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Linking Public and Private Greenhouse Gas Inventories in the Land Use Sector

Reflections on public-private needs for monitoring and reporting land-based mitigation action as driven by recent EU policy developments

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Contents

Abstract

For the past 30 years - since the Kyoto Protocol - national greenhouse gas (GHG) inventory compilers have relied on science-based guidelines and tools to estimate GHG fluxes and carbon stocks in the land use sector, with the goal of contributing towards climate change mitigation action. In the past 10-15 years, several frameworks, standards, tools, and rulebooks have emerged to support the private sector to develop their GHG Inventories, given the significant footprints of many corporations. Since the Glasgow Climate Pact in COP26, there has been a booming of voluntary 2050 net-zero commitments and emissions reduction targets from the corporate world, which frequently count on land investments and/or rely on land mitigation as part of their carbon footprint reduction strategies. Initiatives like the Greenhouse Gas Protocol and Science Based Targets Initiative are among the most adopted by companies who wish to measure and disclose emissions, mitigation targets and trajectories. Recently the EU Green Taxonomy has introduced rules and criteria on how the financial sector and corporations must report and disclose their GHG fluxes and carbon stocks from their related land investments. Private and public rules are now starting to converge.

High quality GHG inventory data (e.g. transparent, accurate, complete, comparable, consistent data=TACCC principles), as well as traceable emissions and removals, are critical to back up any claim on land mitigation action. For this reason, recent policy developments at the EU and private sector levels have driven investment to improve the compiling and reporting of GHG inventories, as well as the development of tools and methodological refinements to support this improvement. Such policies include the Carbon Removals Certification Framework proposed by the European Commission, the EU Green taxonomy, private sector initiatives, and a suite of policies adopted or underway on how to estimate and promote corporate climate claims. This report explores the possible linkages and interfaces between private and public GHG inventories on the land use sector. In particular, the connected role of the Technical Screening Criteria of the EU Green Taxonomy and the Carbon Removal Certification.

A major need in the compilation of GHG Inventory data for the land use sector is the coherent and comparable reporting of land emissions and removals at different scales, as well as the need to nest different climate mitigation action that rely on the same land parcels but at different scales (e.g. land-use national mitigation claims as part of European targets *vs* land mitigation claims from private investors as part of their 2050 net-zero commitments). In this line, a positive trend can be seen in the EU Green Taxonomy criteria, which relies on the latest Intergovernmental Panel on Climate Change (IPCC) guidelines for compiling and reporting GHG inventories in the land, as well as for tracking climate mitigation action (e.g. IPCC 2019 Refinement). This requirement is pushing land GHG compilers from the private-sector to align with the TACCC principles, which are central for the GHG inventories and a guarantee of data quality standardization. Furthermore, GHG inventory compilers from the private-sector are likely to use similar methods and seek to overcome many of the same challenges that national compilers have faced in the past decades. And while a dialogue is being fostered, estimates for the same land parcel may still be different and not comparable, as data input, models, and assumptions still remain different. Understanding the differences and the reasons behind them will therefore be key to ensure the credibility of the data from multi-scale GHG Inventories and nested land climate action. This is the more relevant since the land area under reporting by private sector GHG inventories, is expected to grow in the coming 20 years.

Foreword

This document is part of a collaboration between the Joint Research Centre (JRC) and DG Climate Action (DG CLIMA) in supporting the EU Member States with greenhouse gas (GHG) inventory development and in preparing to meet the requirements in the LULUCF Regulations 2018/841 and 2023/839. The work was coordinated by the JRC and conducted by external experts who worked in their individual capacity. The document was prepared in spring 2023 and is based on extensive literature review and dedicated workshops with countries (two sessions in the 2023 JRC LULUCF workshop, organized in physical attendance in Ispra and online, on 11-12 May 2023).

This document reflects on the new user base and their rapidly developing needs for greenhouse gas (GHG) inventory data in the Land Use, Land Use Change and Forestry (LULUCF) sector, and addresses frequently arising questions on the potential use of public GHG inventory data by private sector initiatives. A draft version of this document was shared with the JRC LULUCF workshop participants ahead of the meeting, and the comments received during the workshop and afterwards have been considered when revising the document. The editors and author thank warmly the LULUCF experts from EU MS, Switzerland, Norway, and the United Kingdom, as well as colleagues from the JRC, European Environmental Agency, and DG CLIMA for all the engaging discussions, sharing of experiences and views, and for the constructive comments received during this work.

Section 1 provides an overview of recent EU policy developments and associated needs for the monitoring and reporting of GHG emissions of land-based climate action. It has a focus on the private sector as the newly regulated (and emergent) player on land-based climate action (e.g., corporate 2050 net-zero mitigation strategies), in particular as GHG data users and producers. These new requirements are then related to existing monitoring setups long established at national level in the public domain (e.g., national GHG Inventories), and other jurisdictional levels (regional, municipal). It then reinforces the need for data sharing, data alignment, and nested approaches for these arising monitoring and reporting requirements at local scale. It identifies these needs in the private and public sectors and reflects on their use to track land-based climate action by the private sector. Section 2 discusses frequently asked questions, particularly the need to integrate public and private monitoring systems and data, to offer harmonized data for the same land areas.

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1 Introduction: short history of LULUCF inventories

For the past 30 years since the Rio Summit, and in practice since the adoption of the Kyoto Protocol in 1997, national Greenhouse Gas (GHG) inventory compilers of the Land Use, Land Use Change, and Forest (LULUCF) sector in the European Union (EU) and in other developed countries have set up national monitoring system to provide estimates of their land emissions and removals. These estimates have helped track and demonstrate compliance with a diversity of climate mitigation commitments both at international level (e.g. United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol (KP), Paris Agreement) and at EU level, with its own climate targets under the European Green Deal. While not means in themselves, the importance of the inventories has grown as climate action in the land sector has increased with better understanding of ecosystem functioning, better modelling, and more reliable data on GHG fluxes and carbon stocks in forests, grasslands, croplands, wetlands and their soils, as well as the losses resulting from land use changes, such as deforestation.

Simultaneously, over the past ten years, an increasing number of corporations and private sector actors have started to take on voluntary commitments on GHG reductions, including 2050 net-zero targets, *beyond* their legally established commitments towards national mitigation action. Similar to the public sector, where national scale reporting of GHG Inventories are compulsory, the private sector must report GHG data on its footprints, including any investment done in the land, as a way to assess the environmental impacts of their investments and the integrity of their land-based mitigation action to mitigate their own emissions. Multiple collaborations, partnerships, and initiatives have been set up, and by the time of COP26 in Glasgow in 2021, the Climate Pact became an important milestone for mitigation action in the private sector. Many companies with significant carbon footprints, voluntarily committed to reduce their carbon footprints and to reach carbon neutrality by 2050, as a way to contribute to global action under 2 °C (1.5 °C as much as possible) emission pathways. If widely adopted and implemented by companies, for the first time in history public and private sectors have targets under the same framework – the Paris Agreement (PA).

The above-described private-sector commitments and the recently growing attention of the private sector on credible and transparent climate action in general, includes the emergence of target setting standards and reporting principles for the Land Use, Land Use Change and Forestry sector (LULUCF). Tools and datasets are also being developed to support the implementation of land mitigation action by the private sector, the monitoring of land GHG emissions and removals, and the tracking of private climate commitments. As a consequence, a LULUCF Tech Sector to advice and support climate action implementation and reporting, is growing. Tools, data collection, partnerships, and investments can be seen as sub-national, sometimes project or land management unit level initiatives that can complement and support national LULUCF GHG inventories (particularly with data and tools). If projected into the future, these GHG monitoring and reporting developments give us a glimpse of multi-layered system, where national, sub-national, corporates, corporate supply chains, and land management unit inventories co-exit and deliver estimates of GHG fluxes and carbon stocks for many different purposes beyond the national compliance reporting that initiated the LULUCF sector reporting 30 years ago. The development of this multi-layered, multi-user, and multi-purpose ecosystem may lead to different scale systems being embedded and connected, but the road there is complicated.

1.1 IPCC Guidelines as the starting point

The *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* outlines how sub-national and in this context project and land management unit level greenhouse gas (GHG) inventories may benefit – and benefit from - national GHG inventories. The perceived benefits are described as (vol 1, p8[1] cited below, and in V4, in the new Box2.0A on p11):

> *Citation from the 2019 Refinement on subnational reporting in GHG Inventories*
>
> *Subnational GHG inventory compilation and facility-reporting (e.g., cities, states, provinces, territories, and facility emission registries) can bring benefit to and gain from engagement with more structured and coordinated national GHG inventory arrangements. This benefit can result from interest in and contribution to combined efforts to gather/collate/use geographically resolved data such as for regulated sites, and diffuse traffic and transport, agriculture and forestry. Use of common guidelines, approaches and assumptions and pooled resources/expertise between national and subnational*

[1] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch01_Introduction.pdf

estimation activities will also help to improve the efficiency and credibility of GHG estimates and decision-making processes associated with them.

In general, the Refinement recommends realising these benefits and alleviating risks by following certain steps (see box 2.0A in V4) and by enabling linking of GHG inventory activities with other data collection and reporting e.g., in form of a wider strategy and work plan, encompassing all land monitoring processes and reporting requirements.

This report aims at i) identifying monitoring and reporting requirements and data needs for the GHG inventorying of the land use sector, ii) identifying and explaining the interfaces, interlinkages, and differences of GHG inventories from diverse stakeholders (private vs public sectors) under new EU regulations, and iii) identifying the synergies and potential risks of further linking and aligning the long existing public national LULUCF GHG Inventories with the emerging LULUCF reporting from the private sector. We hope to offer some reflections on the need to enhance public-private dialogue around land sector monitoring and reporting activities.

