the UNFCCC reporting guidelines for annual GHG inventories). It would also be in line with the INSPIRE directive and the Better Regulation guidelines; Member States should therefore be encouraged and supported to overcome the technical and organizational barriers so that the existing systems and databases can be brought together and adapted where necessary for the purposes of LULUCF related monitoring and reporting. In terms of the expected level of uptake of LULUCF relevant measures, it could be quantified on the basis of CAP and forestry policy programming instruments such as RDPs or forest management plans or equivalent instruments. To address knowledge gaps, the Commission and Member States should promote further research and innovation efforts (e.g. through continuous support from LIFE and Horizon 2020 programmes, both mentioned sporadically in the Article 10 reports). The existing and new knowledge could also be shared more effectively among the land managers, public administration and other stakeholders.

Thirdly, the reports submitted under Article 10 are very heterogeneous; they are not guided by detailed reporting requirements or embedded in a harmonised template. The reports vary in terms of scope and level of detail. While they are a valuable record of what each Member State considers to be the key elements of LULUCF mitigation activity in their national context, there is very little potential for comparing the LULUCF mitigation actions reported by Member States. The reports promote a sharing of experience and discussion among Member States only to a limited extent. While there is no doubt that the LULUCF actions reporting by the

Member States is essential to the EU-level assessment of progress and impacts of policies in this area, there could be value in Member States providing more consistent information to a similar format in the final reports due under the LULUCF Decision in 2020. After 2020 (according to the European Commission's legislative proposal) the reporting on LULUCF actions could become a part of the integrated national energy and climate action plans required under the Energy Union Governance Regulation. This would increase visibility of the LULUCF actions reporting outcomes and enable coherence in the wider EU climate and energy policies assessment. While the final outcome of the legislative process on the Energy Union Governance Regulation is uncertain, any future reporting on LULUCF policies and measures at Member State level should ideally be based on a common reporting format, including the required information specifications. To address information gaps (e.g. on applied methodologies for land use and GHG impacts data collection and analysis), the reporting format could explicitly require this kind of information from Member States. The format could also help Member States to report only on measures relevant to the (future) LULUCF Regulation, as opposed to reporting on all measures relevant to the AFOLU sector.

Finally, the review of Member State Article 10 reports did not identify any national strategies dedicated to LULUCF that would help frame the short-term and long-term actions required to pursue the sector's mitigation (and adaptation) potential; instead, LULUCF actions are scattered across a wide range of sectoral strategies. The Article 10 reports rarely consider actions beyond the 2020 horizon. This is to some extent due to the fact that LULUCF emissions and removals are not counted towards the Member States GHG emission mitigation targets until 2020. Member States are also at the beginning of the learning process about the GHG mitigation potentials of different LULUCF actions, with a number of pilot initiatives such as paludiculture (growing cranberries, cattail and other crops) in the Netherlands or the "forest carbon farms" in Poland. The vast majority of the reported measures have implementation periods aligned with the accounting period specified in the LULUCF Decision (2013-2020) as well as the current EU financing period (2014-2020) and consequently, also the CAP programming period. Creating strategies framing climate action through LULUCF would not only improve coherence of the Member States' actions in this area, but also reduce the costs. Taking action early would be more cost effective than delaying it as it would (i) address the increasingly detrimental climate change impacts on ecosystems and economies, (ii) allow more time for action and capacity building, and (as a result) costs of the rolled out technologies to be brought down. LULUCF mitigation strategies could be developed, among others, with support from high level of coordination between the relevant ministries in the Member States and wide stakeholder consultations.

The project findings show that the CAP funds are the main sources of finance supporting LULUCF actions, and that CAP itself covers almost all measures reported under Article 10 (for instance under the thematic objective "Low Carbon Economy" the EAFRD's planned contribution to 2014-2020 rural development measures reported by the Member States under Article 10, is over €7.6 bn including more than €5.1 bn from the EU budget[102]). This strong reliance of the current LULUCF mitigation actions on the CAP makes their continuation dependent on the policy's design post-2020. Further progress in climate mainstreaming in the next MFF is therefore important to ensure a greater focus on EU budget's potential to support

[102] Calculation based on ESIF 2014-2020 FINANCES PLANNED DETAILS dataset available on the EC website, updated on 21 August 2017, https://cohesiondata.ec.europa.eu/dataset/ESIF-2014-2020-FINANCES-PLANNED-DETAILS/e4v6-qrrq

climate action in land use sectors. More clarity on priorities through the development of dedicated LULUCF strategies, as suggested above, could bring significant benefits in terms of availability and targeting funding possibilities, e.g. under CAP and other policy support.

With the post 2020 time horizon in mind, several potential enhanced LULUCF actions could contribute to mitigation in the sector. Forest management and avoidance of deforestation are considered to offer the most benefit in this respect. To ensure that the enhancement of forest management (or afforestation) brings a net reduction of GHG emissions, Member States should ensure greater clarity on the intended use of the biomass produced, and on how the forests are managed, in order to demonstrate the impact this has on sequestration potential and the carbon sink, and on net economy-wide emissions, in the medium to long term. From that perspective the increased production and use of harvested wood products can bring a more lasting LULUCF contribution to the EU's climate efforts.

Last but not least, and with a link to the previous conclusion, the pursuit of the LULUCF mitigation potential in EU-28 should be conducted with wider climate and environmental sustainability in mind. Many Member States seem to take that into account by promoting long-lasting wood products for material purposes, such as furniture or building sectors (e.g. Tall Wooden Building initiative in France). While it is not in the scope of this study to analyse the robustness of EU rules on GHG accounting in the LULUCF and energy sectors, the high number of reported measures dedicated to increased use of forest biomass for energy purposes raises questions about the permanence of GHG removals by forests. In addition, even sustainable forest management practices adopted to produce high quantities of biomass for energy use could impact on the net GHG emissions and removals outcomes across the economy as a whole. This underlines the important role of (i) sustainability criteria for solid biomass under the recast of the Renewable Energy Directive (ii) resource efficiency in the use of wood, in order to use forest resources in a way that minimises the impact on the environment and climate, whilst prioritising the forest products with higher added-value, and (iii) implementation of EU nature legislation. Improved links to long-term decarbonisation strategies would be beneficial here, enabling a focus on the timescales across which carbon sinks would need to be maintained in order to maximise the effectiveness of their contribution to the delivery of long-term climate mitigation goals.

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Annex 1 Synthesis of the LULUCF reports

General observations

Heterogeneity of the reported data

The review of the reports shows a very mixed picture in terms of the nature and level of detail of the reported information relevant to LULUCF actions. The Member States **were not given a common reporting format to follow**, but had flexibility to provide information as they saw fit. Ideally, a common approach to identifying policies (Government intervention designed to promote specific behaviours) and measures (the mitigation and other actions taken by land managers etc.) would have helped in synthesising information from the reports. However, there is no standard approach in the reports to recording policies or considering measures separate to policies. Some Member States present a mix of policies and measures supported by policies. Others present primarily policies and it is then often difficult to identify the specific measures aimed at by these policies. The level of detail is therefore highly varied.

In general the reports differ in terms of: distinction made between policies and measures; the granularity of description of measures and policies; consistency in linking measures to policies; inclusion of estimates of the mitigation impacts for individual measures; clarity on impacts to enable the identification of risks of double counting of the reported measure or policy; and many other aspects such as provision of information on costs or sources of funding.

All Member States however seem to try to address to some extent the minimum requirements established in Article 10 of the LULUCF Decision, even if only by mentioning that the required information (e.g. an indicative timetable) was not available at the point of reporting.

There is no sign of Member States devising long term strategies on how to exploit LULUCF climate change mitigation potential. While the majority of the reported measures and policies have impacts on the LULUCF sector's contribution to the overall mitigation efforts, they appear to be targeting LULUCF sinks and sources as a secondary rather than a primary objective. In other words, the lion's share of **LULUCF relevant activities are undertaken as part of wider policies** dedicated to, among other things, rural development, sustainable forest management, or promotion of renewable energy sources.

Seven Member States (BG, DK, FI, IT, LV, NL, and UK) provided **quantitative estimates of the mitigation impact** of part of the LULUCF relevant measures quoted in the reports. Most Member States presented the expected qualitative impacts (e.g. increased carbon sequestration). The links between the measures and the GHG emission scenarios, including their "with additional measures" variants, are either absent or not robust enough to make judgments about the impacts of the measures on future GHG emission trajectories.

In terms of the **links between the activities and national policies**, the national agricultural policies implementing the **Common Agricultural Policy** (CAP) are mentioned most frequently. They are followed by policies dedicated to: forestry, climate mitigation and adaptation, energy, biodiversity, soil, water, circular economy and industrial development. The Member

States frequently bring up **compliance with EU law and policies** as the principal driver of their LULUCF relevant activities.

A wide range of **LULUCF-relevant priorities** have been reported by the Member States, either explicitly or in a more indirect manner. The stated priorities clearly focus on forestry related activities. The following priorities have been named most often:

- Maintaining and fostering multifunctional forest systems
- Sustainable forest management
- Afforestation
- Increased carbon sequestration in wood products
- Replacement of fossil fuels by biomass
- Forest fire protection and restoration of degraded forest land
- Promotion of rural development

Determination of land use and GHG emissions

In terms of **land use data methodologies**, the reports were mostly silent about the approaches or tools deployed. A use of spatially explicit methods (approach 3 – geographically explicit land use data[103]) has been noted in 8 Member States (BE, CY, SK, EE, LV, LT, LU, and NL). An approach consisting of survey methods (approach 2 – survey of land use and land use change) could be identified in 5 Member States, and a basic approach (approach 1 – basic land use data, no data on conversions between land uses) was also mentioned by 5 Member States. Two Member States provided some information about the tools used for land use data determination: Czech Republic mentioned the use of the CAP's Land Parcel Identification System and Cyprus and Italy noted the use of CORINE land cover raster data. It is therefore **impossible to determine what kind of land use data methodology or tools were used in most cases**, and even in the instances where a method or tool is mentioned in the report, it cannot be considered as the only method or tool used; it is possible that other methods and tools are in use but have not been mentioned.

A similar observation can be made about the **GHG emissions estimation methods**. The most advanced, tier 3[104], method has been mentioned by 6 Member States (AT, FI, HU, IE, NL, and UK). Tier 2 method was noted by 7 Member States (BE, CY, CZ, EL, IE, NL, and UK), and tier 1 by 11 Member States (BE, BG, CY, CZ, EL, LV, MT, NL, RO, SK, and UK). As can be seen from the example of the Netherlands or the UK, all three tiers can be in use by a Member State at the same time, serving different purposes and covering different parts of GHG emission estimates. In the majority of cases, an explicit **reference to the National Inventory Reports** (NIR) submitted under UNFCCC was made, suggesting that more detailed information about

[103] The approaches described as part of the IPCC Good Practive Guidance for LULUCF, Milne, R., Jallow, B. et al. (2006), Basis for Consistent Representation of Land Areas, http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp2/Chp2_Land_Areas.pdf

[104] The tier structure, as used in the IPCC Guidelines (Tier 1, Tier 2 and Tier 3), is hierarchical. Higher tiers imply increased accuracy of the method and/or emissions factor and other parameters used in the estimation of the emissions and removals. Tier 3 include models and can utilize plot data provided by NFIs tailored to address national circumstances Tier 2 employs the gain-loss method described in the IPCC Guidelines with the emission factors and other parameters which are specific to the country. Tier 1 employs the gain-loss method described in the IPCC Guidelines and the default emission factors and other parameters provided by the IPCC. IPCC (2003), Good Practice Guidance for Land Use, Land-Use Change and Forestry, http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

the methodologies applied can be found in those reports. A review of the National GHG Inventory Reports is however beyond the scope of this study.

