Why the EU's plan for climate neutrality by 2050 will likely fail

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1 Summary with links to main text

A review of planning and modeling for key EU climate legislation finds the EU's plan for achieving "climate neutrality" by 2050 is based on flawed and unrealistic assumptions that will prevent restoration of the land carbon sink and ensure that net zero emissions by 2050 remains out of reach. Achieving net zero emissions, or close to it, depends on reducing economy-wide emissions precipitously while achieving a massive increase in CO_2 removals from the atmosphere, removals that will rely on greatly increasing net carbon uptake by forests and the land sector overall. Yet despite the clear need for aggressive policies to increase carbon uptake in the land sector, EU policymakers have chosen a weak land sector carbon target for 2030 of -310 million tonnes (Mt) CO_2, less than the -316 Mt of CO_2 that the land sector sequestered as recently as 2013 (§ 4.1). Under the EU's plan, biomass use overall will double and use of forest wood for fuel will increase 50% (§ 6.1.1), contributing to the weak land sink target and making the EU reliant on biomass energy with carbon capture and storage (BECCS), a technology that effectively does not exist and that may never deliver negative emissions (§ 5, § 6.2.1), for removal of an additional -250 Mt of atmospheric CO_2 uptake per year. The prominent role for BECCS is likely not known by policymakers, as it is only mentioned in a single footnote in an impact assessment for the recent Land Use, Land Use Change and Forestry (LULUCF) Regulation proposal (§ 6.2.1), and obtaining details on the modeling requires searching through documents from 2018.

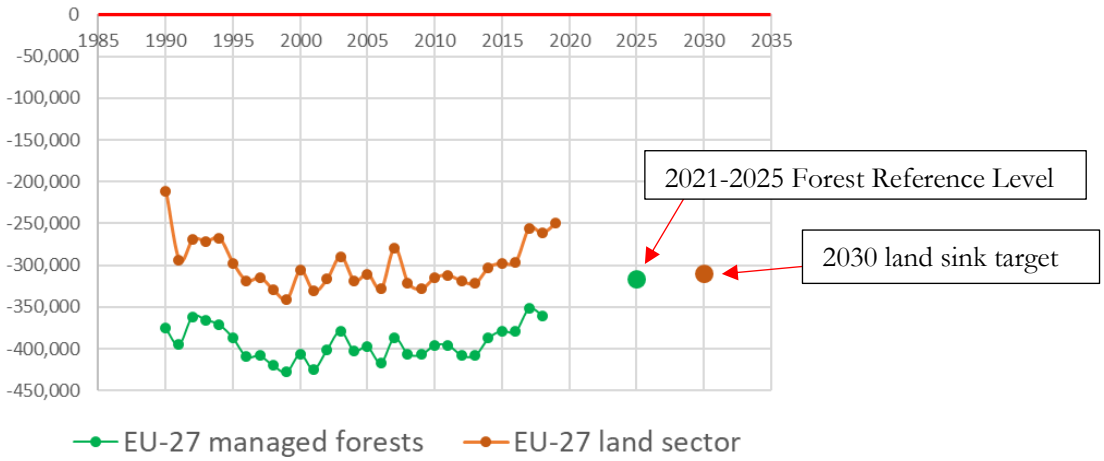
Beyond the assumption that BECCS will be able to capture and store 250 Mt of CO_2 per year, a key factor contributing to the weak land sink target is the EU's dependence on burning forest biomass to meet renewable energy targets. Although it is well known by scientists advising the European Commission that the EU's current use of forest biomass for renewable energy is increasing net CO_2 emissions compared to fossil fuels and degrading the forest carbon sink, the modeling underpinning the land sink target assumes that use of forest biomass for energy will increase by 50% by 2050 (§ 6.1.1), undermining the forest carbon sink even further.

Currently, about half of the wood harvested in the EU is burned for energy, and forest biomass harvesting is recognized as a key factor contributing to the EU's declining forest carbon sink. Nonetheless, biomass is counted as having zero CO_2 emissions in the Renewable Energy Directive, making it eligible for publicly funded subsidies that amount to more than €10 - €17 billion per year. When scientists and environmentalists have pointed out to policymakers that harvesting and burning biomass emits more CO_2 per unit energy than coal and undermines the goal of restoring forest ecosystems, policymakers have often responded that biomass emissions are going counted under the EU's LULUCF Regulation, which for the first time includes a framework for counting land sector carbon flux (carbon emissions and carbon uptake, or "removals") toward the EU's climate targets.