2 The EU LULUCF Policy Framework

The relevance of LULUCF GHG inventories from the private sector, has been underpinned by recent trends in EU policies concerning a broad range of economic sectors, including the financial-, and land sectors. While these trends are covered in the next section, this section first briefly outlines the EU LULUCF framework and its origin in the United Nations reporting and accounting principles for national GHG Inventories. The EU LULUCF policy framework has been instrumental in driving the development of GHG inventories for the land use sector, but does not apply to private sector compilers.

Since the adoption of the Climate Convention in the 1990s, *national* GHG inventories as guided by the IPCC Guidelines (IPCC-GL) have served the main purpose of disclosing GHG data for countries with reporting commitments, in a structured and comparable manner, including the LULUCF sector. By aligning with the IPCC and UNFCCC reporting requirements and cycles, MS GHG reporting to the EU (which reports aggregated EU data under the UNFCCC) has been the basis for proving compliance towards both UN and EU targets and commitments, as relevant.

EU LULUCF Policies have developed extensively over the past 10-15 years but have so far only regulated governments and public inventories. National LULUCF GHG inventories have therefore been a governmental responsibility. The key milestones for the governance of MS level GHG Inventories and Accounting, are the legislative pieces below, all set against a current and past UN backdrop (Wehrheim & Olesen, 2015):

- ✓ LULUCF Decision (529/2013)
- ✓ LULUCF Regulation (2018/841)
- ✓ Revised LULUCF Regulation (2023/839)

These sector-specific legislative pieces, framed by the Effort Sharing Regulation (2018/842) and by higher-level policies and legislation such as the 2020 Climate and Energy Package, and the European Green Deal, have faced increased interest and scrutiny in recent years as societies and policy makers have realised there is no climate neutrality without the land use sector. At the core of this interest lays the capacity of MS to prove climate action compliance from the LULUCF sector, and the demonstration of progress towards frequently revised targets. Policy development has been mostly at the MS level by stipulating rules for MS, including topics around emission trading flexibility, natural disturbances, forest reference levels, and coverage of targets and inventories.

2.1 Forward looking trends in the EU LULUCF framework

The amended LULUCF Regulation (2018/841) fixes a Union target for net removals per year at 310 $MtCO_2eq$ by 2030. The target is intended to break the curve of a declining sink, so that by 2050 land sector removals and technological removals, e.g., Direct Air Capture (DAC) or Bioenergy with Carbon Capture and Storage (BECCS) can balance out residual emissions across the economy and ensure annual climate neutrality. While the Regulation allocates targets for MS, it does not establish any targets or direct incentives at land manager level. MS implementation and policies may impose different and country specific regulatory incentives or establish financial incentives, but at risk of creating an unlevel playing field between farmers and foresters from different MS but within the internal market.

2.1.1 Subnational levels: From regional to land manager level

As foreseen in both the EU Forest Strategy (COM 2021/572) and the Farm to Fork Strategy (COM 2020/381), a system of common or uniform rules for incentives at land manager level was proposed with the Carbon Removals Certification Framework (COD 2022/394) and is now being discussed by legislators and by an EU Expert group. Once agreed and in force, the common rules will set minimum thresholds for Monitoring, Reporting, and Verification (MRV) and removal accounting that will govern the quality of the removals. This certification scheme will allow the transparent and consistent transfer of incentives from MS to land managers, and thus enhance carbon farming. This shall encourage the achievement of the EU LULUCF target of (-310 $MtCO_2eq$) by 2030, which suffers from a decreasing land sink trend for the last decade. The Carbon Removals Certification (CRC) Framework is all about enabling financial incentives at farm and forest level to transparently achieve this target at national and EU scales.

It should also be noted that the CRC Framework can also apply when nesting regional, municipal, and other sub-national LULUCF GHG Inventories into national level inventories, and ensure consistency across all levels – national, subnational, and farm or forest manager levels.

2.1.2 Sector-wide regulatory coherence: Uniform Carbon Removals

Results based payments that use farm level GHG data are needed to create incentives at farm or forest manager levels, which is the engine in the emerging Carbon Farming Business Model introduced and explained in various EU publications over the past years. An important element is, however, that the new incentives driving the Carbon Farming Business Model, are not only public funding.

In the CRC proposal, and more clearly in the Sustainable Carbon Cycles (SCC) strategy (COM 2021/800), the need for consistency and quality across all uses and types of incentives is mentioned as a driver of the CRC proposal. Among other, the CRC Framework can be applied for in-scope reporting, certificates, offsetting, which are all mostly relevant in the private sector, but also as basis for payments under the CAP, municipal sink certification, or government support through project results reporting.

As environmental and transparency concerns link the CRC framework and the emerging EU legislation for private sector reporting and disclosure, the recital of the CRC proposal makes direct reference to the *Do No Significant Harm* criteria for forestry (and agriculture *To Be Defined*) defined in the Technical Screening Criteria of the EU Green Taxonomy (covered in detail below), which will apply to the private sector. As such, the QUAL.I.TY criteria and the verification and certification requirements can be expected to apply to all claims of net carbon removals within the union, where relevant legislation applies or public money are involved. A union wide, user agnostic, policy wide interpretation of what constitutes a net removal of carbon is being established.

2.1.3 UNFCCC and National GHG Inventory compatibility – with land manager level data

Anyone compiling activity data (AD) and applying emission factors (EF) to estimate GHG stocks and fluxes within the union could benefit from applying the basic criteria proposed in the CRC Framework text. Ensuring compatibility and consistency between nested inventories of regional authorities, agricultural corporations, and national level LULUCF Inventory compilers can enhance transparency and quality of reporting and foster knowledge sharing and learning. The private sector inventory compilers could be data or environmental scientists and practitioners working for large agricultural or forest landowners, as part of the sustainability teams of major integrated agricultural entities, or in specialised consultancies, or on farm extension services. To deliver EU Taxonomy aligned reporting to investors or data for sustainability reporting on net-zero targets, these experts will use parcel level data together with regional and country level data and statistics, to compile the private sector LULUCF GHG inventories.

For consistency and quality, it is therefore important that the CRC framework is designed to be aligned with IPCC rules and methodologies. In the actual proposed regulation (Art 4(9)), it reads: *To support the quantification of carbon removals generated by carbon farming, the operator or group of operators shall gather data on carbon removals and greenhouse gas emissions in a manner compatible with national greenhouse gas inventories under Regulation (EU) 2018/841 and Part 3 of Annex V to Regulation (EU) 2018/1999.* The interpretation and application of 'compatible' may be clarified by the EU Expert group in part, while guidance and testing in the years after entry into force will establish actual practice and the degree to which private, subnational, and national level GHG Inventories are nested and linked.

The aspiration of the CRC proposal is to ensure access for all land managers to measure carbon farming practices by 2028. Once in force, it will be a precondition for enhanced private sector action to generate certified net removals that contribute to the 310 $MtCO_2eq$ target. A key enabler for being able to deliver land manager level site-specific reportable net carbon removals is activity data. The CRC proposal leans on the LULUCF Regulation requirements for coordination of monitoring land use in a geographically explicit way. The explanatory memorandum of the CRC proposal underpins this trend. At a higher level, the *Energy Union Governance Regulation (*2018/1999*)* and *INSPIRE Directive* (2/2007) on spatial data, set requirements for the supporting infrastructure and the quality of spatial and spatially explicit land sector data within the EU, and driving the system development needs. In Annex V, part 3 of the Governance Regulation, it is stipulated that MS shall use geographically explicit data for land conversion in their inventories and strive towards inter-operability of inventory system with external databases and GIS. These inter-connected systems must be able to detect and monitor some special areas: areas under protection, areas with high carbon stocks, areas designated for restoration, areas exposed to high climate risks, and more. As such areas must be delineated and reported under EU Taxonomy and for almost all private schemes in the market, such infrastructure is of high importance for private sector inventory compilers.

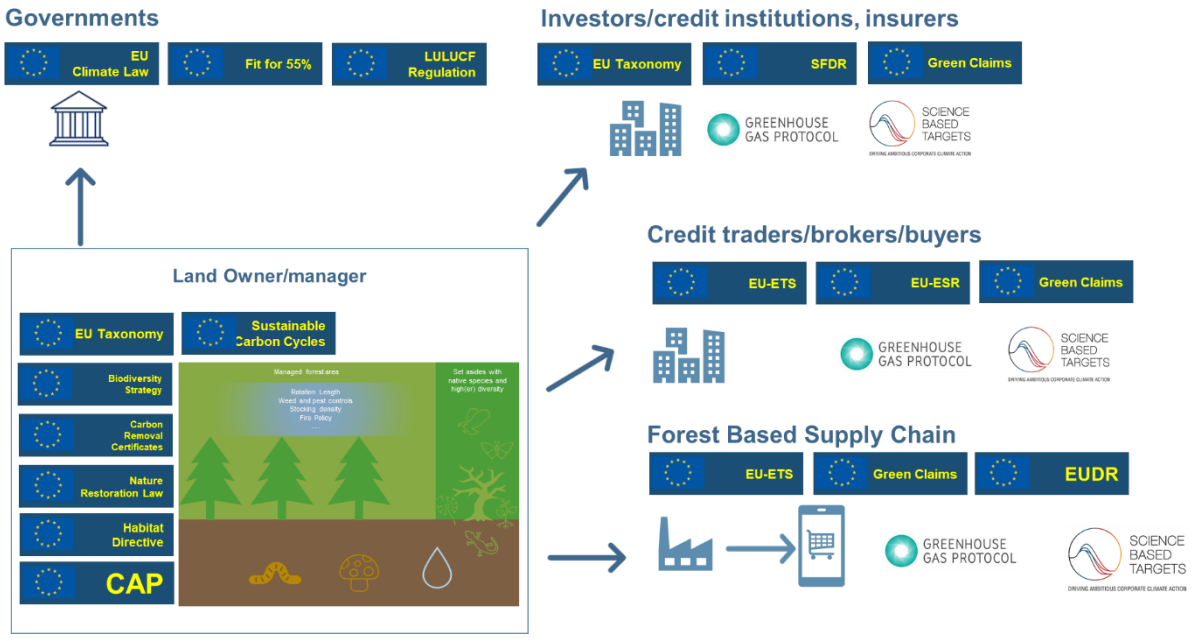
2.2 Beyond LULUCF Compliance

Building on the above trends, the relevance and role of LULUCF GHG Inventories will move beyond MS level compliance and into enabling land sector climate action directly through data, modelling, and knowledge sharing. Complementing the EU LULUCF policy trends outlined above, specific consumer, environmental, and financial sector policies are expected to be both drivers and incubators of private sector GHG reporting and accounting in and outside the land sector. The ways in which EU Policy has driven and will drive corporate GHG reporting and accounting in the future is explored in the following with a focus on EU-induced monitoring, reporting, accounting, and marketing requirements.