Overview of measures and policies

The review of the 51 reports submitted by the Member States under Article 10 of the LULUCF decision identified a total of **679 existing or planned LULUCF-related measures and policies** relevant to climate action. A synthesis of the results showed that some of the measures and policies are quoted more often than others; and helped establish an overview of the main existing LULUCF-related activities at EU level. The following areas of intervention have been chosen as a focus for this initial synthesis; it should be noted that they are not mutually exclusive and the measures and policies they include are often relevant to more than one area of intervention:

- Forest management
- Protection against natural disturbances (with a focus on fire prevention)
- Afforestation and reforestation
- Biodiversity/nature conservation measures
- Biomass for energy use
- Grassland, grazing land and/or pasture management
- Nutrient, tillage and water management
- Conservation of carbon in existing forests
- Restoration of degraded land
- Organic farming
- Substitute of GHG intensive materials with HWP (excluding energy feedstocks)

In the following sections, the information on each of the above measures and policies is presented in form of a synthetic overview of Member State inputs, as reported under Article 10.

It is important to bear in mind that the measure categories presented below are not mutually exclusive. For instance “Nutrient, tillage, and water management” area covers “Organic Farming” measures, and “Forest management” often includes measures dedicated to protection against natural disturbances. Wherever the reported information allowed to disentangle measures falling into specific selected categories, such information has been presented in separate subsections.

Forest management

Area of intervention	Forest management is a broad category. The analysis of Member State reports for forest management LULUCF measures and policies explicitly excludes those activities covered in other sections of this initial synthesis report. Included in this section are: Sustainable Forest management (general); Enhancing production of forests; Prevention of deforestation
Short description	Forest management, as defined above is mentioned in **174** (including 9 planned and 7 potential) measures and policies reported by the Member States. The range of reported **measures** include: - Construction of roads and other forest infrastructure (BG, SK, SI, EE, AT)

	- Forest certification (LU, BE, SE) - 20 measures enhancing production in forests (AT, BG, EE, FR, IE, LU, SK, SI, ES, SE) - Data banks/inventories (IE, PL, EL, BE, HU, ES) - Guidance and advisory services (FI, IE, SE, LT) - Stakeholder engagement (AT, FR) - Diverse sustainable management forest activities (e.g. Maintaining a high level of cases of replenishment felling with natural seed restoration, BG or "Implementation of sounder management methods and elimination of pressure from game" CZ, or "pre-commercial thinning, LV, CY, BG): The reported **policies** include: - CAP (Rural Development Programmes) (AT, CZ, EE, EL, HU, LT, MT, RO, UK) - Forest Strategy/Plan/Programme (CY, FI, HU, SI, ES, SE, SK, PL, IE, EL, FR, FI, CZ, EE, BG, AT) - Forest Act (CZ, EE, FI, HU, IE, PL, SK, SI, SE, UK) There are 10 measures dedicated to **prevention of deforestation** (2 in AT, 1 in each: DE, BG, HR, CY, NL, PL, SK, and UK).
Type of instrument	**Economic incentives** are the most common instrument supporting implementation of the reported forest management measures and policies. These are closely followed by **action plans and strategies** relevant to climate or/and forestry, and **legal requirements** and standards such as forest codes.
Objective	The stated objectives reflect the level of diversity of measures and policies in this area. They can be summarised with the following examples: - to improve the management and use of forests - to increase the resilience and adaptability of forest ecosystems to climate change - to facilitate reporting of carbon emissions/sinks in the forestry sector - to facilitate monitoring of changes in forest stands - to improve availability of forest relevant data/develop knowledge base - to create regulated carbon pools - to improve species composition - to foster and maintain multi-functionality of forests - to promote health of forest stands - to raise public awareness - to mitigate climate change (36 measures and policies mention it explicitly as part of their targets) - to secure future demand for forestry resources - to increase forest resilience (including climate change adaptation) - increase removals by carbon sinks in living biomass and soils

	GHG emission impacts of forest management activities appear to be a **secondary objective for most reported measures**. However, several measures for which this seems to be a primary objective could be identified (e.g. "Avoiding forestry methods which increase GHG emissions from forest soils").
Scope	Forest management is mentioned in 80 policies and 94 measures reported by most (26) **Member States** (**AT, DE, CY, CZ, EE, FI, FR, EL, HU, IE, LV, LT, LU, MT, RO, SI, ES, UK, SE, DK, BE, HR, PL, SK, BG, NL**).  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Costs and sources of funding	The main reported source of funding is **EAFRD** (implied where RDP measures are mentioned). Other mentioned sources are: - **LIFE** programme in "Climatree" and "Foresmit" projects in EL - the (former) **European Agricultural Guidance and Guarantee Fund** (EAGGF) joint with Financial Instrument for Fisheries Guidance (FIFG) supporting "Rural development and Multifunctional Agriculture (Agriculture OP)" in CZ - **ESF** (European Social Fund) funds actions under Operational Program Administrative Capacity's project "Strategic Planning in the Bulgarian Forests - a Guarantor for Effective Management and Sustainable Development" in BG. Many Member States refer directly or indirectly to **national budget** financing.

	Several Member States provided information about the **costs** of some of their reported measures. A sample of such information is presented below. - BG: 94.17 mln BGN, ("of which 17 mln BGN under the "programmes and financial instruments of the EU, 170 000 BGN from the Ministry of Agriculture and Food and Executive Forest Agency and 77 mln BGN from State Forestry Enterprises, municipalities, non-state forest owners and forest operators and others") on "Improving the management and use of forests" - EE: 10 mln EUR on "Improvement of forest economic and ecological vitality" under its RDP 2014-2020 (EAFRD and national budget) - FR: 15 mln EUR on "Innovation and Forest Increment" initiative running since 2017, the funds come from the Forest and Wood Strategic Fund (EAFRD and national budget) - LV: 21.3 mln EUR for "Pre-commercial thinning of forests (Improvement of ecological value and sustainability of forest ecosystems)"under its 2014-2020 RDP (EAFRD and national budget) - LT: 38 500 EUR on "Improvement of the research program *Sustainability of agro-, forest and water ecosystems* and the execution of research projects" 2015-2016 to 2020 - ES: 20.6 % of its overall 2014-2020 RDPs budget dedicated to forestry (EAFRD and national budget)
Expected impact	The expected impacts are presented in both qualitative and quantitative terms. The most frequently reported qualitative objectives are: - Stabilisation of **carbon stocks** - **CO_2 emissions reduction** - Carbon **sequestration** - Improvement of forest economic and ecological vitality Other examples of the qualitative descriptions of impacts include: - LV , under its "pre-commercial thinning of forests" reports "the short impact is a **transfer of certain portion of the carbon from living biomass to the dead biomass** pool with following conversion into CO_2 during 20 years according to Tier 1 approach. The long term impact is to **increase the growing rate** (by 15% annually on average, according to an expert judgement used in some growth models). Contribution to the dead wood stock is not evaluated yet, therefore, only living biomass is considered in the impact assessment." - NL "Improved forest management" is expected to bring "increased carbon stock but decreased annual removals, **possible offset of emissions from energy sector** and carbon pool in HWP".

	While most Member States did not provide any quantitative descriptions of the expected effect of the measures on emissions and removals, those that did report data include: - HU "Afforestation" under RDP => 196 ktCO2 removed by 2020; fast growing tree plantations on agricultural land – 218 ktCO2 by 2020; agroforestry – 48 ktCO2 by 2020 - LV "Development and adaptation of drainage systems in forest land" => total GHG reduction potential of 1.2 $MtCO_2$ (1.3 tCO2/ha). "The duration of the impact is equal to an average rotation for particular species – 101 years for pine, 81 years for spruce, 71 years for birch and 51 years for aspen." - LV "pre-commercial thinning" => total GHG reduction potential of nearly 2.2 $MtCO_2$ (1.9 tCO_2/ha) - accounting for 14% of total GHG emission reduction under RDP - UK "Prevention of deforestation" => - 0.7 MtCO2 per year assuming reduced to zero - FI "Sustainable forest management" => at least 10-17 $MtCO_2$ yearly sequestration - UK "Improved management" => from -5 to 5 $MtCO_2$ per year depending on timeframe and assumptions - LT "Inter-institutional action plan on the implementation of the Goals and Objectives for 2013- 2020 of the Strategy for the National Climate Change Management Policy "=> minimum annual removals by sinks in LULUCF of 3.7 $MtCO_{2eq}$.
Links to (other) policies or measures	Links are made between forest management measures and policies and broader **biodiversity, climate, energy, agriculture** (CAP Ist and II Pillar), **forestry**, and **social/employment** policies. Forest management is a broad category relevant to **measures covered in other sections** of this report. Separately covered are measures and policies that are most relevant to Afforestation and reforestation (section 3.3), Protection against natural disturbances in forests (section 3.2), Biodiversity/nature conservation measures (section 3.5), Biomass for energy use (section 3.4), Restoration of degraded land (section 3.10), Conservation of carbon in existing forests (section 3.8), and Substitute of GHG intensive materials with HWP (section 3.11). In the initial scoping it was found out that there are 7 strategic documents on **climate and renewable energy** (e.g. Renewable Energy Action Plans in ES, SI, and LT) There are 2 **biodiversity** strategies/programmes (AT, FI) making a direct link to forest management practices.
CAP relevance	CAP is mentioned explicitly by 16 Member States (HU, EL, SI, AT, ES, LV, LT, EE, MT, PL, CZ, CY, FR, IE, UK, RO) – primarily in relation to Rural Development Programme (**CAP, pillar II**) support. The relevant RDP measures, as reported, are in majority supported under

	"Development of forest areas and the improvement of forest viability" (M08[105])
Data sources	Limited information is reported. Only LV reports the use of Tier 1 methodology in relation to the implementation of forest drainage - reconstruction of drainage systems in mature stands before regenerative felling and young stands to secure that growth of the second generation of trees on drained lands follows the growth curves characteristic for naturally dry and drained forests. They also make note of the "GHG inventory report". The Netherlands makes reference to Naburs *et al,* 2016[106] in relation to improved forest management.