Notwithstanding that even accurate accounting of carbon loss in the land sector will not counterbalance billions in subsidies allocated to private companies to harvest and burn forest wood, in fact the LULUCF Regulation as currently proposed will not fully count emissions from harvesting and burning forest wood. The emissions impact of burning forest wood is concealed in the 2021-2025 accounting period of the proposed amended LULUCF Regulation (published July 2021) because only emissions above member state forest reference level (FRL) baselines will be counted, thereby effectively counting existing levels of forest harvesting, plus whatever additional harvesting is allowed under the FRLs, as having zero emissions (§ 5.1). If member states harvest up to the level allowed by the FRLs, this will produce a potential unaccounted loss of over 40 million tonnes of forest CO_2 uptake per year compared to average uptake in 2016-2018 (Figure ES-1; § 5.1; also see Annex for graphs of member state data). The proposal to reform land sector carbon accounting so that actual flux is counted in the 2026-2030 period, rather than accounting flux against a baseline as in the 2021-2015 period, is an important improvement, but in the meantime, member states will be permitted to further degrade their forest carbon sinks.

To restore ecosystems and the forest carbon sink, the EU needs to harvest and burn less wood. Unfortunately, revisions to the biomass provisions in the EU's Renewable Energy Directive (RED) now under consideration will do

little to reduce biomass harvesting or protect forest ecosystems (§ 3.1). Fundamentally, the "sustainability criteria" in the RED are not capable of redressing the central problem with burning forest wood, that combustion emits CO_2 quickly, while trees regrow slowly. Forest biomass is not carbon neutral, but even if it were, balancing emissions and offsets in the land sector is not sufficient – to rebuild land sector carbon, uptake must exceed emissions.



ES-Figure 1. Historic data for (kilotonnes CO_2) for net carbon uptake by the land sink (brown line) and the managed forest sink ("forests remaining forests" plus harvested wood products, green line), compared to the 2030 land sink target of -310 million tonnes CO_2 (brown dot) and the forest reference level for the EU overall (green dot).

The EU's plan for climate mitigation via burning more biomass then relying on BECCS to remove CO_2 from the atmosphere will be extremely costly. On top of current subsidies for bioenergy that cost €10 - €17 billion per year, increasing biomass use will involve more subsidies. These costs will look small, however, compared to the costs of developing, deploying and upscaling BECCS fuel provision and infrastructure. As an alternative, current biomass subsidies should be reallocated to support additional carbon removals in the land sector. For example, each tonne of CO_2 emitted from a biomass power plant receiving €50 per MWh in renewable energy subsidies costs the public about €36 in subsidies, which if reallocated could pay for an additional 4 to 7 tonnes of CO_2 uptake in the land sector, according to the modeling cost estimates (§ 6.3). It seems likely that EU citizens would rather support restoring and protecting forests, rather than burning them for energy.

Recommendations

1. Stop counting forest biomass burning toward renewable energy targets and reallocate subsidies toward rebuilding the land carbon sink in full respect of ecological principles.
2. Set a "no regrets" 2030 land sink target that assumes BECCS will never deliver negative emissions at scale.
3. Adopt an aggressive land sink target closer to -600 Mt CO_2, and prioritize ecosystem restoration.
4. Replace the flawed baseline approach in the 2021-2025 period with counting actual emissions as in the 2026-2030 period, and set a 2025 land sink target as a staging point toward the 2030 target and beyond.

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1.1 A note on terminology used in this report

- The revised RED was published at the end of 2018. This document hereafter refers to this as **RED-2018**. The document containing the EC's proposed amendments to that revision, which was published in July 2021, is labelled **RED-PA**.
- Likewise, the LULUFC Regulation was published in 2018. This document refers to that as the **LR-2018**. The EC's proposed amendments were published in July 2021. That document is referred to here as the **LR-PA**.