2.2.1 Solid data for product and company claims: Driven by EU Consumer and Financial Sector Regulation

The role of MS GHG in this new era of data needs for climate action in the land sector is depicted below in Figure 1. It shows how EU climate regulation relates to all actors that have land use in their GHG domains associated to scope 1 or 3 (e.g. scope 1 includes all direct emissions that are generated from sources that are directly owned or controlled by an organisation, scope 3 includes all the emissions in an organization's value chain). The scope 3 downstream for any forest manager coincides with the scope 3 upstream for any company processing or selling the wood, and this flow of wood is what is labelled Harvested Wood Products in UNFCCC/IPCC GL terminology. This is not subject to the LULUCF Regulation itself, but MS reporting and accounting of HWP is as shown in the illustration.

Figure 1. Overview of data exchanges by an EU based land managers under to upcoming EU policy architecture covered in the following sections.



The arrows in Figure 1 above illustrates where a need for land use GHG data exists or will materialise soon, driven by well aligned downstream demand created by EU Climate Policy and a few non-climate pieces in combination with frequently used carbon standards to set mitigation targets and to elaborate associated GHG inventories, such as the SBTi and the GHG-P. These two are among the most used full target and compliance cycle carbon standards by the private sector but are others are available. ISO 14064 is another frequently used standard for GHG Inventorying under corporate carbon footprint initiatives and the Task Force for Climate-related Financial Disclosures (TCFD), Partnership for Carbon Accounting Financials (PCAF), and Climate Disclosures Project (now CDP) also offer guidance.

At the scale of land manager action, the certification requirements, data needs and availability, and public and private incentives, are critical for standardising and driving action. However, the restrictions and standards

applied to the user, sponsor, or provider of funding are also important. Besides the EU LULUCF regulations, other key policies of particular and cross-cutting importance in framing and defining LULUCF data needs for the private sector include:

- The Green Claims Proposal (COD 2023/85)
- The CRSD directive (COD 2021/104)
- *The Sustainable Finance Package*, comprising the *Sustainable Finance Disclosure Regulation* (SFDR; Regulation 2019/2088) and the *EU Taxonomy (*Regulation 2020/852*)*, with accompanying Delegated Acts and guidelines.

The EU Emission Trading Scheme (EU-ETS) is included in the figure but not in the coverage, because its scope excludes land-based emissions and removals as trading units[2] . This effectively limits demand for land removal units for the time being, but at the same time maintains pressure for in-scope climate mitigation by the utility and energy companies covered by the EU Emissions Trading Scheme.

2.2.1.1 Green Claims

The Proposal for a Green Claims Directive, as published by DG ENV on behalf of the EC on March 22nd, 2023, actually forms part of a long existing but growing body of legislation aiming at protecting any sort of buyer from greenwashing at product level. Together with the newly passed regulations: Ecodesign rules (proposal COD 2022/95); Directive 2013/34 on annual reports and financial products; and Organic Farming and Products under Regulation 2018/848, there's a long tradition of regulating statements on sustainability. The novelty of the Green Claims Directive proposal (COD2023/85) is that the Commission is asking for delegated rights to define sector specific rules on how to calculate Product Environmental Footprints (PEFCRs) and Organisation Environmental Footprints (OEFSRs). The Green Claims directive is essentially regulating the work that has been increasingly undertaken by companies in accordance with frequently used carbon footprint standards (SBTI, GHG-P and various Life Cycle Assessment (LCA) (which also applicable at other sub-national and public levels).

The Green Claims Directive read in its recital: '*The Commission may adopt delegated acts to supplement the provisions on substantiation of explicit environmental claims by further specifying the criteria for such substantiation with regard to certain claims (e.g. climate-related claims, including claims about offsets, "climate neutrality" or similar, recyclability and recycled content). The Commission should be empowered to further establish rules for measuring and calculating the environmental impacts, environmental aspects and environmental performance, by determining which activities, processes, materials, emissions or use of a product or trader contribute significantly or cannot contribute to the relevant environmental impacts and environmental aspects'.* While recognising this is recital text in a much to be debated proposal, and thus not regulatory text in any form yet, the direction of travel is clear. To make statements on products, including on climate neutrality, primary data, solid methods, as well as transparent and reviewed tools and modelling must be applied.

2.2.1.2 EU Taxonomy and the Sustainable Finance Disclosure Regulation

Any entity that invests in, insures/re-insurers, provides credit to or otherwise is financially linked to a land manager and wishes to label their activities as green (as opposed to not-green/grey) will have to follow the principles and criteria laid down in the EU Taxonomy and its growing number of sector specific annexes and technical guidance. As stipulated in its article 9 shown below of the Taxonomy Regulation, the activity (understood as the investee) must be able to prove adherence and delivery against at least one of the below environmental objectives, while preventing any significant harm against the remaining. Note that these objectives are equal to the six stipulated in article 7 of the CRC proposal under Sustainability.

[2] Use of international credits (europa.eu)

Article 9

Environmental objectives

For the purposes of this Regulation, the following shall be environmental objectives:

(a)	climate change mitigation;
(b)	climate change adaptation;
(c)	the sustainable use and protection of water and marine resources;
(d)	the transition to a circular economy;
(e)	pollution prevention and control;
(f)	the protection and restoration of biodiversity and ecosystems.

Qualifying for (a) Climate Change Mitigation is *"strengthening land carbon sinks, including through avoiding deforestation and forest degradation, restoration of forests, sustainable management and restoration of croplands, grasslands and wetlands, afforestation, and regenerative agriculture"*, essentially the LULUCF sector, and largely corresponding to the eligible activities for Carbon Removal Certification under the proposed framework.

In the delegated act (EU CDR 2021/2139), the Technical Screening Criteria define when an activity can be considered to significantly contribute to climate change mitigation. Across the 349 pages, criteria per activity is given for most land management activities relevant to the LULUCF sector. A core element across all activities is the conductance of a mandatory Climate Benefits Analysis. Here the criteria for the analysis as applicable to forest management activities is quoted: *"For areas that comply with the requirements at forest sourcing area level to ensure that carbon stocks and sinks levels in the forest are maintained or strengthened over the long term in accordance with Article 29(7), point (b), of Directive (EU) 2018/2001"* (the Renewable Energy Directive, recast), which again links back to LULUCF policies. The Climate Benefit Analysis (CBA) *"demonstrates that the net balance of GHG emissions and removals generated by the activity over a period of 30 years after the beginning of the activity is lower than a baseline, corresponding to the balance of GHG emissions and removals over a period of 30 years starting at the beginning of the activity, associated to the business-as-usual practices that would have occurred on the involved area in the absence of the activity".* Anyone undertaking to commit to Climate Mitigation for a supply chain or investment linking to an FMU, will need to develop Forest Reference Levels at FMU level, ideally in accordance with LULUCF practices.

Furthermore, the drafters of the criteria included specific wording on alignment with UNFCCC principles in the form of a direct reference to the 2019 Refinement when stipulating how that CBA analysis should be undertaken. Table 1 below reads the exact technical screening criteria (TSC) for climate change mitigation action (CCM) within Forest Management (EU CDR 2021/2139).

Table 1. Full text of EU Taxonomy Technical Screening Criteria for Forest Management, applicable for Climate Mitigation objectives proving a climate benefit.

FM TSC CCM 2.3	The calculation of climate benefit complies with all of the following criteria
Climate Benefit Analysis	(a) the analysis is consistent with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The climate benefit analysis is based on transparent, accurate, consistent, complete and comparable information, covers all carbon pools impacted by the activity, including above-ground biomass, below-ground biomass, deadwood, litter and soil, relies on the most conservative assumptions for calculations and includes appropriate considerations about the risks of non-permanence and reversals of carbon sequestration, the risk of saturation and the risk of leakage.
	(b) the business-as-usual practices, including harvesting practices, are one of the following: (i) the management practices as documented in the latest version of the forest management plan or equivalent instrument before the start of the activity, if any; (ii) the most recent business-as-usual practices prior to the start of the activity; (iii) the practices corresponding to a management system ensuring that carbon stocks and sinks levels in the forest area are maintained or strengthened over the long term as set out in Article 29(7), point (b), of Directive (EU) 2018/2001.
	(c) the resolution of the analysis is proportionate to the size of the area concerned and values specific to the area concerned are used.
	(d) emissions and removals that occur due to natural disturbances, such as pests and diseases infestations, forest fires, wind, storm damages, that impact the area and cause underperformance do not result in non-compliance with Regulation (EU) 2020/852, provided that the climate benefit analysis is consistent with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories regarding emissions and removals due to natural disturbances.

At this point, there is very limited practice and thus evidence of how to interpret "*consistent with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*". There is no mentioning of tiers or approaches in the TSC, but presumably stock and pool coverage and clear adherence to either a stock change or gain-loss method will be minimum criteria. Also, data requirements, leakage, reversals, and natural disturbance regimes should be covered with reference to principles in the 2019 Refinement and the 2006 Guidelines.