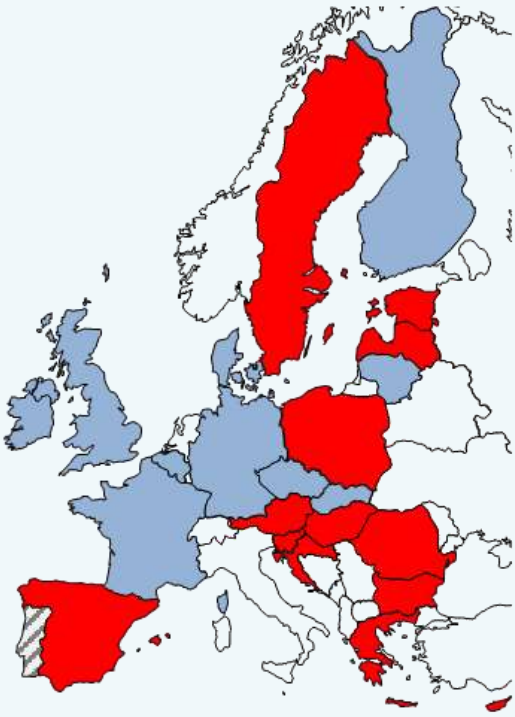
Protection against natural disturbances in forests (with a focus on fire prevention)

Area of intervention	Protection against natural disturbances in forests
Short description	The protection against natural disturbances is mentioned in **152** (including 8 planned and 1 potential) **measures and policies** reported by the Member States. The reported **policies** include: • Forest strategies and acts (e.g. EE, CY, IE, FI, FR, CZ) • Adaptation strategies (e.g. SE, EL, FR, BG, IE, SI, SK, CZ) • CAP pillar II (e.g. ES, SI, LT) A range of reported **measures** include: • Insurance support (e.g. FR) • Sustainable forest management with explicit mention of forest fire prevention (e.g. BE, SE, ES, BG, RO, SK) • Deforestation prevention (e.g. PL, UK, HR, SK) • Natural regeneration (e.g. CZ, BG) • Austrian Forest Dialogue to operationalize the Austrian Forest Programme (AT) The protection and **management of fire risk** is mentioned in 33 cases across 13 Member States (AT, BG, HR, CY, EE, EL, HU, LV, PL, RP, SI, ES, SE). Policies include primarily the CAP and RDPs (ES, EL, HU); alongside specific fire control policies (CY), low carbon development strategies (HR), forest financing programmes (EL) and biodiversity protection (SE). Measure types are much more diverse, covering preventative actions (unspecified), measures to improve sustainable

[105] Measure code under the COMMISSION IMPLEMENTING REGULATION (EU) No 808/2014 of 17 July 2014 laying down rules for the application of Regulation (EU) No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0808&from=en

[106] Nabuurs, G. J., M. Schelhaas, J. Oldenburger, A. d. Jong, R. A. M. Schrijver, G. B. Woltjer and H. J. Silvis. (2016). Nederlands bosbeheer en bos- en houtsector in de bio-economie. Wageningen Environmental Research, Wageningen. http://edepot.wur.nl/390425

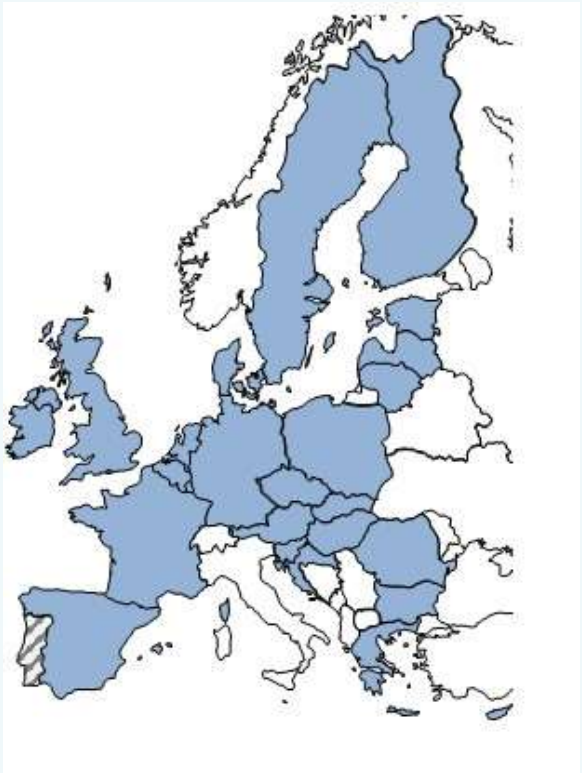
	forest management, restorative actions after a fire event, and improving the economic and ecological viability of forests.
Type of instrument	More **individual measures** are noted (96) compared to specific policies (55). Together these cover a range of different instruments, including: economic incentives, such as support for thinning of trees to prevent fire risk or fire protection plans and actions; information and awareness raising, such as forest maps, guidance and advice to forest owners; plans and strategies for forests and climate; and legal instruments and acts, such as forest acts, rules regarding protection of forests, etc. For **fire protection**, instruments tend to be concentrated on economic incentives to put in place fire protection measures, including preventative actions (e.g. thinning, fire breaks, removal of flammable timber) and restorative actions (e.g. clearing of fire debris, replanting, etc.).
Objective	The objectives of policies and measures that are used to protect against natural disturbances are highly varied. Some have the specific objective of addressing individual threats, for example 12 measures have objectives that address fire risk or restoration after fire events (ES, BG, EL, CY, LV, EE), whereas others are more general in nature, addressing 'climate change', 'improving forest management' or 'addressing biodiversity'. LULUCF mitigation activities are usually a **secondary objective** to those mentioned above, yet there are cases where carbon sequestration is an explicit objective of the measure, such as SE, PL, FR, or where improved understanding of carbon sequestration is the objective (EL).
Scope	Protection against natural disturbances is mentioned in **97 measures and 55 policies by 24 Member States** (with the exception of PT, IT, MT, NL). The protection and management of **fire risk** is mentioned (although not as the explicit and only objective) in 33 cases across 13 Member States (AT, BG, HR, CY, EE, EL, HU, LV, PL, RO, SI, ES, SE). Interestingly fire risk management is not restricted to high fire risk areas in the Mediterranean and southern Member States, with reference to fire prevention and restoration occurring throughout central and eastern Europe and in Nordic countries.

	 *MS which include fire risk measures & policies = Red; Other measures and policies = Blue. **As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Costs and sources of funding	The funding source was rarely mentioned in the reports. Those which did identify funding mentioned primarily the CAP (specifically **EAFRD**) support. Two **LIFE** funded projects were noted in EL, and the BG report identified a range of funding sources (**state, EU, private**).
Expected impact	As with other measures and policies, quantitative impacts remain difficult to assess within the reports with only LV, UK, FI and HU providing any quantitative information. • HU - Afforestation - 196,000tCO_2 removed by 2020; fast growing tree plantations on agricultural land - 218,000tCO_2 by 2020; agroforestry - 48,000 tCO_2 by 2020 • UK – Improved woodland management from -5 to 5 MtCO_2 per year depending on timeframe and assumptions; - reduced deforestation 0.7 MtCO2 per year assuming reduced to zero • LV - to maintain forest fire prevention system, including reconstruction of existing and building of new fire observation towers ((133.4 tCO_2/ha); - Forest drainage - reconstruction of drainage systems in mature stands before regenerative felling and young stands to secure that growth of the second generation of trees on drained lands follows the growth curves characteristic for naturally dry and drained forests (1.3 tCO_2/ha); - regeneration of forest stands after forest fires and other natural disasters, and maintenance and improvement of preventive system of the forest fires (0.59

	tCO_2/ha); - to support pre-commercial thinning of young stands in private forests to secure implementation of sustainable forest management practices (1.9 tCO_2/ha)
Links to (other) policies or measures	All 24 Member States with these policies and measures make an explicit link to other policy priorities. These include: **afforestation** (HU, IE), **air quality** objectives (LV), **CAP** priorities (EL, ES, HU), **Climate and energy** policies (FI, CZ, BG), **Social and rural economic development** (ES), and **water** (LT).
CAP relevance	12 Member States (BG, LV, HU, EE, EL, ES, SI, PL, LT, CY, CZ, AT) link these measures to **CAP pillar II**. Management of fire risk is identified in EL, ES, HU, CY, PL as relevant to support through CAP. EL for instance supports it under "Investments in forest area development and improvement of the viability of forest" (M08). PL RDP supports fire protection of afforested land under "Afforestation and creation of woodland" (M08, sub-measure 8.1). HU RDP lists such measures under "Prevention against catastrophic events" (M08, sub-measure 8.3) category of its forestry measures. A similar link is made in to CY RDP.
Data sources	FI provided information about the methodologies used to model development of the tree stock and drain (MELA model using information from the national forest inventory), LV provided information on data sources, identifying Tier 1 methodology, the GHG inventory report and expert judgment in relation to forest drainage, pre-commercial thinning and forest fire prevention respectively.

Afforestation and reforestation

Area of intervention	Afforestation and reforestation
Short description	Afforestation and reforestation is mentioned in 150 (including 6 planned and 7 potential) **measures and policies** reported by the Member States. The reported **policies** include: • Forest policies and acts (EE, HU, SK, SI, SE, IE, PL, ES, FI) • Dedicated afforestation plans (PL, IE) • Climate Acts and policies (HR, IE, SE, LT, FI, RO, HU) • CAP – II pillar Programmes (EE, SI, LT, AT, CZ, MT, UK, EL, HU, RO, FR, ES); A range of reported **measures** include generally afforestation and reforestation activities, whether this is extension of existing forest areas, dedicated new afforestation projects or afforestation under CAP Pillar 1 greening requirements.
Type of instrument	The actions reported by Member State are spread almost equally between **policy and measure** categories. These represent a mix of **economic incentives** for actions, such as establishment grants and

	annual premiums under national and RDP supported afforestation schemes; information and awareness raising campaigns (to improve understanding on the scope to increase afforestation (IE)); alongside broader strategies and plans such as climate and energy, biodiversity adaptation, and bioeconomy strategies.
Objective	Afforestation and reforestation serves multiple objectives for Member States. Whilst the increase in forest area is likely to lead to an increase in sequestered carbon (depending on where it is planted) this is only mentioned in a small selection of Member States as the objective of the planting (BG, HR, FI, PL, SK, SI, ES), suggesting LULUCF mitigation as a generally **secondary objective** of activities in this area. Biodiversity protection is mentioned on a number of occasions (BE, EE, FI, MT, SE, DE), along with the intention of using biomass to feed a growing bio-economy and promoting wood use (e.g. SE, ES, FI, SK), the multi-functional use of forests (recreation, biodiversity, production) (e.g. ES, LT), and protective functions of forests (e.g. erosion prevention in ES). Many simply do not state clearly the rationale for the afforestation or restoration, merely that increased forest area is the end goal.
Scope	Afforestation and reforestation is mentioned in 74 policies and 76 measures reported by **26 Member States** (**AT, BE, BG, DE, HR, CY, CZ, DK, EE, FI, FR, EL, HU, IE, LV, LT, LU, MT, NL, PL, RO, SK, SI, ES, SE, UK**). As presented on the map below, the coverage of afforestation and reforestation actions spans the entire bio-geographic spread of the EU. 

	*As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Planning period	There is no clear pattern relating to the planning periods reported by the Member States in relation to afforestation and reforestation. The period of the measure or policy dictates the information given in the LULUCF report. For example, the CAP Rural Development Programmes cover the **2014-2020** programming period. Some measures refer to historic acts, such as the PL Forest Act of 1991, with others looking for future strategy time horizons, such as the Lithuanian Strategy for National Climate policy to 2050.
Costs and sources of funding	The majority of Member States do not list explicitly the sources of funding used for afforestation or reforestation measures. Where funding is mentioned, this is primarily related to the **CAP (EAFRD).** The national afforestation policy in DE (GAK[107]) is used to support the enhanced use of forests and provides a parallel source of funding to that of EAFRD, with different objectives.
Expected impact	The following quantified impacts of afforestation and reforestation are given in the Member State reports: - HU provides the most comprehensive assessment quoting "Afforestation - 196,000tCO_2 removed by 2020; fast growing tree plantations on agri land - 218,000tCO_2 by 2020; agroforestry - 48,000 tCO_2 by 2020" - LT identifies "In the Action plan target and assessment criteria are set in order the minimum annual removals by sinks in LULUCF shall comprise 3.7 MtCO_{2eq}." - The UK identifies a potential impact of "0 to 30 MtCO2 over 5 years UK GHG" - DK quotes removals of 1.134 MtCO_{2eq} by 2020 - LV "On average, afforestation of 1 ha will contribute to removal of 596 tonnes of CO_2 during the rotation or 7.4 tonnes of CO_2 annually." - DE did not identify explicit quantified impacts, but do suggest the limited potential of afforestation due to limits on the appropriate number of sites
Links to (other) policies or measures	11 Member States make explicit links to other policies or measures (LT, IE, HU, AT, EL, ES, FI, BG, LU, SE, LV). These are primarily **CAP RDPs**, but include also **climate change** action plans and policies, **biodiversity** policy, national **forest policy** and rural **economic diversification** plans.
CAP relevance	19 of the Member States reporting for afforestation and reforestation identify the CAP as a policy tool to support action. This is primarily in relation to Rural Development support under **CAP** e.g. through "afforestation and creation of woodland" (M08, sub-measure 8.1); "establishment of agro-forestry systems" (M08, sub-measure 8.2); "afforestation of abandoned farmland, afforestation

[107] Original: Rahmenplan der Gemeinschaftsaufgabe „Verbesserung der Agrarstruktur und des Küstenschutzes"

	of degraded land" reported by MT; PL, DE, LU, AT, BE, DE, LV, HR, BG), but includes some instances of the use of **CAP Pillar I** Greening support provided by the EAGF (e.g. LU, EE, PL, IE, HU, EL, ES, HR, BE and FI), mainly as EFAs but the information needed to determine specific measures is not stated explicitly in most cases.
Data sources	At measure level, only one academic paper is listed as a data source on which afforestation and reforestation has been developed.