1.2 Locations of main documents and sections of documents cited in this report

EU climate law: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119&from=EN

RED-2018: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=fr

RED-PA: https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

Impact assessment for RED-PA: starting at 77th page of pdf at https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

LR-PA: https://eur-lex.europa.eu/resource.html?uri=cellar:ea67fbc9-e4ec-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

Explanatory memo for LR-PA: page 1 at https://eur-lex.europa.eu/resource.html?uri=cellar:ea67fbc9-e4ec-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

Impact assessment report on the LR-PA: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2021:0609:FIN:EN:PDF

2018 Clean Planet for All modeling document: https://is.muni.cz/el/fss/podzim2019/HEN644/um/com_2018_733_analysis_in_support_en_0.pdf

Paper Tiger report: https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

2 Introduction

"1.5 degrees is within reach but its pulse is weak."
– Alok Sharma, COP26 President

"If we do what we promise here, humanity will learn to live within planetary boundaries"
-Franz Timmermans, VP of European Commission

Closing plenary of Glasgow COP26, November 13, 2021.

To slow climate change and address the biodiversity crisis, the EU needs to store more carbon in forests and other lands, while protecting and restoring natural ecosystems. This principle is recognized in the Glasgow Climate Pact from the COP26, which includes in the preamble, "*38. Emphasizes the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement temperature goal, including through forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases and by protecting biodiversity, while ensuring social and environmental safeguards.*"[1] European Union policy recognizes the importance of natural climate solutions and mandates building carbon in the land sector (via the LULUCF Regulation) as part of achieving the legislatively mandated target of climate neutrality by 2050.[2] Beyond adding targets for carbon removals, policymakers have recognized the importance of protecting and restoring natural ecosystems in the Biodiversity Strategy and the Forest Strategy. In contrast to these goals, however, the EU's Renewable Energy Directive (RED) promotes logging and burning forest biomass for energy, which is recognized by scientists as increasing emissions compared to fossil fuels and eroding the forest carbon sink.[3] The EU depends on burning biomass to meet increasingly aggressive targets for renewable energy generation. Despite purporting to engage the land carbon sink in achieving climate neutrality by 2050, the LULUCF Regulation accommodates the EU's dependence on burning forest wood for fuel, allowing and arguably encouraging erosion of the forest carbon sink with a weak land sink target and a flawed framework for land carbon accounting. Ultimately, the EU's plan for achieving climate neutrality relies on deploying massive amounts of unproven technology such as bioenergy with carbon capture and storage (BECCS). The fundamental incompatibility of policies promoted in these key pieces of climate-related legislation with achieving climate neutrality is the subject of this review.[4]

The RED and the LULUCF Regulation both influence the role the land carbon sink will play in mitigating climate change because both influence the balance of carbon in forests, and forests provide the largest share of carbon uptake in the overall land carbon sink (Figure 1). The RED contributes to loss of carbon from forests because it promotes and incentivizes harvesting and burning forest biomass for energy, which transforms carbon held in forests into atmospheric CO_2. The RED-2018 contains sustainability criteria for forest biomass that are supposed to address the climate and ecosystem impacts of harvesting forests for fuel, but as explained in much greater detail elsewhere,[5] these do not provide meaningful protections for forests and climate. In response to critiques of the RED-2018 biomass criteria, the EC has proposed amendments that will ostensibly address some of the problems (the RED-PA). However, as discussed further below, these reforms would not meaningfully reduce the impacts of harvesting and burning forest biomass on forests and the climate.

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[1] https://unfccc.int/sites/default/files/resource/cma2021_L16_adv.pdf

[2] Article 2 of EU Climate law: "*1. Union-wide greenhouse gas emissions and removals regulated in Union law shall be balanced within the Union at the latest by 2050, thus reducing emissions to net zero by that date, and the Union shall aim to achieve negative emissions thereafter.*" At https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119&from=EN

[3] Booth, M. S. and B. Mitchell (2020). Paper Tiger: Why the RED II biomass sustainability criteria fail forests and the climate. Pelham, MA, Partnership for Policy Integrity. https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

[4] This document does not purport to provide a comprehensive critique. The LULUCF Regulation, both original and as amended in 2021, contains numerous "flexibilities" and other provisions that undermine prospects for truly increasing the amount of carbon stored in the land sector. For reasons of brevity, this paper does not discuss those issues, but that does not mean they are unimportant.