Similar specific criteria for forest restoration, A/R, and peatlands have been published, while criteria for agricultural land use are still being researched and negotiated. The latter will only be published when alignment and linking with the EU'S Common Agriculture Program (CAP) requirements have been sorted out.

The above policies are targeting land management activities but do not set any thresholds nor requirements of use of certain data, such as Earth Observation tools. However, they will create a previously unseen demand for data and methodologies and tools that can produce outputs aligned with national GHG inventories for the LULUCF sector. Since investors in general are seeking to green investments, they will need data on GHG profiles and projections of land invested in or to be invested in for due diligence and SBTI/GHG-P reporting purposes. Pension funds, insurance companies, and other institutional investors have been among the front runners, but also wealth and asset managers are now slowly mobilising. Given the size of these sectors, exposure to both EU agricultural, forestry, and downstream sectors, their financial capabilities, and preference for working with huge amounts of data, it is not surprising to see the upheaval and professionalisation of the climate tech sector in this decade. There is a market to be served.

3 Emerging private sector LULUCF Inventories standards and governance

Most of the land reported by MS LULUCF inventories is managed by private entities, be it farmers or foresters, and feeding products into local, regional, or global supply chains for everything from wheat over wood pellets to leather. Supply chains consist of companies processing or marketing products and are themselves part of Effort Sharing Regulation sectors or even the EU-ETS, but they are also increasingly setting own voluntary GHG targets under major schemes like the Science Based Target Initiative (SBTi), and reporting progress in accordance with the Greenhouse Gas Protocol (GHG-P). An understory of service providers, analytical tools, complementary guidelines, and partnerships and coalitions has grown to support devising, implementing, and monitoring these targets in recent years, and now constitute a new emerging LULUCF Tech & Advisory sector.

3.1 The Standards

During 2022 both GHG-P (for reporting) and SBTI (for target setting and accounting) have released fully complementary second draft versions of land sector relevant guidelines for final consultation. The respective GHG-P Land Sector & Removals[3] and SBTI Forest, Land, and Agriculture (FLAG)[4] guidance documents, gives elaborate and detailed direction on approaches, methodologies, and are eagerly awaited by major EU based companies with 2050 net-zero targets.

The GHG-Protocol and SBTI are the most prominent examples of elaborated standards for private sector actions developed in collaboration between academia, NGOs, and the private sector itself. WRI, WWF, UN Global Compact, and Carbon Disclosure Projects/CDP are the founders. There are numerous other standards and schemes available, including but not limited to the ISO 14064-I standard, that offers solid and transparent reporting rules that ensure consistency and comparability (between companies applying the same standard). In principle any of these can be used by a company to report towards an SBTI target or any other net zero target. However, SBTI and GHG-P have developed their standards and requirements in coordination and provide promotional and supportive materials that have led to significant uptake with companies in recent years.

3.1.1 Mitigation hierarchy for target setting and reporting.

Both SBTI and GHG-P apply the Mitigation Hierarchy principle to direct the attention of companies and their investments into reducing their own footprint before applying offsetting, aiming to minimize offsetting as much as feasible. In SBTIs own words it means "*companies must prioritize value chain emission reductions ahead of actions or investments to mitigate emissions outside their value chains to achieve net-zero*"[5]. In fact, to achieve and communicate a true net zero target, companies cannot apply more than 5-10% offsetting (relative to full footprint), and no internal use of removals to cancel industrial emissions is allowed. Land sector removals can only be used to 'neutralise' (SBTI term) land sector emissions.

The adherence to the Mitigation Hierarchy, is a key defining feature of the SBTI/GHG-P target & compliance package. The hierarchy itself was defined while working on biodiversity protection and offsetting appx 20 years ago and is widely used also in Environmental Impact Assessments[6]. When applied at project or impact level, the mitigation hierarchy is useful when prioritising and distinguishing between mitigation, remedy, or compensation. In this context, the hierarchy can be used to separate reporting/inventory from accounting against targets and again from offsetting and set rules for each activity.

The mitigation hierarchy applied to corporate GHG targets is depicted below in a simpler version, adapted for forest-based sectors (Figure 2). The hierarchy is to the left, while on the right an example of an Impact Report issued by a SBTI/GHG-P compliant company, demonstrating the corporate journey towards net-zero. In the example used in the figure, the company needing information on forest impacts and mitigation measures is a downstream company, not managing any hectares themselves, referring to situation 1 or scope 3 as outlined in the next section.

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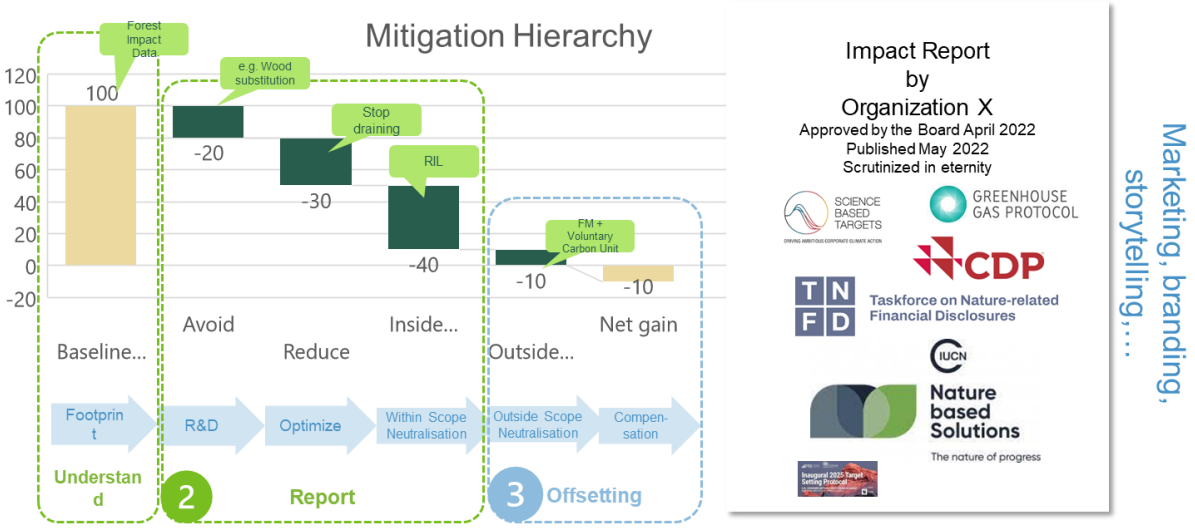
3 https://ghgprotocol.org/land-sector-and-removals-guidance
4 https://sciencebasedtargets.org/sectors/forest-land-and-agriculture
5 https://sciencebasedtargets.org/blog/net-zero-urgent-beyond-value-chain-mitigation-is-essential
6 https://www.forest-trends.org/bbop/bbop-key-concepts/mitigation-hierarchy/

Figure 2. The simplified mitigation hierarchy and SBTI/GHG-P reporting. Own production, from FSC International. RIL stands for reduce impact logging, here used as an example, that could enhance a reportable sink within a forest unit.



Other than the adherence to the mitigation hierarchy, another important characteristic of private sector inventories is the three scopes introduced below.

3.1.2 The three scopes

GHG-P and SBTI and other similar standards and the need for setting up private sector LULUCF and Agriculture GHG inventories are relevant in this context in two different situations:

1) A land manager or owner, e.g., a farmer or asset manager sets a target.
2) A company uses materials produced on land, e.g., a food processing plant or a wood furniture seller and sets a target.

According to GHG-P and SBTI, and almost all other private sector standards, targets and GHG reporting must be applied to three scopes (Table 2), where scope 1 corresponds to situation 1 above, and situation 2 refers to scope 3. There are no land emissions or removals in scope 2.

Table 2. GHG protocol definitions of the various scopes of company GHG inventories

Scope 1	Scope 1 emissions are direct emissions from owned or controlled sources.
Scope 2	Scope 2 emissions are indirect emissions from the generation of purchased energy.
Scope 3	Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.
Source: https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf	

This means companies downstream of the land sector supply chain (situation 2) will have to report and account towards their target, so called *in scope* GHG emissions and removals associated with the croplands, grasslands, forests and animal herds of the EU in an IPCC LULUCF and Agricultural Sector GPG comparable manner. This reporting, and any target accounting downstream, is not constituting double claiming or accounting against MS GHG reporting or targets but has been set up to ensure pathways for Paris Agreement alignment of all and any SBTI target.

As compared to IPCC GPG, scope 1 equals the territorial reporting and accounting by MS and other parties. Scope 3 is an additional feature of private sector GHG inventories that covers to upstream and downstream supply chains and aims to drive action and transparency of action on suppliers and product life cycles. In

aggregate, the three scopes can be referred to as the GHG footprint of any given entity and in reality, one entity's scope 1 in another entity's scope 3.

3.1.3 UNFCCC and IPCC alignment

Both SBTI and GHG-P from the onset decided to align entirely with relevant IPCC rules, the UNFCCC nomenclature, and effectively defining private sector, entity-level GHG inventories applying the same sector breakdown as the UNFCCC. The GHG Protocol guidance on accounting for the LULUCF and Agriculture sector *"is structured around stock-change accounting methods to estimate the net biogenic CO_2 flux"*. Hence, GHG-P *"is consistent with accounting approach for the Agriculture, Forestry and Other Land Use (AFOLU) sector in the IPCC Guidelines for National Greenhouse Gas Inventories"*, with the latter referring to the 2019 Refinement (both quotes from GHG-P, Land Sector Guidelines, 2022, p48).

In a few ways, as pointed out by the GHG-P in the guidance material, the reporting and accounting also differs from UNFCCC reporting by MS:

- The supply chain driven dynamic delimitation of land: there are subtle but critical differences between GHG-Protocol and UNFCCC reporting. The scope of reported land (inventory boundary) is fundamentally different, and for private sector inventories dynamic from year to year.
- Requirements for reporting CO_2 removals, including reversals accounting. Partly as a result of the above, companies must prove that monitoring of sequestered and stored carbon continues when land is no longer supplying that company, and hence falls outside of scope 3. If not, reversals must be accounted, which is a technical correction whereby previously reported removals must be withdrawn from the account in the year in which monitoring ends, or a reversal event has happened.
- Lastly, the SBTI went further and defined guidelines and standards for sectors that go across UNFCCC sector breakdown, like financial sector, pharma, and thematic guidelines for water and biodiversity.