Biomass for energy use

Area of intervention	**Substitution of GHG intensive energy feedstocks with HWP and other biomass**
Short description including examples of measures/policies	Forest and agricultural biomass use for energy purposes is a popular LULUCF-relevant activity, Member States report **92 measures and policies** in this area (including 4 planned and 9 potential initiatives). A range of reported **measures** include: - Favouring grass crops on organic soils for biogas production (FI) - Energy advisory and training services promoting "efficient use of woody biomass for energy purposes" (ES, SE, FR, AT) - Task Force Renewable Energy (AT) - Sustainable forest management (SE, ES, LT) - Energy accord between the National Government and social and private partners (NL) - Heat Fund, renewable energy feed-in tariffs, green certificates and other economic incentives to drive bioenergy demand (FR, AT, IE, DK) - Research activities involving a survey on energy crops (EE) - Focus on farm or groups of farms capacity to generate and use biofuels and biogas; Expand the area of woody and non-woody biomass crops (RO) - Promotion of efficient use of woody biomass and its use to improve ambient air quality, support to energy advising and training and development, Promotion of the use of energy from the biomass (SI) The reported **policies** include: - Biomass Action Plan (NL, FR, EE, CZ) - Emissions Trading Scheme (as a national implementation of the EU Emission Trading System) (AT) - National Renewable Energy Action Plans (ES, SI, RO, LT, EE) - National Wood Utilisation/Forestry action plans or strategies (SK, SE, FI, SI) - Rural Development Programme (AT, HU, EE, RO) - Bioeconomy policy (FI)
Type of instrument	The reported Member States actions are spread almost equally between policy and measure categories. In terms of policy instruments, the actions relevant to biomass use for energy purposes

	are part of the Member States **policies outlined in national strategies and action plans**. Some Member States report bioenergy activities under their National Renewable Energy Action Plans (LT, RO, SI, ES, EE) or/and bioenergy sector specific strategies and action plans. Reported references to bioenergy promotion could be found in relation to the Rural Development Programmes, forestry strategies and action plans, as well as strategic documents relevant to climate policy (e.g. Finland's Medium-term Plan for Climate Change Policy adopted in 2017). Some Member States also report **economic incentives** to promote bioenergy production, such as the "Fonds Chaleur" (Heat Fund) in France supporting mainly forest biomass for heat production. Other reports are focused on agricultural biomass for energy, especially in biogas production. Other types of relevant policy instruments include: legal requirements (e.g. on sustainable forest management, SE), information and awareness raising tools (e.g. Klima:aktiv initiative, DK), research activities (e.g. survey on energy crops, EE), and voluntary agreements between public and private sectors (e.g. government accord, NL).
Objective	Among the stated objectives driving bioenergy related policies and measures, there are: - Replacement of fossil fuels/decarbonising power and industry sectors - Promotion of renewable energy sources - Drive demand for forest bioenergy - Limiting GHG emissions from livestock sector/improved manure/slurry management (thanks to agricultural biogas production) - Enhancement of sustainable forest management - Development of bioeconomy - Energy security thanks to reliance on domestic energy feedstocks Reduction of GHG emission from LULUCF related activities is usually a **secondary objective** in the reported measures and policies. LULUCF's contribution to climate change mitigation in this respect is often indirect; it is contributing to replacement of fossil fuel with biomass, therefore reducing GHG emissions in sectors other than LULUCF (notably, but not exclusively, from the energy sector).
Scope	Biomass use is mentioned in 49 policies and 43 measures reported by **19 Member States** (AT, BE, HR, DK, CZ, EE, FI, FR, HU, IE, LV, LT, NL, RO, SI, SK, ES, SE, UK). As presented on the map below, the main geographic concentration of the Member States which report bioenergy initiatives as relevant to LULUCF is in the Nordic and Baltic countries, as well as in those Central European and Southern Member States where the agriculture or forestry sectors are particularly strong. There is no information available about the

	estimated volume of energy produced, surface of energy crops, or volume of wood biomass dedicated to energy purposes.  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Costs and sources of funding	Although the sources of funding for bioenergy related measures and policies are generally not defined in the reports, some indicate the contribution of **national budgets** as well as the **EAFRD**.
Expected impact	Finland provided the following estimates of the impacts per measure: Biogas/manure separation => sum of emissions of 58.57 $MtCO_2$ over the 2013-2020 period. With +13.31 MtCO2 as a net result for the accounting period 2013-2020. The FI report also notes that "Biogas production or manure separation together with transport of phosphorus containing the dry fractions of manure would reduce the need to clear new lands for manure spreading, and this would show as emission reduction in croplands. However, the effect in 2013-2020 would be modest since the increase in the area was assumed to stop only from 2015 onwards." No others estimates for bioenergy relevant measures and policies have been reported.
Links to (other) policies or measures	The reported measures and policies relevant to biomass use for energy are predominantly linked to climate, energy (including the implementation of the Renewable Energy Directive 2009/28/EC) and forestry policies. In terms of agricultural biomass these initiatives link to climate action in the agriculture sector, including livestock related measures and policies.

CAP relevance	Some of the reported bioenergy related activities (e.g. AT, EE, HU, RO, SK, ES) are eligible for support under the **CAP pillar II**., through a wide range of measures eligible under RDPs such as "Advisory services" e.g. EE (M02) "Investments in forest area development and improvement of the viability of forests" (or just referring to sustainable forest management) e.g. SK, RO, LT, ES, SE, EE, FI (M08) and "Investment in physical assets" e.g. RO (M04). CAP pillar I - Greening is reported by FI growing "short rotation energy wood " on EFAs.
Data sources	Non-specified at measure or measure category level. For more details see section 2.2.

Biodiversity/nature conservation measures

Area of intervention	This is not a category specifically listed in Annex IV of the LULUCF Decision but is an area identified as important and which also relates to a number of different land categories, given the importance of wetlands, forests, grasslands and farmland for biodiversity.
Short description	There are many measures and instruments that make reference to delivering biodiversity or which deliver biodiversity as one of a number of outcomes. The focus of this section is on initiatives linked to biodiversity that have a direct LULUCF benefit whether this be the regeneration/restoration of wetlands, protection of organic soils, the increase in protection of semi natural grasslands, changes in management practices on arable land or in forests that lead to carbon sequestration. Biodiversity and nature conservation is directly relevant to the delivery of LULUCF goals in **92** (including 3 planned and 2 potential) **measures and policies** reported by the Member States. A range of reported **measures** include: - Subisidies for the conversion of arable land on organic soils to nature (DK) or to pasture (LU, LV) - Shelter belt restoration (BG) - Agroforestry measures (e.g. creation of small pockets of forest land on agricultural land at risk of soil erosion etc) (EE) - Support for the maintenance of pasture land (PL through additional support for sheep, SE) or semi natural grassland (EE) - Rehabilitation of moorland (DE – specific targets noted at Länder level for delivering 20% of moorland in natural management by 2010 and another 10% by 2020) and restoration of wetlands (BE, BG), protection of bogs (UK) - Sustainable forest management and increasing forest biodiversity and resilience (AT, BE, DK)

	- Initiatives to limit consumption of peat in horticulture (UK) - Protection and management of the Natura 2000 network (NL, MT, EE specifically support for private forest owners) The reported **policies** include: - Rural Development Programmes are commonly cited as being important to securing both general biodiversity goals, but specifically maintenance of certain habitats relevant to LULUCF such as grasslands (FI, HU, EE); addition of valuable features for biodiversity eg shelter belts (BG, BE through non-productive investments) and agroforestry systems (EE) - Forestry strategies, Acts and Development Plans (BG, DK, EE, FI, LT, LU, EE) - Biodiversity Strategies (AT, EE, FI, DE) - Fruit & vegetables Common Market Organisation - Environmental Framework (IT) - Strategies and Action Plans to combat Climate Change (BG specifically mentions support for addressing restoration of wetlands and peatlands in this context) It should be noted that there are a very wide range of policies and measures potentially relevant to this category. The common theme is that they all provide for the development, protection, restoration or enhancement of a land use that is beneficial in LULUCF terms. Logically this will encompass a wide range of motivations and policy tools.
Type of instrument	Most measures and policies are supported with economic incentives, generally related to either funding for Natura 2000 sites or funding linked to RDPs or State aid supporting sustainable forest management. 15 plans and strategies are listed; these relate to biodiversity strategies, action plans for wetland protection and strategic approaches to the management of specific challenges such as wetlands and Forest Management Plans. There are also 11 entries relating to legal standards and requirements. These are commonly laws implementing the requirements of the EU nature directives and establishing the Natura 2000 network.
Objective	The common thread linking the policies and measures is the ability of measures for **biodiversity to contribute to management of land** in line with LULUCF priorities. There are some linked measures and policies cited as directly relevant to delivering GHG mitigation and these relate primarily to the conversion of organic **soils** to favourable **habitats** for biodiversity, or the c**onversion of arable land to pasture**.
Scope	Biodiversity is mentioned in **33 policies and 59 measures** reported by **25 Member States** (**AT, BE, BU, HR, CZ, DK, EE, FI, FR, DE, HU, EL, IE, LV, LT, LU, MT, NL, PL, SI, SK, ES, SE, UK, IT**). As presented on the map below, biodiversity protection is directly targeted by LULUCF relevant measures and policies in almost all EU Member States.