3.1.4 Creating need for GHG data

In target setting, devising of mitigation plans, and setting up and implementing data management systems, companies essentially undertake the exercise of finding, mining, indexing, and QA/QC of activity data and emission factors. And they face the same challenges that EU GHG Inventory compilers have faced in past decades. In fact, the most advanced and ambitious companies and service providers are facing the very same challenges as national LULUCF Inventory compilers, as the GHG-P explicitly requires e.g., HWP, uncertainty estimates, data collection, and the managed land definition and proxy among other shall be applied in accordance with the 2019 Refinement. The main difference is that companies will apply the guidelines on land of variable sizes, management regimes, landscapes across the EU and beyond as outlined above. Furthermore, under GHG-P companies must ensure traceability to at least the land management unit level if they wish to include removals into scope 3 accounting and to produce primary data. The guidelines rule out use of Tier 1 data and default carbon stock and stock change factors, as will be the case for MS GHG Inventories from 2026 under the LULUCF Regulation, which will require Tier 2 for all pools and all land uses from 2026 onwards.

Any company with forest land impact in their scope 3 must model the necessary trajectory of net carbon balancing towards Paris Agreement targets of their forest footprint (net zero in 2050 at latest). This trajectory must align with regionalised forest sector pathways that serve as a reference target level. In similar ways, pathways for peatland restoration, soil carbon sequestration, and afforestation are defined and add up to a land sector pathway for regions incl. the EU, that are more ambitious that the EU land sector sink projection behind the CRC proposal (Roe et. al., 2019; Griscom et al., 2017). In other words, in the years towards 2050, companies and MS governments will have shared interest in increasing the net-sink well beyond the –310 Mt CO_2e in 2030, and make sure it can be reported and accounted at land management unit level at least annually, and closely tied to key measures, as discussed in previous chapters of this report.

3.1.5 LULUCF Tech & Advisory

Driven by market needs, the LULUCF Tech & Advisory sector has emerged in the last decade. At the core of this sector is servicing data, data processing, computation, and reporting needs. Many companies are too small or not organised to build in-house carbon data management systems to meet reporting requirements from SBTI, GHG Protocol, Taskforce for Climate-Related Financial Disclosures (TCFD), CDP, or any other standard. For the past decade, getting upstream activity data and structure internal processes, assigning roles, and build capacity has been the overarching and all-consuming challenge of most companies, and this will remain so for another decade or more.

Hence, what the LULUCF Tech Sector offers is various versions of full cycle data and reporting service. The service providers rely on and build their tools and business model on the data from an increasing set of Earth Observation Technologies and providers that again rely on the same satellites, data sources, and methodologies as current MS GHG inventories for the land sector. Figure 3 below provides and overview of the generalised land sector data flow for these providers.

Figure 3. Generic overview of stages of land sector activity data collection, processing, computing of estimates, and provision of outputs for decision makers. The generic model is built from explanatory material for the Full Lands Integration Tool (FLINT) which is a modular cloud based, open-source version of the GCBM-CFS3. Source: Moja Global.

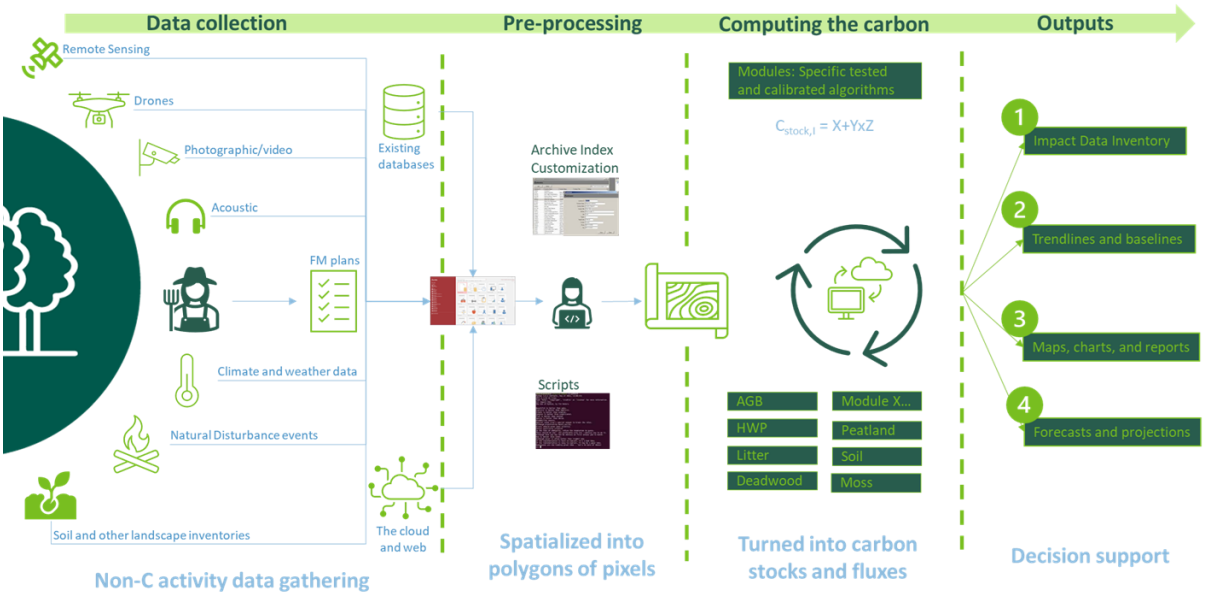


Table 3 shows a non-exhaustive list of appx. 20 service providers in the LULUCF Tech space, with relevance for the land sector. They have been distributed across the four stages of the above data flow illustration. Based on service offering as shown on their main homepage, and presented as a preliminary screening, it shows different approaches and business models of the entities. Many of the entities are fully commercial, venture or other capital backed, and have ambitious growth and business plans, while others are more open, R&D focused, with a few even being non-profits. In the illustration, green boxes represent entities that are mostly processing and modelling data, while the blue cohort consists of entities that have started from or mostly rely on Earth Observation tools and technologies. The EO based companies all mostly rely on Remote Sensing inputs, while some have integrated various drone-like technologies. On the ground data collection, in the soil measurements, and in-situ sensors are not integrated into their Business Models, so despite the developing pace of the sector and the levels of investments pouring in, the primary data challenge remains unsolved.

Table 3. Non-exhaustive overview of a group of LULUCF Tech service providers and tools.

Data product and analytics providers	Website
Keyrros	https://www.kayrros.com/
Orbify	https://orbify.com/
Skylab	https://www.skylabglobal2.com/
Satelligence	https://satelligence.com/
Chloris Earth	https://www.chloris.earth/
Planet Labs	https://www.planet.com/
Earth.blox	https://www.earthblox.io/
Cleartrace.io	https://cleartrace.io/
Impact Observatory	https://learn-about.impactobservatory.com/maps
Downforce	https://www.downforce.tech/
Space Intelligence	https://www.space-intelligence.com/
FLINT	https://moja.global/
Kanop	https://www.kanop.io/
Regrow Ag	https://www.regrow.ag/
Mullion Group/FLINT Pro	https://www.flintpro.com/
Pachama	https://pachama.com/

From the above overview, it can be derived that the full data and processing flow for generating estimates of GHGs, and carbon stocks is a worthwhile business model. In the following, it is explored how EU Climate Policy – and other policies – are helping to build the demand for such services.

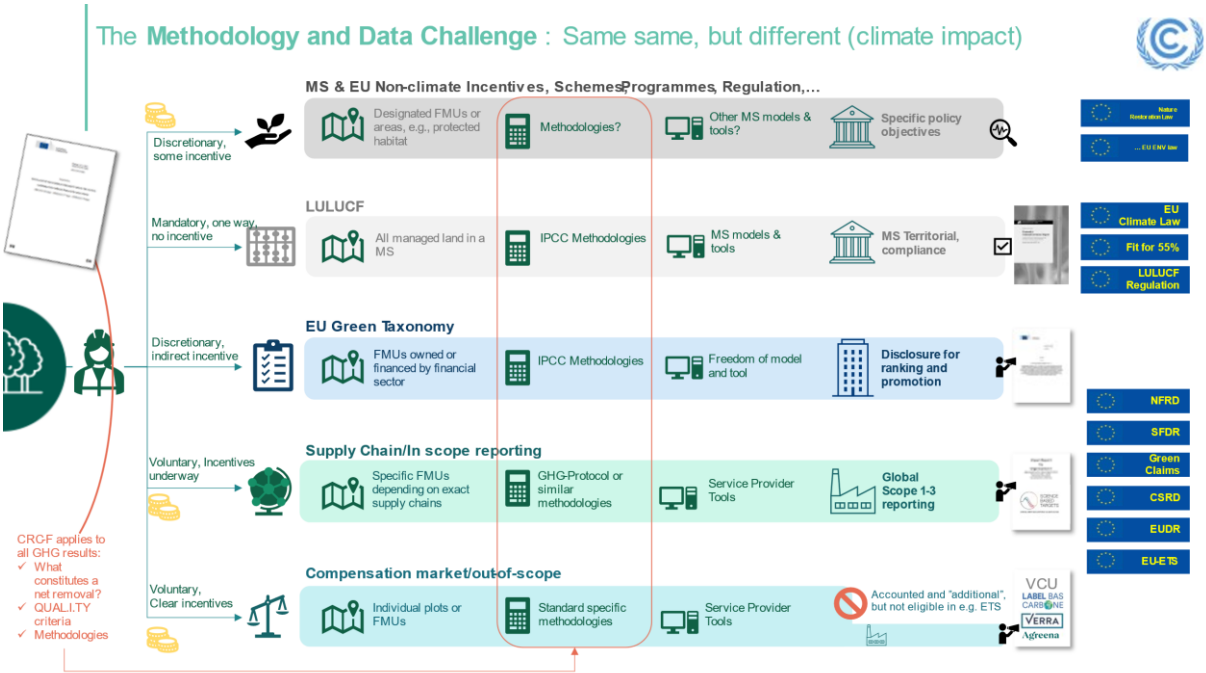
4 Linking public and private sector LULUCF Inventories

From a MS Climate Policy and GHG inventory perspective, the above-described increasing corporate reporting and accounting activity means that activity data, modelling, and model development, as well as emission factors now have relevance for a much wider audience. However, many companies identify lack of data and reporting difficulties as major barriers for major land investments, level of ambition, and thus further climate action. For this reason, the sharing of and access to credible activity data and emission factors for all of EU managed land uses may become an enabler for increased climate action.