	 *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Costs and sources of funding	A number of sources of funding are highlighted including state aids specifically in relation to forestry, **LIFE+** in particular for wetland restoration. The most commonly noted source of funding is however via **Rural Development Programmes**. The reported information on costs includes: - Non-productive investments under RDP in Flanders (BE) 3.6 mln EU (EU + Flemish budget) for this measure for an expected total of about 2.875 projects. - HR's budget with support from EAFRD: "Preservation of high nature value grasslands" => 5.25 mln EUR over 2015-2020 period, "Pilot measure for protection of corncrake (lat. Crex crex) => 878 400 EUR , "Pilot measure for protection butterflies" => 720 000 EUR - EE "Natura 2000 support for private forest land" => 28 mln EUR (public sector, not specified), "Natura 2000 support for agricultural land" => 4.66 mln EUR (public sector, not specified) - FI "the Act on Financing of Sustainable Forestry" reports "in 2015 a total of 1.735 million euros were used for environmental support and 1.337 million for nature management projects." - LT "Support for environmentally friendly agriculture management programs Implementation of biodiversity conservation projects" => 47.3 mln EUR per year between

	2014 and 2020 (EAFRD + national budget), "Ensure compliance of environmental restrictions in forestry to maintain biodiversity and stable populations." => 3294.6 EUR (not specified)
Expected impact	For most measures only qualitative information is provided about the potential impact such as increasing sequestration, reduction in CO_2, CH_4, and NOx emissions. HR's "Pilot measure for protection butterflies" is expected to deliver "CO_2, N_2O emission reduction, increase in carbon sequestration. In addition to reducing the risk of water pollution in surrounding water bodies, the measure has a positive effect on GHG removals through carbon sequestration by planted trees over the years to come." Quantitative estimates are available in: - SE reports an expected emission reduction in a range of 0.058-0.145 $MtCO_{2eq}$ with 40% implementation - Max per ha/year: 0.186 $MtCO_{2eq}$ as well as "increase of soil organic matter, less run-off of nutrients and pesticides to surface water systems, increase of the biodiversity" under "Provisions on nature reserves and habitat protection in the environmental code and nature conservation agreements". - FI "Financial support from the state for forest management and improvement work" under RDP (EAFRD + national budget) => 0.9 tCO_2/ha
Links to (other) policies or measures	As noted above this category relates to a wide number of other areas of intervention including **forest management, wetland protection and restoration, grassland management, management of farmland**.
CAP relevance	**CAP (both pillars)** are highlighted as relevant, with a prevalence of **RDPs** (pillar II) and their Natura 2000 dedicated measures (M12). Other RDP relevant measures are "Agri-environment-climate (M10) and "Investment in physical assets" (M04). Not explicitly linked measures such as Extensification of fertilisation and of use of meadows (LU), establishment of agro-forestry system (HU, EE) are also mentioned. In NL the RDP includes a measure for meadow bird management to raise the groundwater level in peat pasture areas (groundwater level impact on peat pastures is presented in Box 6 below). CAP pillar I is mentioned e.g. by PL with regard to the preservation of permanent pastures requirement as part of the direct payments scheme.
Data sources	At measure level, HU's estimates are based on academic literature/research results. SE reports the use of MITERRA-NL accounting model.

Grassland, grazing land and/or pasture management

Area of intervention	Grassland, grazing land and/or pasture management

Short description	Grassland management, grazing land management and/or pasture improvement is pursued by **71** (including 4 planned and 5 potential) **measures and policies** reported by the Member States. A range of reported **policies** include: - CAP greening (UK, DK, PL, HR, IT, BE, EE, FR, MT, SK, ES) - CAP cross compliance (UK, BE, CZ, FR, SK, DE) - CAP Rural development programmes (EE, RO, BE, LU, FI, IE, PL, ES, DE) - Nature Protection Act, protection of Natura 2000 areas (DE, SK, NL, LU, EE, BE) The reported **measures** include: - Pastures suitable for carbon storage (DK) - Preservation of high nature value grasslands (BE - Intensification of pasture on mineral soils (UK) - Intensification of rough grazing on organo-mineral soils (UK) - Management of pasture land (SE, RO) - Introduction of legumes in managed pastures to replace synthetic fertilization (ES) - Payment for sheep kept in agricultural holdings situated in vulnerable areas (PL) - Grassland sheep scheme (IE) - Grassland renovation (NL) - Maintenance of permanent pasture (HR, DE) - Agroforestry measure ensuring coexistence of forest and grassland (BE)
Type of instrument	A vast majority of the reported measures are subject to two main policies reported by the Member States as relevant to grazing land and pasture management (**CAP greening and rural development programmes**). Most measures are supported with **economic incentives** such as green direct payments.
Objective	The relevant measures and policies have the following objectives: - to stimulate the development of multifunctional grasslands or strips of land to combat erosion, - to improve the quality of maintenance of semi-natural habitats - to preserve and increase biological and landscape diversity; - to maintain permanent grassland area/to avoid massive conversion of grassland to arable land - to reduce GHG emissions from agricultural land - to address emissions from cultivated organic soils - to increase sequestration and loss of soil carbon - to increase the quality and production of grass - rural development - to improve soil fertility - to confer greater resilience to grassland and improve adaptation to climate change - to promote better grassland management

	Many reported measures and policies put GHG emission reduction and carbon sequestration as their **primary objective**.
Scope	Grassland/grazing land/pasture management is mentioned in 20 policies and 51 measures reported by **23 Member States** (**BE, BG, CZ, HR, DE, DK, EE, FI, FR, IE, IT, LU, LT, LV, MT, NL, PL, RO, SK, SI, SE, ES, UK**). As presented on the map below, grassland/grazing land/pasture management measures and policies are taken up by a vast majority of the Member States across the EU.  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision Several Member States report on the expected impacts in terms of surface of the **area** covered by the measure or policy. In BE, Agreements for reduced fertilizer use in and in the vicinity of Natura 2000 grassland are expected to apply to 500 ha grassland in Flanders by 2020. In Wallonia the scope is measured in annual increase of the relevant area: 6.035 ha per year for the period 2014-2020. In EE, the aim of "Support for the maintenance of semi-natural habitats" is to cover 40 000 ha by 2020. NL reports that "Starting from the 1970, grassland renovation has increased till its maximum extent of about 100 000 ha per year (about 10% of the total grassland area) around 2010, whereas in recent years a decrease is observed."
Costs and sources of funding	The main source of funding of the grassland/grazing land/ pasture management related measures are the funds deployed to implement the CAP, namely the **EAFRD and EAGF** as well as **national budgets**. The costs of individual measures are therefore often derived from the RDPs – e.g. EE plans to spend 40.2 mln EUR in the 2014-2020 to

	support maintenance of semi-natural habitats. In LV, nearly 10 mln EUR will be spent on afforestation of abandoned farmland (mostly pastures), which is expected to be the most cost effective measure in LV's RDP, responsible for 85% of GHG removals.
Expected impact	Several Member States provided quantitative estimates of the expected measures in terms of surface covered (see Scope section above). In terms of GHG emissions, the following expected impacts could be identified: - LV – "Afforestation of abandoned farmland (Afforestation and improvement of stand quality in naturally afforested areas)" => on average, afforestation of 1 ha is expected to remove 596 tonnes of CO_2 during the rotation, or 7.4 tonnes of CO_2 annually. "Reduction of CO_2 and N_2O emissions from soil due to land use change from cropland or grassland to forest land is not accounted, considering that there are no benefits proposed in the RDP for afforestation of organic soil." - NL – "Grassland renovation" => assumed 30% implementation – a max. removal per ha/year is 3.586 tCO_2 "With the current pragmatic approach for reporting CM and GM under 2013/529 it is not possible to assess the effects of specific cropland or grassland management activities on reported emissions. MITERRA-NL model assesses the effects and interactions of policies and measures in agriculture on GHG emissions on a regional scale. Other Member States mention qualitative expected impacts such as: - increase of **removals** of emissions (CO_2, N_2O, CH_4) from agricultural land, - **reduction of emission** from **fertilisers** and **plant production products** (reducing or optimising their use), and - **accumulation of CO_2** in living and dead biomass, litter and soil/increased carbon sequestration.
Links to (other) policies or measures	The measures and policies in this area are linked by the reports to Natura 2000 and wider **biodiversity** policy measures, rural development, **CAP**, sustainable agriculture, and climate change **adaptation**. 11 measures involve **erosion prevention** activities relevant to "Protection against natural disturbances" measure presented in section 3.2 of this report.
CAP relevance	The measures relevant to grassland, grazing land and pasture management are supported under both pillars of the CAP. Under pillar I, it is two out of three Greening measures categories, namely maintaining permanent grasslands and EFAs that are quoted most often (MT, DE, BE, PL, IT, SI, ES, EE, FR, HR, NL) followed by a reference to cross compliance requirements (SK, UK, CZ; LU, FR, HR, BE). Under pillar II, it is the "Agri-environment-climate scheme

	(M10) that are most popular in this respect (SK, PL, RO, LU, LT, LV, IE, DE, FR, FI, EE, CZ, HR, BE) .
Data sources	LV reports that data required to estimate impacts of "Maintenance of biodiversity in grasslands" is based on Tier 1 method. NL reported that "the calculation of the change in soil carbon stocks was based on the IPCC 2006 guidelines in combination with soil carbon stocks resulting from the Dutch soil database (LSK). Because the environmental assessment model, MITERRA-NL, works on 4 digit postal code level, the effects of changes in land use can be assessed explicitly and measures can be analysed spatially." No other information about the sources of data was provided at a measure level.

Box 6 Submerged drains in pastures on peat soils (NL)

More than 70% of Dutch **peat soils** are used as permanent pasture for dairy farming. Their drainage results in peat subsidence, mainly by decomposition (oxidation). This is a regularly occurring source of **GHG emissions** as every 10 to 15 years ditchwater levels adapt to the lowered surface. The decomposition of peat soils emits about 20 ton/ha/year of CO_2[108].
The Netherlands see therefore a large **potential for reducing emissions** from its cultivated drained organic soils. Raising ground water levels is a complex issue however due to the many different and sometimes competing interests of stakeholders leading to discussions on costs and benefits for these stakeholders over time. To remain productive the ground water level for pastures for dairy farming needs to be lowered. The resulting peat oxidation leads to eutrophication of surface water and subsidence results in problems for infrastructure and housing[8].
Application of **submerged drains** is seen as **an innovative solution** to reduce carbon loss due to drainage of peatland for dairy farming. Unlike the usual drains, submerged drains are installed around 15 cm below ditchwater level. Thanks to that the grassland is drained in wet periods as with usual drainage but if in dry periods the groundwater levels get below the ditchwater level, water will be infiltrated to reduce subsidence and CO_2 emissions[20].
Social cost-benefit analyses indicate that using submerged drains will be beneficial over time, although this is sensitive to assumptions on the carbon price; but they require an upfront investment for which there is still discussion on who will bear the costs. The use of submerged drains is **currently piloted** in various areas, but so far no policy decisions have been taken on this issue on the national level and as yet no large scale implementation is foreseen[109].

Nutrient, tillage, and water management

Area of intervention	Cropland Management

[108] Alterra (2017) Conservation of peat soils in use as grassland by infiltration via submerged drains, http://content.alterra.wur.nl/webdocs/internet/corporate/prodpubl_eng/factsheets_water/Waarheen_met_het_veen.pdf
[109] NL progress report submitted under Article 10 of the LULUCF Decision.

Short description	Nutrient, tillage and water management are mentioned in **69** (including 1 planned and 7 potential) **measures and policies** reported by the Member States. The measures reported range from adoption of broad management techniques to specific practices. The range of reported **measures** includes: - Conservation tillage ie reduced or no till (DK, NE) - Conservation agriculture (IT) - Support for environmentally friendly horticulture (EE) - Protecting arable mineral soils – essentially through intercropping, reduced till, no till systems (DE) - Extensification of nitrogen fertilizing of selected arable crops (LU) - Leaving crop residues in field and/or banning stubble/residue burning (NE, SE, ES) - Converting cropland from annual tillage crops to perennial crops (potential measure - UK) - Improvement of the management of water resources and to ensure water quality improvement (LT) Importantly, many of these measures were encompassed within a limited range of key policies. The most widely referenced policy actions were: - Rural Development Programmes were mentioned by the following Member States in relation to the following relevant actions, most relating to Agriculture and Climate Measures under the RDPs o AT – low till systems o BE – promotion of crops with low risk of leaching, reduced fertiliser use near Natura sites o HR – limits of nitrate inputs, reduced tillage and limiting types of arable crops on sloped terrain o DK – conservation tillage o EE – support for environmentally friendly horticulture o FI – recycling nutrients, incorporation of manure, managing nutrient load o FR – increasing SOM capacity, return of organic matter to the soils, input restrictions o IE – minimum tillage, reduction in soil erosion and leaching o IT – Conservation agriculture, supporting an increase by 20% by 2020 o LV – stubble remaining over winter period o LU – extensification of fertiliser inputs, reduced tillage/no till o LT - agricultural water projects o PL – stubble retention and creation of fertiliser plans

	○ RO – highlights M10 and M11 under the RDPs ○ SK – buffer strips and annually updated nutrient management plan ○ ES – no stubble burning, use of remote sensing - Cross compliance specifically noted in relation to retention of stubble/residues (HR, FR, SK, SE), fertiliser management (HR, CZ, ES) and no/reduced till (UK, SI) - Implementation of the Nitrates Directive and supporting Action Plans and implementation of Nitrate Vulnerable zones (NL, CZ, FI, HU, IE, LT, MT) the Water Framework Directive was also highlighted in relation to the control of nutrient pollution by LT - Climate Strategies and Action Plans - EE, FI, HU, LT, ES The most important common link between the measures and policies highlighted in relation to the management of nutrients, tillage and water management is the **CAP** and its implementation. The RDPs and measures within them are the most cited source of policy and measure entries in this category. In addition, cross compliance in terms of delivering GAEC was noted as of importance by eight Member States. In addition, cross compliance is also relevant in the context of delivery of other key measures such as the **Nitrates Directive** through the statutory management requirements.
Type of instrument	Given the predominance noted in this analysis of measures and policies related to the CAP, **economic incentive** is the most common type of instrument noted This is due to both RDPs and cross compliance being considered economic incentives due to the receipt of payment for action undertaken, albeit under different pillars of the CAP. Legal standards and strategies and plans are then the most common types of instrument identified. This reflects the importance of action plans both for implementing the Nitrates Directive and in the context of strategic plans for climate mitigation.
Objective	The common themes and objectives noted were - soil erosion prevention, - water management, - improvement of soil organic matter content and soil fertility, - rural development and - the reduction of GHG emissions. One Member State (DK) also noted the reduction in air pollution linked to the banning of stubble burning. Only 5 of the policies or measures cited are explicitly noted as being implemented to deliver GHG emission reductions and of these 4 relate to the reduction of NO_X emissions primarily from the addition of inorganic nitrogen fertilisers. Therefore, emission reduction in the context of the LULUCF sector is very much a **secondary objective** or outcome of actions designed to deliver other goals.
Scope	Nutrient management, tillage and water management are mentioned in 24 policies and 45 measures reported by **24 Member**

	States (**AT, BE, HR, CY, CZ, DK, EE, FI, FR, DE, HU, IE, IT, LV, LT, LU, MT, NE, PL, RO, SK, ES, SE, UK**).  *Yellow colouring shows those Member States who implement measures in this area under their RDPs. Blue highlight shows Member States reporting relevant measures but not under RDPs **As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Costs and sources of funding	The sources of funding most relevant to delivery of measures and policies identified are linked to Direct Payments under **Pillar I of the CAP**, and co-financed payments under **Pillar II** i.e. support under the RDPs. The only other source of funding identified was **LIFE** funding noted by DK (in addition to RDP support) relating to conservation tillage investments. - HR "Tilling and sowing on the terrain with slope for arable annual plants" => 4.2 mln EUR (EARDF + national budget) 2014-2020 - EE "Support for environmentally friendly horticulture" => 3.87 mln EUR (EARDF + national budget) 2014-2020 - LT "To improve the management of water resources and to ensure water quality improvement" => 36700 EUR over 2014-2020 (source not specified), "The implementation of measures of agricultural water projects" => 11500 EUR per year in 2015-2017 (EARDF + national budget)
Expected impact	Reference is only made to the expected impact of 18 out of the 64 measures and policies identified. The majority of comments are qualitative and generic for example that action will lead to an accumulation of soil carbon, improved soil fertility, reduced soil erosion, a reduction in NOx emissions linked to fertilization or higher removal of CO_2 from the atmosphere (in the case of the measure to

	introduce permanent 200m wide bio stripes in SK under the RDP). Several Member States noted that a quantitative description of the impact of expected measures in this field is not currently available or problematic to determine (EE, UK). HU noted a quantitative assessment of impact for the measure to mitigate agricultural emissions with partial change in nitrogen fertiliser utilization and changes in cultivation, set out in their RDP. This measure was estimated to be able to deliver 4–9 tons of CO_{2eq} or GHG emission reduction per hectare using modern soil preparation and fertilization practices.
Links to (other) policies or measures	Reported measures and policies link to CAP, especially its rural development and environmental dimensions, Nitrates Directive and water policy, and climate policy (ES reports policy document guiding mitigation in Effort Sharing Decision[110] sectors), There is a strong potential link to **organic farming** measures and wider initiatives on cover crops/reducing bare soil.
CAP relevance	The **CAP, both Pillar I and II**, is highly relevant to the delivery of policies and measures related to this category of action. Several measures under pillar II are relevant, "Agri-environment-climate" and Natura 2000 and Water Framework Directive payments are mentioned relatively often in this respect (M10 and M12 respectively). Under CAP pillar I: Cross compliance requirements: Statutory Management Requirements and Good agricultural and environmental conditions are supported and reported by e.g. UK and ES.
Data sources	Not specified
Comments/further research questions	A lot of measures relate to reducing fertiliser inputs/use of inorganic fertiliser. This is good as a climate mitigation measure, but may not strictly fall under LULUCF. What does this mean when key measures are actually delivering under other policies? In addition, from a soils/SOM perspective there are likely benefits from decline in use of inorganic fertiliser normally as a byproduct of having to change management to increase soil fertility in another way. Therefore these measures may be relevant but not quite in the way presented by the MS in the current LULUCF reports and you would need to know more about what alternative practices are being promoted as a consequence of dropping inorganic fertiliser use. For example in the Netherlands under the Horizon 2020 project iSQAPER on soil quality and function[111] it was identified that strict implementation of the Nitrates Directive has resulted in a massive drive to decrease

[110] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, OJ L 140, 5.6.2009, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2009.140.01.0136.01.ENG

[111] Joint sequestrate ion.EU, China, and Switzerland research and innovation project, more details available on project website: http://www.isqaper-project.eu/.

	fertiliser use, on some farms this has directly drive a more holistic approach to soil management with improvements due to reduced NOx but also due to changes in practice increases in SOM and

Conservation of carbon in existing forests

Area of intervention	Forestry activities: conservation of carbon in existing forests
Short description	Conservation of carbon in existing forests is targeted by **28** (including 10 potential) **measures and policies** reported by the Member States. A range of reported **measures** include: - Forest litter removal (AT) - Stabilization of carbon volumes bound in forest ecosystems (CZ) - Increasing forest increment and ability to sequestrate carbon through timely regeneration of forests (EE, SI, SK, LU, CZ) - Taking forest out of production (DE) - Requirement to protect forest land (HU) - Integration of climate change aspects in the forest monitoring system (HU) - GHG removals through forest management (SK) - Forest Climate Fund (DE) - Pilot project "Forest Carbon Farms" (PL) - Recognition of general interest in the storage of CO2 by forest and wood products (DE) - Restoration and protection of wetlands in forest areas (BG) - Consultations and forestry science application (LT) The reported **policy instrument** is the Forest Code (BE)
Type of instrument	The reported measures are implemented through a **mix of economic incentives and legal requirements**. In many cases however, there was no sufficient information at measure level to identify a type of instrument through which it is put in place.
Objective	The following objectives have been reported for carbon conservation in existing forests measures and policies: - to increase GHG sequestration - to increase the potential of forests to capture carbon - to stabilize accumulated carbon/preserve carbon sinks - to mitigate climate change - to adapt forests to climate change - to demonstrate the role of forests in climate change mitigation - to create a model of carbon accumulation in forests - to improve the inventory methods of CO_2 removals in forests for reporting purposes It is worth noting that **enhanced resilience of forests** to climate change is one of the most frequently mentioned objective of carbon

	conservation measures and policies. Impacts on GHG emissions, especially in terms of increasing and preserving carbon sinks, is among the **primary objectives** of a majority of the reported measures (alongside enhanced resilience).
Scope	Conservation of carbon in existing forests is mentioned in 1 policy and 27 measures reported by **14 Member States (AT, BE, BG, CZ, EE, FR, DE, HU, LT, LU, PL, SI, SK, UK)**. As presented on the map below, conservation of carbon in existing forests covers vast parts of Central and Western Europ  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision
Costs and sources of funding	There is very little information about the sources of funds deployed to support carbon conservation measures and policies provided in the reports. BG mentions the use of **LIFE** programme, as well as national budget. CZ and BG report some measures as part of their respective RDPs, so the use of **EAFRD** is implied in both cases. DE points to the national budget. Information on relevant costs is scarce. - BG estimates that restoration of floodplain forests will cost some 10 mln BGN while the inventory and assessment of peatlands in forest areas will cost some 5 mln BGN. - EE's "Increasing forest increment and ability to sequestrate carbon through timely regeneration of forests for climate change mitigation" budget in 2014 was 77 000 EUR; in 2015: 64 000 EUR, and in 2016-2020 it is expected to total 500 000 EUR.

	- LT's "Investment in the resistance and environmental value of the forest ecosystems" cost is some 326.5 mln EUR/year from EAFRD and national budget.
Expected impact	Generally, the expected qualitative impacts reflect the hopes behind the stated objectives of the reported measures and policies, and can be summarized as follows: - CO_2 emissions reduction, - Carbon sequestration, - Increased public awareness and knowledge base, - Improved methodologies for data collection and carbon balance modelling. Two Member States provided more quantitative definition of the expected impacts. SI ("Conservation of carbon in existing forests" measure) reports that according to its National Forest Programme "the accumulation of annual wood increment should amount to at least 1 mln m^3 per year considering the sink Slovenia can implement in the first commitment period of the Kyoto Protocol. (…) it is estimated that the sink of CO_2 in overgrowing areas can contribute an additional 5%." BG's "Protection and preservation of wetlands in forest areas" was expected to reduce emissions by 4 681 tCO_{2eq} by 2020. However in the reporting period 2014 – 2016, more than 3 066 tCO_{2eq} reduction has been registered (65% of the 2020 target value). By the end of 2016, 131 ha wetlands have been restored / preserved, 51 ha above the 2016 target. Similarly," Increasing the density in the listed natural and artificial plantations" (BG), was expected to save some 16 720 tCO_{2eq} by 2020, with 1 500 ha plantations with increased density by the end of 2016. The mid-term reporting data shows however that over the period 2013 – 2016 the measure led to (i) reductions of 89 339 tCO_{2eq} (more that 530% of the 2020 target value), and (ii) area of plantations with increased density of more than 18 701 ha (17 201 ha more than 2016 target value). In both BG cases a significant **overachievement of targets** can be observed/expected.
Links to (other) policies or measures	Measures and policies aiming at conservation of carbon in existing forests are very closely linked to **Forest management** (see section 3.2) including **protection against natural disturbances and deforestation**. While deforestation and natural disturbances prevention are covered under Forest management section, the remaining measures selected as relevant predominantly to conservation of carbon in forests are described in this section. One of the reported measure presented here is closely relevant to Measures to prevent drainage and **rewetting of wetlands**. The selection of measures to be covered under "conservation of carbon in existing forests" is therefore somewhat arbitrary and based on the explicitly stated objectives of the measures as reported by the Member States.