As indicated by the Commission in a meeting with the Member States (Working Group 5 meeting in April 2023), the next ten years of EU land, forestry and agriculture related Climate Policy is expected to be characterized by a period of regulatory stability, transition to a reporting-based approach, and a climate neutral framework as enshrined in the EU Climate Law. In the same period, private sector action will scale up driven by multiple policy pressures, facilitated by more and better earth observation data and sensor technologies, and ultimately responding to public and shareholder demands. Most notably the private sector will be front and centre when the transfer of incentives and rules to land manager levels gradually happens over the coming decade (see 1.1.1).

Transferring targets and incentives, but also rules and requirements to land manager levels, will entail enhanced spotlight on the actual estimates of net removals. Currently, the situation is that land managers can supply carbon removal data and have estimates computed in at least five different domains, as depicted below in Figure 4. In each of these five, different levels of scrutiny, consistency, computational and modelling power, and rigor is applied, and objectives are somewhat different. As a result, in practice, five different values for the same LMU can be produced, some of which can be spatially explicit, based on primary activity data, and third party verified. Not all will be following UNFCCC principles and IPCC guidelines, and additionality, accounting rules, and reporting criteria differ. Figure 4 depicts these five flows and summarises the above analysis, including main EU legislation.

Figure 4. Overview of type of scope, methodologies, tools, and objectives of five data value chains relevant to EU based land managers. To the left a generic land manager, and right most various regulated/standardised outputs and applicable regulation. The lowest flow refers to carbon style markets, and it partially blocked as land use credits are currently not eligible for compliance use the the EU-ETS. Own production, copyrights with author.



The proposed Carbon Removals Certification framework proposes quality criteria and ensures verification against minimum requirements in transparent and recognised schemes across these, as shown by the red line and the proposal icon to the left in the illustration. The methodologies applied for estimating the carbon stocks

and balances within each LMU will however remain flexible, within the recommendations and potential requirements proposed by the EU Expert Group and negotiated for inclusion in the legislative text by the legislators. Apart from the harmonisation and minimum criteria, data and solid methodologies will be required to ensure the operation and integrity of the system. For that, national LULUCF inventories and the capacity and skills aggregated over the past years is a crucial source of guidance and support.

4.1 MS & EU LULUCF inventories & tools as enablers of action

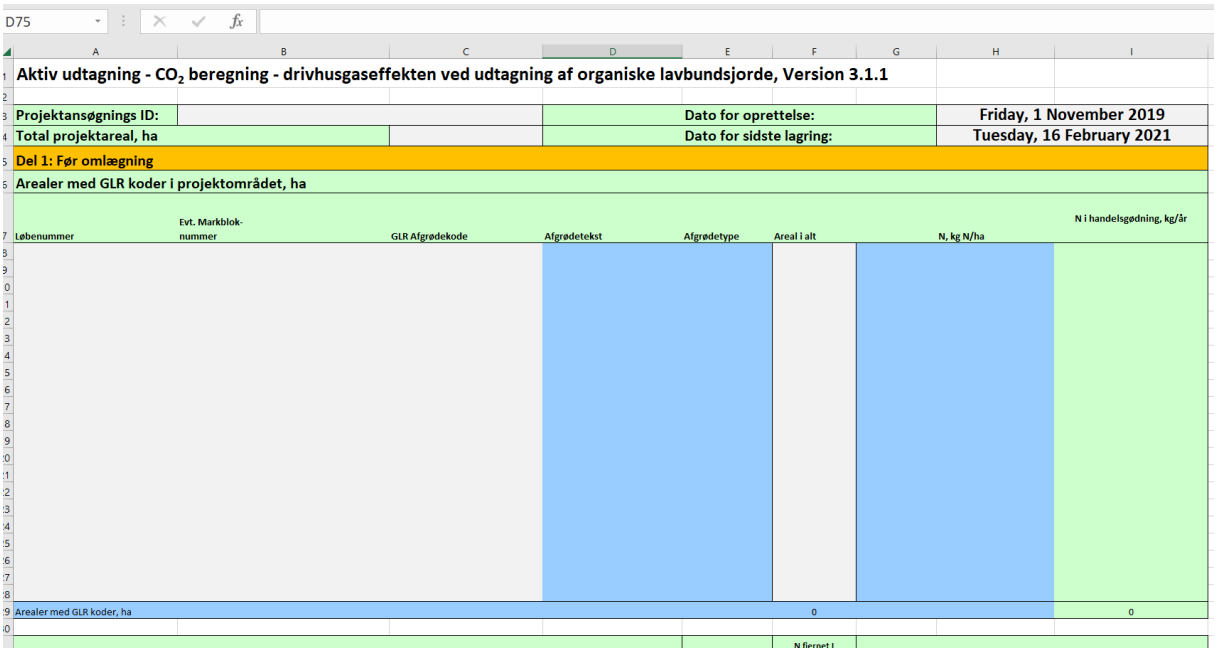
In the period towards 2035 and beyond, three potential enabling roles of MS GHG inventories and experts, can be identified and discussed:

4.1.1 Tool builder, model tester, technology investor

As with the example of FLINT being developed with the support of the Canadian Government based on the GCBM-CF3 model used for the Canadian UNFCCC LULUCF reporting but released for public use, inventory capacity and expertise can in the near future serve as incubator and driver of tools and models to be taken up and used by the sector. FLINT is legally hosted by the LINUX foundation and managed by non-profit Moja Global.

A couple of years ago, the Danish LULUCF and Agriculture compiler released a simple calculation tool in an open source excel sheet (see screenshot below in Figure 5), downloadable from the Danish Agricultural Agency's homepage. The tool allows users to calculate project level GHG benefits in accordance with the methodologies and factors applied in the official Danish GHG inventory[7]. The tool is accompanied by a brief technical advice note (here, only in Danish).

Figure 5. Screen shot of Danish project level tool developed by the DK GHG Inventory team to serve project level estimation of wetland.



A similar intergovernmental effort is the update of the FAO EX-ACT calculation tool. The tool host, the UN Forest and Agricultural Organisation (FAO) is currently aligning the EX-ACT tool to the 2019 Refinement, and this may serve as a helpful entry-level tool for private sector inventory building and estimates. The EU-CBM-HAT which is now made publicly available at the Joint Research Center (JRC) (here), is targeted at MS, but may also be applicable for larger private sector inventories, where companies wish to have in-house computing and modelling capacity. Lastly, developed by the UNFCCC, the CRF Reporter Tool[8] automatically provides default

[7] https://mst.dk/media/222053/co2_ver-311.xlsx
[8] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/crf_reporter_user_manual.pdf

emission factors (EF) for different land uses and land uses changes, based on Tier 1 standard values for EF as presented in IPCC documents[9]. Other GHG reporting tools can be found here.

4.1.2 Emission Factor provider

While many companies will have supply chain specific activity data needs that extend beyond one country, they will all need access to plug-and-play or reference emission factors for a large variety and variation of land management practices and soil types. It will significantly lower barriers for action, and enhance quality of reporting, if MS Inventory compilers offer updated emission factors and guidance in their use. Most companies will not be able to, or capable of, undertaking the trials and field surveys and associated lab work and data analysis necessary to produce reliable emission factors.

An example is the recent French initiative Ecobalyse, regulating use of emission factors in corporate GHG inventories and footprint calculations (e.g. using EU-PEF), ensuring some degree of alignment with official values.

Government, subregional, collaborative, or local funded research programmes systematically sharing of all resulting EFs in an easy access manner would also be a major step forward. An example of this is the German MoorFutures setup in northeast Germany, where regional government money, a long-term research collaboration, and full transparency has resulted in climate action *and* refinement and improvement of emission factors for wetland rewetting in Germany and beyond, freely available to all. Alignment in used EFs across the Climate Tech sector, would also address potential competitive greenwashing, and ensure reverse alignment between corporate and MS GHG inventories in the future. Some initiatives already compile and provide data sets, emission factors, and selected activity data, e.g. the Integrated Modelling Platform for Agricultural Practices & Policy (IMAP) data on carbon impacts of a range of agricultural practices, hosted by European Commission. Similar national or thematic frequently updated and maintained platforms will be of great value for private sector inventory compilers.

4.1.3 Preparation of Remote Sensing, GIS and other spatial products

Use of similar or the same data layers, prepared and quality checked to uniform standards, as input into GHG reporting and accounting across reporting levels is one way to ensure both consistency and reduce costs (and confusion) for private sector LULUCF inventory compilers. Open source, MS GHG Inventory endorsed Remote Sensing products will help guide private sector action. Data layers for biomass density, soil type maps, or forest fires (and other Natural Disturbance events) are time consuming and costly for small and medium enterprises to acquire or produce.

Ongoing EU funded research projects are already preparing several RS, GIS, or other spatial products for open access. Below in Table 4, an overview of major ongoing EU funded projects:

Table 4. Overview of ongoing EU funded projects providing resources for public and private sector GHG inventories

Project/Tool	Link	Explanatory note
CLC Core by European Environmental Agency	CLC Core product: https://clcplus-core.land.copernicus.eu/ Contact LULUCF@eea.europa.eu for more information	Copernicus Land Monitoring Service (CLMS) geospatial data to support the LULUCF inventory process using a flexible database solution (CLC+ Core) that can (1) harmonize existing (dissimilar) LC/LU input data by using a common nomenclature (EAGLE) (2) combine existing data by developing extraction rules in the system (3) output 100m grid, tailor made products
Holisoils, EU funded	Project link: www.Holisoils.eu	Covers forest soils and build knowledge, free European soil maps

[9] https://www.ipcc.ch/data/

	Interactive online interface: https://github.com/elisabruni/Holisoils-multimodel Test version of web tool (to be updated): https://elisabruni.shinyapps.io/test4/ Policy brief: https://efi.int/publications-bank/forest-soils-can-increase-climate-change-mitigation-targeted-management Collected input data for maps available here: https://dashboards.isric.org/superset/dashboard/holisoils	and tool basis. Review of tools published in Forest Ecology and Management (Mäkipää et al., 2023)
Forest Navigator project, EU funded.	Project link: https://www.forestnavigator.eu/ LinkedIn: Forest NavigatorEU Project Tool Portal: upcoming	Mapping and linking modelling advancements for the LULUCF community and co-designing the modelling of policy pathways for the forest sector
ForestPath, EU funded	Project Link: http://www.forestpaths.eu/ Canopy policy support platform: upcoming Free Database with substitution factors and impact factors: upcoming Training materials, podcasts, videos: upcoming	Co-designing, quantifying, and evaluating forest sector pathways and delivering (open access): High resolution maps, next generation simulation modelling, and improved data and tools.
Pathfinder, EU Funded	Project link: https://nibio.no/en/projects/pathfinder	Developing an integrated forest monitoring (field protocols) and pathways assessment framework with maps, monitoring plots, and C stock change estimates for use or reference.
Credible, EU Funded	Project just started (Q2 2023), see link: https://www.creaf.cat/building-momentum-and-trust-achieve-credible-soil-carbon-farming-eu	Will later develop and share standards for soil monitoring
MRV4SOC, EU Funded	Project just started. Project Description link: https://spectralab.gr/wp-content/uploads/2023/01/mrv4soc.pdf No project page as of Q2 2023.	MRV4SOC aims at designing a comprehensive, robust, and cost-effective Tier 3 approach, accounting for changes in as many C pools as possible, to estimate GHG and full C budgets, coupling C and N cycles, quantify Soil Organic Carbon (SOC) accumulation, and assess the results of traditional management practices and Carbon farming.
MARVIC, EU Funded	Project just started.	Use of AI and digital tools to improve and scale MRV of soil carbon.

Where relevant at national level, similar higher resolution or specific thematic products may be needed.

4.1.4 Reference Level

SBTI FLAG guidance, and the Climate Benefit Analysis required for all activities under the EU Taxonomy to claim green status, demands computing a 15-30 year reference level for each land manager (and hence LMU). This daunting task will be repeated many times in the coming decade by company staff that have little or no

experience in doing so. Basic projections, tools/algorithms, and datasets would again lower the barriers more and better corporate action and help benchmark and improve the commercial reference levels offered by the climate tech sector.

4.2 Integration of project information into National LULUCF Inventories

The linking between national and private sector inventories goes both ways. Scope 3 GHG-P monitoring and reporting, projects for the voluntary carbon market (VCM) and private schemes are all likely to produce data using Approach 2-3 for area reporting and Tier 2-3 methods for emission factors, because of the need to produce more locally reliable estimates within defined geographical boundaries ('spatially explicit'). Therefore, if and when using project level data in national inventories, the 2019 Refinement suggests the following steps:

i) Define and report the reference conditions (e.g., climate, soil, management system) for which the data from the activity or project are valid and how it could be used in the NGHGI compilation.

ii) Determine if the activity or emissions factor data in the project are representative of the national average and, if not, apply methods that ensure the NGHGI is not biased by them, e.g., limiting the use of the data to the land subject to the activity or project only and modifying the data used in the NGHGI to prevent bias.

iii) Define and report the level of variability (heterogeneity) of the data.

iv) Ensure the data is available and consistently applied for the entire time series.

Citation in italics from 2019 Refinement volume 4, chapter 2, box 2.0A. The idea of referring to the 2019 Refinement and Box2.0A seems to be to encourage private sector inventories to use most recent default values (where dynamic modelling is not applied), application of approaches and tiers 2 and 3, and disaggregation into activity level for all reporting (pers. comm).

Furthermore, ensuring that consistency, comparability, and reference conditions are reported and shared, and hence easily integrated and useful without excessive ad-hoc data mining and control, calls for national level guidelines or requirements. Similar to the French Emission Factor initiative mentioned above ('Ecobalyse'), mandatory formats and a digital platform or interface might be necessary to address inconsistency and credibility risks and to leverage the spatially explicit data provisioning that some projects may be able to.

In conclusion, it is important to note that the MRV and Inventory compilation by public and private entities alike, serves the purpose of demonstrating and documenting impact of climate action on the ground in the land sector. Even if the same land manager can and will report impact under the EU Taxonomy, for a Carbon removal Certificate at the same time as that impact is recorded and reflection in the relevant public GHG inventories at national and subnational levels, all the reporting estimates reflect the same climate action. By lowering data barriers and interlinking tools and methodologies across these levels, more and more ambitious climate action may be possible because ex-ante estimation and ex-post documentation may become more cost effective over time. After all, it is more climate action that is needed, not monitoring and inventories for their own sake.

5 FAQ

The below answers seek to clarify questions commonly asked but doing so with information available at the time of writing.

- How are GHG-Protocol and EU Taxonomy FM reporting different from LULUCF inventories?

The most pronounced differences are the geographical coverage and purpose. While LULUCF inventories cover all (managed) land within a given MS (or third country), both GHG-protocol and EU Taxonomy reporting will apply to specific land management units or groups of units, potentially across several MS and possibly third countries. The key is to manage or influence the area that is reported on, as the GHG inventory should reflect the emissions and removals that the reporting entity can be considered accountable for. A MS is assumed to have direct influence over management decisions within its own territory, while downstream companies buying wood or agricultural produce from a farmer or forest are assumed to have direct (scope 1) or indirect (scope 3) influence over management decisions through use of procurement tools including price paid. The other chief difference between MS LULUCF inventories and private sector LULUCF inventories is the purpose. National GHG inventories primarily serve compliance reporting purposes, while private sector inventories show adherence to reporting rules and demonstrates if the company is on track with its self-induced reduction trajectory or climate neutrality pathway.

- Who will the EU Green Taxonomy apply to?

It does not directly apply to EU MS, LULUCF inventory compilers or land managers (except where the latter is owned by a financial institution). The EU Taxonomy applies to financial institutions and regulates what documentation and analysis must be conducted to what standards, and how it shall be disclosed in order to make statements on sustainability, including climate change mitigation and biodiversity restoration. Where a financial institution wish is based in the EU or wish to place a financial product on the EU market with statements on sustainability (e.g., an Impact Fund or a green pension scheme), and that institution has invested money in one or more land managers, it must provide estimates and a baseline at asset level. Any land manager in the EU (or abroad) that has a loan, credit, mortgage, insurance or part or full ownership with an eligible financial institution can be subject to one or more private sector LULUCF inventories.

- Will private sector inventories need spatially explicit and timely data?

Yes. Under the EU Green taxonomy (Technical Criteria for Forest Management) all data must be provided and estimated at asset level. The conditional Climate Benefit Analysis (to be performed in accordance with the 2019 Refinement) must apply values specific to the area (of the invested activity) and updated annually. For agricultural land the rules have not been proposed, consulted and discussed yet. Landscape or regionalised benchmarks and baselines cannot be applied.

For GHG-Protocol reporting of removals similar requirements apply and tier 3 modelled estimates including for HWP must be provided in order to become eligible to apply certain safeguards and make certain claims.

- Will private sector inventories cover all reported land?

No. With pronounced differences between countries (in the EU) and subject to the differences between EU Green Taxonomy and the voluntary standards (SBTI and GHG-P and others), expectedly 5-20% of managed land will be covered by one or more of the schemes that requires a LULUCF inventory. While the application and extent of EU Taxonomy driven LULUCF reporting depends on the nature and exposure of the financial sector to the land sector in each country, the negotiation and adoption of criteria for the agricultural sector will largely determine the timeline for implementation. Where a MS is dominated by forests, organised predominantly in professionally managed estates well above 10-20 ha, and with access to debt and equity from major financial institutions (as compared to local credit institutions) the coverage of private LULUCF inventories will be high. In countries dominated by privately held, small agricultural units, with limited access to financial markets and services, the share of land subject to private LULUCF inventories by 2030 may be well below 10%.

As for SBTI and GHG-P, the uptake of the standards among major companies downstream of the agricultural or forest sector in a given country will drive up coverage. For MS with significant export of agricultural products into the fabrication of consumer facing products the pull for adoption and application of the GHG-protocol will be stronger. It is mainly big global conglomerates with many products targeted at retail that have adopted SBTI targets. Adoption of SBTI targets means the company will need GHG data for scope 3 to be able to report, which will include farm level data produced with Approach 2-3 and Tier 2-3 methods. As agricultural supply chains are long and often complicated, what happens is the company will require activity data from suppliers, essentially traders and producers of finished products like ice cream or confection. The degree of control,

traceability and integration of the supply chain will be important factors. As a result, the pull for activity data for agricultural lands will materialise at high and aggregate level, and regional statistics and average values will most likely suffice in the next 5-10 years.

For the forest sector it may look different as the only access to reported removal for many companies are through FMU specific scope 3 reporting. Also, some important supply chains for e.g., furniture and construction wood have high traceability and a consumer and policy pressure to reduce footprints quickly.