CAP relevance	Some measures fostering conservation of carbon in existing forest are eligible for support under **CAP, pillar 2**. CZ, BG, EE report their measures relevant to this category as being supported under their respective RDPs (M15 but no explicit link made apart from CZ).
Data sources	There is **no specific information** provided at measure level; where mentioned, data sources are those used for **reporting under UNFCCC**.

Box 7 Forest Carbon Farms (PL)

The Polish government's new initiative aims at increasing carbon stock in Polish forest through enhanced forest management. The Polish report reminds that the Paris Agreement encourages its signatories "to take appropriate measures to increase the potential to remove GHG by forests and allows to account for these activities in the future." In 2015 the Polish government's idea on how to achieve this was put in motion by the State Forest Holding that is preparing a pilot project "Forest Carbon Farms". "Forest Carbon Farms" rely on additional activities carried out as part of sustainable forest management. The reported objectives of the project include:

- Demonstrating the role of forestry in mitigating the negative effects of climate change, and removing atmospheric CO_2 in the environment.
- Creating a model of carbon accumulation in Polish forests, taking into account their diverse structures.
- Selecting stands for the so-called forest carbon farms, where additional measures will be carried out (beyond planned forest management) with the intention of increasing CO_2 accumulation in forest ecosystems, and testing the efficiency of these activities.
- Improving the inventory methods of CO_2 removals in Polish forests for reporting purposes.

The first stage of the project "Forest Carbon Farms" is to include 26 forest districts of the State Forests, with a total surface area of more than 20 000 ha. When modelling the carbon balance, the project takes account of the carbon reservoirs in the forest ecosystem, in line with the reporting Poland applies under international agreements. It is also consistent with the system of determining wood resources applicable in Polish forestry: above-ground biomass (including standing volume, woody debris, assimilative apparatus, understory), underground biomass (including thin and thick roots), litter, dead wood, and organic carbon in soil. The effect of additional activities in "Forest Carbon Farms" depends nevertheless on the entire forest ecosystem.

The expected impacts of "Forest Carbon Farms" include:

- increasing public awareness of the stabilising function of forests in the context of climate change caused by the increase of GHG in the atmosphere;
- increasing practical knowledge in the field of the carbon accumulation capacity of individual carbon pools of forest ecosystems;
- developing and implementing a method for mass collection of data for developing and updating the model of forest carbon balance, an inventory of carbon accumulated in forests, and an assessment of the amount of carbon removed by the additional activities implemented as part of forest management; and

- developing a model of the forest carbon balance: the development of original Polish allometric equations and conversion factors for biomass is expected to improve the quality of reporting methods for CO_2 removal by forests.

Additional pluriannual programmes for rebuilding the species composition of forest stands and programmes for shaping their multi-layer structure will be created within forest carbon farms. It is assumed that the additional effect can be achieved also by means of revising the age of generational replacement of stands and changing the forest renewal system.
In May 2017 the State Forest Holding released a video to explain and promote the initiative[112].

Organic farming

Area of intervention	Cropland and grassland management/agricultural organic soils improvement/organic agricultural production - cross cutting through areas listed in Annex IV of the LULUCF Decision
Short description including examples of measures/policies	Organic farming is mentioned in **25 measures and policies** reported by the Member States. The reported organic farming measures are principles and standards applicable to organic agricultural production. Generic term "organic farming" was reported by BE, HR, CZ, EE, LV, SK, PL, ES, IT. RO mentions organic farming under "Improved management of soil organic matter" measure. LT reported it under "Support for environmentally friendly agriculture management programs". The reported **policies** include: - Action Plan for Development of Organic Farming 2016–2020 (CZ, PL, SI) - Rural Development Programme (CZ, PL, SI, BE, AT, HR, EE, FR, LT, MT, RO, SK, ES,)
Type of instrument	A vast majority of reported measures involves **economic incentives** to organic farming. Half of the reported initiatives in this area are plans and other strategic documents, mostly the rural development programmes under CAP.
Objective	The stated objectives of organic farming include: - Support for sustainable agriculture and forestry - Rural development - Improvement of soil management and biodiversity - Benefit to the environment and animal welfare - Preservation of the local crop varieties and domestic animal breeds valuable for cultural heritage and genetic diversity. - Competitiveness of organic farming - Improvement of soil fertility and water quality - Avoided degradation of land

[112] The video is available in Polish and English here: https://www.youtube.com/watch?v=pHPAiIO6N4s

	Reduction of GHG emission from LULUCF related activities appears to be a **secondary objective** of organic farming for the Member States who report it as a LULUCF-relevant activity.
Scope	Organic farming is mentioned in 18 existing policies and 7 existing measures reported by **16 Member States** (**AT, BE, HR, CZ, EE, FR, IE, LV, LT, MT, PL, RO, SI, SK, ES, IT**). As presented on the map below, the geographic concentration of the Member States is Central Eastern Europe, the Baltic States, as well as France, Spain and Ireland.  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision There is no systematic information about the surface area covered by organic farming measures, but the following information could be found in the reports: - BE reports 10 000 ha covered with organic farming in 2007-2013 in Flanders. In Wallonia 55 000 ha were under organic farming in 2012. Both figures are due to significant increases in the total area under organic farming in Belgium. The aim of Wallonia is to reach 14% of the agricultural area under organic farming by 2020. - CZ reports that at the end of June 2015, a total of 4 176 farms applied organic farming practices on 503 000 ha of land, which represents a 12% share of the overall agricultural land. - In EE, there were 1 013 enterprises producing organic products in 2005 (using 59 742 ha of farm land). In 2012 the

	number of the enterprises reached 1 478 and they were using 144 149 ha of land. Organic farm land constituted 15.3% of the total agricultural land in EE in 2012. 75% of organic farm land was grassland. - In ES, 17 out of 18 2014-2020 RDP's include organic farming measures.
Costs and sources of funding	Although the sources of funding for organic farming measures and policies are generally not defined in the reports, 13 indicate the contribution of national budgets as well as the EAFRD under the RDPs. Several Member States reported on the past and expected budgets supporting organic farming. - BE reports 6.7 mln EUR (EU + Flemish budget) spent on support for organic farming in the period 2007-2013 resulting in a covered area of about 4.000 ha in Flanders in 2014 and almost 10.000 ha for the whole programming period. About 7.8 mln EUR (EU + Flemish budget) will be allocated in Flanders for organic farming in 2014-2020 programming period. - In EE, around 925.2 mln EUR of public sector funds support agriculture and rural development over 2014-2020 period, including 583 000 EUR for growing plants of local varieties and 92.2 mln EUR for organic farming. - In ES a combination of agri-environmental measures and organic farming under the RDPs represents over 16% of the total EAFRD allocation for 2014-2020 (slightly below the contribution to forestry measures). This amounts to more than 1.3 mln EUR from EAFRD, and total of nearly 2 mln EUR. - In LT 47 305 000 EUR per year is allocated to "Support for environmentally friendly agriculture management programs and Implementation of biodiversity conservation projects". - HR plans to spend 40 913 117 EUR on payments to conversion to organic farming practices and 87 396 507 EUR on payments to organic agricultural practices between 2015 and 2020.
Expected impact	Reports do not provide any quantitative estimates of the expected GHG-emission related impacts from organic farming. Several Member States spell out the expected area (ha) target (see Scope section above) and qualitative emission related impacts - lower emissions N_2O a CH_4 – reducing or optimising use of fertiliser, plant protection products. (SK), - limitation of direct N_2O emissions from N fertilization by improved and adequate fertilization practices on cultivated soils, either based on inorganic fertilizers or organic manure. This would be achieved by adjusting fertilizer N application rates to match crop needs, e.g. avoiding N applications in excess and applying fertilizer and manure when it is least susceptible to loss i.e. when crops are growing most actively.

	Potential is meaningful for both small and large farms as they all manage various types of sources of N_2O. (RO) - Increased absorption of CO_2 and decreased risk of N_2O leakage due to protection of soil organic layer (LT) - CO_2, N_2O, CH_4 emission reduction, carbon sequestration (EE) - impact on GHG emissions and carbon sinks; minimum requirements for soil erosion and soil organic matter levels, as well as the obligation for farmers to maintain permanent grassland are illustrative for these impacts. Inter alia, the management requirements arising from the European regulations and directives prohibit the modification of certain vegetation and landscape elements and provide requirements for the storage and for the low-emission application of manure. climate change mitigation by reducing the use of fossil fuels (for fertiliser and pesticides production) and by increasing the organic carbon content of farmed soils (BE)
Links to (other) policies or measures	The reported measures link to policies aiming at **agricultural sector competitiveness and climate policy**. The is an overlap between some organic farming measures and policies covered in this section and those relevant to **Biodiversity/nature conservation** (section 3.5) and **Nutrient, tillage, and water management** (section 3.6).
CAP relevance	Organic farming related activities are eligible for support under **both pillars of the CAP**. 13 Member States reported organic farming activities as part of their rural development programmes (pillar II of the CAP, M11).
Data sources	Non-specified at measure or measure category level. For more details see section 2.2.

Restoration of degraded land

Area of intervention	Restoration of degraded lands
Short description	Restoration of degraded land (excluding wetland restoration) is mentioned in **23 existing measures and policies** reported by the Member States. A range of reported **measures** include: - Recovery of damages on forests caused by fires, natural disasters and illegal actions (BG, CY, LV, ES) - Afforestation of degraded land (HR, BG) - Restoration of the land degraded by peat extraction (EE, UK) - Restoration of contaminated sites and water bodies (EE) - Restoration of agricultural degraded lands (RO) - Re-vegetation and reforestation of Asbestos Mine and further restoration of abandoned mines (CY) The reported **policies** include: - Laws on land reclamation and restoration (BG, PL, EE) - Action Plan to the Strategy for the National Climate Change Management Policy (LT) - National Strategy for Sustainable Development (RO) - Forest sector strategies (RO) - National Renewable Energy Strategy (RO) - Pilot Peatland Code (UK) - Strategic Approach to the Restoration of Blanket Bog (UK) - Rural Development Programme (UK) Both **forest and agricultural degraded land** are the main targets of the measures and policies. Peat extraction sites and other mining areas are also targeted. There is very little detail provided on technical aspects of the restoration measures. BG and UK measures for instance involve stock taking of degraded land. Other actions consist of water regime control to speed up revegetation of the former peat extraction areas. Legal instruments provide obligations to restore land, relevant standards and indication of the source of funding.
Type of instrument	The majority of the reported instruments in the field of degraded land restoration is in the form of **economic incentives**. These are followed by **legal instruments and strategic documents**. The type of instrument was not always possible to identify however, and it is very likely that many of the measures and policies involve a **mix** of strategic, legal and economic tools.
Objective	Among the stated objectives driving restoration of degraded land there are: - increasing of the effectiveness of preventing and combating forest fires and illegal activities in the forests - ensuring that blanket bog habitat is actively moved towards 'favourable' conservation status - improving peatland management and protection