- Are private sector inventories developed for all LULUCF land categories and Agriculture?

Over time yes, but currently the rules for the different land categories are developing in different tracks and at different speeds.

The most advanced is the forest sector, where certification schemes and carbon schemes have been active for a couple of decades, but in the past decade agricultural and soil schemes have proliferated all over Europe at national, regional and local scales. Under the EU Green Taxonomy, the Forest Sector (Afforestation, Forest Management, and Forest Restoration) rules and technical screening criteria have been developed, consulted, and adopted, and implementation is ongoing. For wetlands and peatlands, rules are also developed and implemented. For the agricultural sector, including cropland and grassland, rules are still being drafted and the consultation will likely be contested and difficult.

As concerns SBTI and GHG-Protocol, the land sector approach was consulted last fall, and rules are expected to enter into force in 2023. The land sector rules are generic to a large extend as they cover reporting on removals and net removals, though with detailed rules for specific activities. Regionalised sector level net zero pathways have been adopted, based on Roe et al (2019), that covers both agriculture and forest.

- How can national LULUCF Inventories benefit from private sector inventories?

First and foremost, national LULUCF GHG inventories can benefit from the private sector capacity and capabilities developed through investments by financial institutions and companies either owning land or buying critical ingredients or material produced on managed land. In the situation where a subnational and/or several private sector inventories with significant area coverage are fully inter-operable with and embedded in the national inventory set-up, it would be a full collaboration and allow national inventory compilers to focus more on public or protected lands.

Investments into Earth Observation data, sensors, data processing, advanced applications, and model development may produce activity data for parts of the managed land in a given country. As the EU Taxonomy rules for e.g., FM requires annual updates of reporting, timeliness of estimates will be critical for compliance and a specific area of investment.

In terms of skills, knowledge building and the development and use of tools very similar to those applied by national inventories will result in networks, expert groups, and communities that can become national or regional LULUCF groups.

- Will private sector LULUCF inventories be reviewed and controlled?

The answer depends on the standard applied by the downstream company. For SBTI targets and associated GHG accounting, the answer is no, not for now. The secretariat behind Science Based Targets Initiative is working on modalities for how to introduce review of the corporate GHG inventories, including the LULUCF. These will most likely be equivalents to centralised NC/BR reviews and will not go into methodologies or data management systems.

For companies voluntarily reporting GHG footprint across scopes 1, 2 and 3 under the GHG Protocol, there are currently no requirements for third party validation or verification, but some companies choose to do so to build trust and credibility in estimates.

As it looks now, there is no external review mechanism for the reporting by financial sector entities towards the EU Green Taxonomy, and thereby the private sector inventories that will be required to apply the 2019 Refinement AFOLU rules will not get automatic feedback and corrections. There are no indications that national LULUCF inventory compilers will be required to check, review or approve any private sector LULUCF Inventory. However, the foreseen compliance mechanism under the EU Taxonomy and SFDR is currently only a requirement that all reporting entities must be able to prove at any time that they are not in active breach. Financial Regulators are required to undertake spot-checks, and take corrective action (i.e., downgrade alignment level of reporting entity), if breaches are detected. NGOs, researchers, and other watch dogs may very well play an

important role. If and how Financial Regulators establish oversight, review, or control regimes nationally that include a role for LULUCF Inventory Experts remains to be seen.

- Are the boundaries of the private sector LULUCF monitoring and reporting limited to the EU?

No. It is not the land that determines whether the EU Green Taxonomy applies, but the location and the products of financial institutions such as pension funds, insurance providers, banks, and asset managers that counts. Land all over the world may be required to report to the criteria.

The EU Green Taxonomy applies to financial institutions domiciled in the EU and/or placing a financial product in the EU market. Where an EU based financial institutions has debt, equity, ownership or other significant financial exposure such as long-term credit or mortgage into a land title in the EU, the taxonomy applies. Furthermore, forests and agricultural land also outside of the EU will be required to report to the standards of the Taxonomy, if the financial institution wishes to uphold a high grading allowing it to promote itself as dark green within the EU.

Regarding SBTI and GHG-P, the uptake has been predominantly with US based companies and large EU based companies. They will need to promote, develop, or fund private sector LULUCF inventories in the geographies where they source.

- Are the Corporate LULUCF inventories required by already adopted EU laws?

Yes. The EU Green Taxonomy and the technical screening criteria for forest management entered into force in 2019 and 2021 respectively. The LULUCF style inventories that financial institutions will need to set up are however not mandatory for all financial institutions in the EU. It regulates however, that if the financial institutions wish to promote itself as "dark green" (adhering to the highest standard) AND make any statements or claims on its action to mitigate climate change, the Climate Benefit Analysis (incl. an aggregate of FMU level FRLs with spatially explicit data) and an aggregate LULUCF inventory for all its forest assets and exposure (money invested or out on loan) is mandatory. As for agricultural land, the drafting process is still ongoing, and the specific rules are not known.

- Can the 2019 Refinement – and the 2006 AFOLU GPG - be applied at project or FMU level?

Yes, but it takes some adaptation and expertise. The GHG-Protocol and in more general terms the 2019 Refinement itself, lists similarities and differences, and gives high level recommendations on how to reconcile national and private sector inventories. *See sections 1.2.1 and 1.4.2 above and references therein.*

- How is SBTI and GHG Protocol different from 2006 AFOLU GPG and EU Taxonomy Forest Management Reporting?

In principle, the two frameworks are very similar and comparable. SBTI and GHG-P have built on and refers to AFOLU/LULUCF rules frequently throughout. The latest GHG-P draft Removal Guidance has more than 40 references to IPCC AFOLU/LULUCF decisions, guidelines, and principles on elements such as timely estimates, natural disturbances, harvested wood products, and uncertainty. On one key element the GHG-P goes further than IPCC GPGs as biogenic removals can only be reported and accounted for towards a target if primary data for the forest are available and used.

6 Conclusions

Over the past 5-10 years private and public rules for GHG inventories for the land sector have been converging. The guidelines and rulebooks applicable to governmental and national GHG Inventories are based on the extensive research and years of negotiations under the UNFCCC and IPCC and transposed into EU law via LULUCF Policies. Recently the extensive EU Green Taxonomy Regulation has introduced rules and criteria on how the financial sector and larger corporate entities must report and disclose the GHG fluxes and the carbon stocks they might have in the land sector and other sector, with a particular interest in tracking climate mitigation action. This policy area will expand further in the coming years with e.g., the Corporate Sustainability Report Directive (CSRD) and the Green Claims directive. Also, requirements for due diligence, traceability, and methodological consistency as concerns carbon reporting in the land sector are under negotiation or preparation. In combination, these policy developments will most likely drive private sector interest and investment into data, tools, and GHG inventory compilation and reporting.

Simultaneously, in the past decade, several frameworks, standards, tools, and rulebooks have emerged out of cross-sector collaboration for private sector GHG Inventory compilation for companies, driven by voluntary net-zero or emissions reduction targets and significant footprints in the land sector. Initiatives like the Greenhouse Gas Protocol and Science Based Targets Initiative are among the most adopted by companies who wish to disclose targets and trajectories. While many of these are aligned with the IPCC Good Practice Guidelines and principles, there are also notable differences between these and the national GHG inventories, among other in scope of what is reported, and the range of objectives served. Public GHG Inventories have traditionally served compliance purposes against EU and UNFCCC or KP reduction targets, while private inventories serve as documentation for compliance *and* marketing, product, or offsetting claims by companies. A major question for the coming years is therefore how EU Taxonomy criteria that require IPCC 2019 Refinement-compliant climate benefit analysis in the land sector will push private-sector compilers to align with the TACCC principles that are central for the GHG inventories? And a more operational level, how national GHG inventories for the land sector embed, link, or connect with many and different private sector GHG inventories within their territory, and also sub-national level inventories like municipal or local initiatives.

In the next decade, when the interoperation of private and public land GHG inventories will happen, the private-sector compilers are likely to use many of the same methods and seek to overcome many of the same challenges that national compilers have faced in the past decades. In some member states, compilers and research institutions have developed practical tools, guidelines, or standards based on IPCC Guidelines that are helpful and meets needs of private compilers. But even so and given the potential scale of private sector inventories in the coming years, estimates for the same land parcel may still be different and not comparable, as data input, models, and assumptions remain different. Understanding the differences and the reasons behind them will therefore be key for ensuring the credibility of both inventories and a mutually beneficial co-existence.

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List of abbreviations and definitions

AFOLU	Agriculture, Forest, and Other Land Use. IPCC sector.
BECCS	Bioenergy with Carbon Capture and Storage
CBM	Carbon Budget Modelling
DAC	Direct Air Capture (of CO_2)
DG CLIMA	Directorate General for Climate Action (of the European Commission)
DNSH	Do No Significant Harm, herein used as defined in the EU Green Taxonomy
EC	European Commission
EEA	European Environmental Agency
EF	Emission Factor
EU	European Union
EU-PEF	EU Product Environmental Footprint
FAO	Forest and Agricultural Organisation (of the United Nations)
GHG	Greenhouse Gas
GHG-P	Greenhouse Gas Protocol
GIS	Geographic Information System
IMAP	Integrated Modelling Platform for Agro-economic and resource Policy analysis
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre, the research institution of the European Commission
LMU	Land Management Unit
LULUCF	Land Use, Land Use Change and Forestry. IPCC sector.
MRV	Monitoring, Reporting, and Verification
MS	Member State of the European Union
PCAF	Partnership for Carbon Accounting Financials
RS	Remote Sensing
SBTI	Science Based Targets Initiative
SCS	Sustainable Carbon Cycles
SME	Small and Medium sized Enterprises
TACCC	Transparency, Accuracy, Completeness, Comparability, Consistency
TCFD	Taskforce for Climate-Related Financial Disclosures
UNFCCC	United Nations Framework Convention on Climate Change

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