	- increasing the absorption of GHG and thus contributing to climate change mitigation, to the protection of biodiversity and of the soil against erosion - enabling use of land for beneficial purposes - improvement of land productivity (restoration of land for agricultural purposes) Increasing sinks or decreasing sources of **GHG emissions** thanks degraded land restoration has been mentioned as a primary objective in two reports. In the majority of reports, degraded land restoration is in the first place expected to foster **productivity** and wider social and economic gains, as well as improve **nature** protection and forest **fire prevention**.
Scope	Restoration of degraded land is mentioned in 11 existing policies and 12 existing measures reported by **10 Member States** (**BG, HR, CY, EE, LV, LT, PL, RO, ES, UK**). As presented on the map below, there is no clear geographical pattern of across the EU; among the countries reporting on degraded land restoration measures are those which are or were active in peat extraction, suffer from frequent forest fires and/or illegal logging activities.  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision In terms of the surface of land affected by restoration measures and policies, the Member State did not provide any systematic information. The following projections/targets from single measures have been reported by 3 Member States: BG => 1 400 ha

	of afforested area, LV => 31 000 ha, Estonia => 2 000 ha. Majority of measures is introduced at Member State level, although part of the UK's measures and policies are reported as relevant to individual countries constituting the UK (namely Wales, Northern Ireland, England; Scotland is not mentioned).
Costs and sources of funding	Although in most cases the costs and sources of funding have not been reported, a number of Member States points out to the financing from **national budget, EU Cohesion Fund, EAFRD, and other** (not specified, possibly LIFE) **EU programmes**. BG reports that the estimated cost of "afforestation of abandoned agricultural land, barren and deforested areas, eroded and threatened by erosion land outside forest areas" (BG) is 7 mln BGN (ca. 3.6 mln EUR) over 2013-2020 period (ca. 2 571.4 EUR per ha), developed under a RDP with EAFRD and other EU funds (not specified) support. CY "Support for the restoration of damages from forest fires, natural disturbances and catastrophic events" will be supported with 500 000 EUR under its RDP.
Expected impact	LV and BG provided quantitative estimates of impacts for one of their respective reported measures and policies. - BG's measure "afforestation of abandoned agricultural land, barren and deforested areas, eroded and threatened by erosion land outside forest areas" is estimated to generate GHG emission reduction of 0.035112 $MtCO_2$ by 2020. However, this target has been overachieved already in 2016, with the reported GHG emission reduction of 0.040265 $MtCO_2$ for the period 2013 – 2016. - LV's measure "Regeneration and reconstruction of degraded and non-valuable forest stands" is estimated to save around 0.0182 $MtCO_2$ (0.59 tCO2/ha) per year, or some 1.86 $MtCO_2$ by 2030. LV reports further that "duration of the impact of the activity is 100 years; however, the most of the contribution will be reached during the first 50 years." and that "The impact on dead biomass and soil carbon pools strongly depends on initial conditions; therefore, it is complicated to predict the impact of the measure on these pools. In evaluation of carbon stock changes in living biomass two scenarios are compared – natural regeneration and planting of trees, considering that planted trees will grow faster according to recent research results". Other reports include the following expected (qualitative) impacts: CO_2, CH_4 emission reduction, and increased surface of afforested land, biodiversity protection, protection against fire and other risks such as illegal logging.
Links to (other) policies or measures	The reports link measures and policies in restoration of degraded land to: **forestry policy, rural development, climate policy, and soil protection**

CAP relevance	Some of the measures are eligible for support under the **CAP, pillar II**. CY, LV, ES, BG, UK (Northern Ireland) have reported use of support to restoration of degraded land under their respective RDPs. In LV "Regeneration of forest stands after forest fires and other natural disasters", CY "Support for the restoration of damages from forest fires, natural disturbances and catastrophic events" (M08, sub – measure 8.4) and ES "Sustainable forest management: Forest health (monitoring and control of damage to forests)" are part of "Investments in forest area development and improvement of the viability of forests" RDP measure (M08). Northern Ireland includes peatland restoration measures within the "Agri-environment-climate" - the Environmental Farming Scheme (EFS), as part of its NI Rural Development Programme 2014-2020 (M10).
Data sources	There is very little information on the data sources used at the level of measure. Apart from non-stated sources, some reports present assumptions based on **research** study results and **expert judgment**.

Substitute of GHG intensive materials with harvested wood products

Area of intervention	Substitute of GHG intensive materials (excluding energy feedstocks) with harvested wood products
Short description	Substitution of GHG intensive feedstocks and materials with harvested wood products is pursued by **22 measures and policies** (including 1 planned and 3 potential initiatives) reported by the Member States. A range of reported **measures** include: - Increasing timber production (EE) - Strategic contract for the timber sector (FR) - Improvement of technologies, practices and equipment for the use, transformation, mobilization and commercialization of forest products, as well as the improvement of the economic value of the forests (ES) The reported **policies** include: - The Government resolution on bioeconomy (FI) - Use of wood in multistory building construction (SE, FR see Box 8 below) - National biomass strategies (FR, NL, SK) - Action plan for material use (DE)
Type of instrument	A vast majority of reported measures and policies in this area takes form of **plans and strategic documents**. Some of the existing on the ground measures are supported with economic incentives. Many measures and policies rely on stakeholder organization (e.g. advisory and organizational activities of bundled sales of timber in LU, and a strategic contract for the timber sector - CSF Bois – in FR) and information/awareness raising campaigns (e.g. information campaigns for promoting timber use in EE, a study improving the understanding of the cascading use of wood in LU).

Objective	The reported objectives are as follows: - to reduce the environmental impact related to the use of fossil fuels and non-renewable natural resources - to renew in business and industry, and spur economic growth in **bioeconomy** and clean technology. - to bring together all **stakeholders** in the timber industry - to coordinate measures contributing to the sector's industrial and economic development including its specific **employment** aspects - to **remove obstacles** in the use of wood for construction - to increase use of wood products - to reduce GHG emissions in **other sectors** - to **sequester carbon** in the LULUCF sector - promoting **renewable** materials Apart from two measures ("Increasing the amount of carbon stored in HWP", SE and "Increasing timber production", EE) LULUCF contribution to reduction of GHG emissions is a **secondary objective** of the reported measures and policies.
Scope	Substituting of GHG intensive materials with HWP (excluding energy feedstocks, covered under "Biomass for energy use") is mentioned in 7 policies and 15 measures (including 7 planned or potential measures) reported by **11 Member States** (**DE, EE, FI, FR, LV, LU, NL, RO, SK, ES, SE**) across the EU.  *As of September 2017 PT did not submit any report under Article 10 of the LULUCF decision

	The coverage appears to be mostly national, with the exception of ES and UK where RDPs are adopted by regions/countries (e.g. 14 out of 18 RDPs include a measure targeted at substituting GHG emission materials with HWP). There is no further information about the surface area covered by the measures and policies or volume of HWP to fall under their scope.
Planning period	Three Member States provided information on the planning period of the reported measures and policies in this area. **2014-2020** perspective was mentioned by SK (The National Programme for Wood Potential Utilization and its Action Plan) and ES (Sustainable forest management: Promotion of the use of other forest products, RDP).
Costs and sources of funding	Two Member States provided cost estimates of the reported measures: - EE "Reducing the environmental impact related to the use of fossil fuels and nonrenewable natural resources by increasing timber production and use in Estonia" 2014: 65 000 EUR; 2015: 65 000 EUR; 2016-2020: 325 000 EUR, and - ES "Sustainable forest management: Promotion of the use of other forest products" will account for 8.5% of the RDPs' budget for forests in 2014-2020 programming period. Apart from the EAFRD in the latter case, no sources of funding could be identified.
Expected impact	No quantitative estimates of impacts associated with the measures and policies in this area could be found in the reports. However, EE expects "to **alleviate climate change**" thanks to the use of timber. It notes that "it is estimated that the amount of carbon deposited in timber products used in Europe forms approximately 30% of the carbon deposited in European forests. Estonia has a large stock of timber. Due to that, the proportion of carbon deposited in timber products is lower than in Europe, but it still amounts to almost 100 mln tons. The duration of **depositing carbon in timber products** depends on the type of products and may exceed half a century in construction products. At the end of a life cycle of timber constructions, timber will be reusable or usable as a fuel without significant costs of energy. Also, use of timber instead of other materials helps **to reduce consumption of fossil fuels and non-renewable natural resources**." Other expected impacts reflect, in qualitative terms, the stated objectives of measures and policies, as presented above
Links to (other) policies or measures	The reported measures link to the following policies and policy objectives: **forestry** policy, **industrial** policy, **sustainable development**, development of **bioeconomy**, and **rural development** (including employment in rural areas).
CAP relevance	Some measures supporting diversification of use of wood biomass can be supported by **CAP pillar II (EAFRD)**. The main relevant measures are "Investments in forestry technologies and in

	processing, in mobilising and in the marketing of forest products" (M08, sub-measure 8.6) but also "Investments in forest area development and improvement of the viability of forests" in general (M08). ES reported such measures under 14 of its 18 RDPs.
Data sources	There is no information on sources of data used in the presentation of the measures relevant to this area of intervention.

Box 8 Tall Wooden Buildings (FR)

Wood in construction in France faces many **obstacles**: regulatory bottlenecks, insufficiently trained staff, difficulty with technical characterization of exploitable species, and inadequacy between the French products supply and market needs are just a few of them.

In 2009 the Planning, Housing and Nature General Directorate of the French Ministry of Ecology, Sustainable Development, transports and housing commissioned a study to identify and overcome these obstacles. The study laid ground for the adoption of **the Wood-Material National Action Plans**, implemented between 2011 and 2017.

To accelerate implementation and to foster innovation, various French actors (industry and building sectors, project owners, designers, technical bodies, etc.) created the "**Wood Industries Plan**". The plan became one of the 34 "New Industrial France" initiatives launched in September 2014 by the French president F. Hollande. In 2015, minister of economy E. Macron integrated it into a "sustainable city" axis of the "Industry of the Future" programme. One of the ambitions of the Wood Industries Plan (formalised in a specific "**Tall Wooden Building Plan**") is to construct 30-storey wooden buildings by 2030 (wooden buildings currently do not exceed 8 storeys in France, while there are 14 storey buildings in Europe and 30 storey projects in North America). France's aspiration is to become a **world pioneer** in the field of tall wooden constructions. According to the Plan, there will be tall wooden buildings "Vivre Bois" constructed also beyond the French borders.

An initial step is to demonstrate that the construction of tall buildings made of wood is feasible and to spread the technical solutions that enable it by constructing 36 large scale **"showcase" buildings** ("Vivre Bois" buildings) by 2018. 24 buildings will be between 6 and 15 floors, and 12 buildings will have up to 18 floors. The future buildings are advertised as being "comfortable, energy efficient, and sinking carbon".

The Plan is coordinated by two French **wood industry associations**: CODIFAB (professional Committee for the Development of French Furnishing and Wood Industries) and ADIVBois (Association for the Development of Wooden Buildings), with the support of the **French Economy and Environment ministries**. It is financed through the General Secretariat for Investments through the "Investments for the Future" State Investment programme.

A **call for candidate projects** targeting local governments and project promoters willing to include a significant amount of wood in a construction project was launched in 2016. It allowed to identify 24 candidate sites where tall wooden constructions could be built

(including 4 office buildings, 1 university building, and 1 hotel). The selected projects will be supported with technical, administrative and financial measures, including joint organisation of architecture competitions, support for the technical assessment and construction project management, possible support for the choice of technical solutions by the provider, financing of feasibility studies and expertise, and a facilitated access to additional grants or financial support from the French Environment and Energy Management Agencies. Design of the selected projects is awaiting Architecture competition results to be presented in September 2017.