[5] Booth and B. Mitchell (2020). https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

Some policymakers have claimed that the LULUCF Regulation accounts for forest carbon loss from harvesting[6] and thus counterbalances the RED's incentives for harvesting and burning wood for renewable energy. However, as discussed in more detail below, the framework for accounting for land carbon losses set out in the LR-2018 and LR-PA does not fully count emissions from the land sector, and the framework allows considerable erosion of the forest and land carbon sink from forest harvesting. Further, the LULUCF Regulation only provides weak penalties for member states that fail to meet land carbon sink targets, penalties that can not disincentivize harvesting forests for fuel given that member states pay out more than €10 to €17 billion a year[7] in renewable energy subsidies to private companies that harvest and burn biomass.

3 The EU's Renewable Energy Directive promotes burning forest biomass for renewable energy

The EU is heavily dependent on burning biomass, including biomass sourced directly from forests, to meet its renewable energy goals.[8] Based on estimates from the EC's Joint Research Centre, it appears that forest biomass was providing around 18% of renewable energy in 2015-2016, and about 3% of the EU's energy overall. Of all primary woody biomass, the report estimates that 47% is "stemwood," and 53% is branches and tops.[9] About half the wood harvested in the EU is burned for energy, and the vast majority of this is counted toward the EU's renewable energy targets.[10,11] The EU is also increasingly dependent on biomass imported from beyond its borders.[12] However, as summarized in more detail elsewhere, burning biomass emits more CO_2 per unit energy generated than fossil fuels, and harvesting forest wood degrades forest ecosystems and the forest carbon sink, further undermining climate mitigation. Accordingly, biomass "sustainability" criteria included in the RED-2018 and amended in the RED-PA are not capable of addressing the fundamental problems with biomass for two main reasons:

1. Burning forest biomass is always going to emit CO_2 faster than emissions can be offset, thus net emissions from burning forest wood for energy are positive over policy-relevant timeframes. Sustainability criteria can not redress this fundamental problem, because they can not ensure instantaneous offsets for the carbon emitted by burning biomass.[13]
2. The criteria do not protect forest ecosystems because they do not prohibit damaging harvesting practices like clearcutting, or require protective measures such as retaining minimum amounts of forestry residues be left onsite after logging. Any such guidance is suggested but not required.

Table 1 summarizes the significant changes to biomass policy proposed in the RED-PA and why they fail to address the carbon, ecosystem, and biodiversity impacts of harvesting forests for fuel. However, the table does not include suggested improvements for these amendments because there are a variety of possible approaches. Most

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[6] "Emissions of biomass used in energy will be recorded and accounted towards each Member State's 2030 climate commitments, through the correct application of accounting in LULUCF." At https://ec.europa.eu/clima/eu-action/forests-and-agriculture/land-use-and-forestry-regulation-2021-2030_en

[7] The RED-PA impact assessment estimates €10.3 billion in 2018 (page 20 of RED-PA impact assessment report, starting at 77th page of pdf at https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf). However, another report commissioned by the Directorate General for Energy of the EC states that biomass subsidies were €17 billion in 2019. Page 35, downloadable at https://op.europa.eu/en/publication-detail/-/publication/be5268ba-3609-11ec-bd8e-01aa75ed71a1/language-en. Neither report is clear how much support went to solid biomass, versus liquid biofuels.

[8] See overview of JRC report estimates at https://forestdefenders.eu/wp-content/uploads/2021/03/JRC-study-biomass-study-overview_final.pdf

[9] Footnote 2 at https://forestdefenders.eu/wp-content/uploads/2021/03/JRC-study-biomass-study-overview_final.pdf

[10] Booth and Mitchell 2020. https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

[11] The EU's renewable energy targets are set on an "energy input" basis, meaning the energy inherent in biomass fuels is counted toward targets, rather than useful energy generated.

[12] Brack, D., et al. (2021). Greenhouse gas emissions from burning US-sourced woody biomass in the EU and UK. Chatham House, London, UK. At https://www.chathamhouse.org/sites/default/files/2021-10/2021-10-14-woody-biomass-us-eu-uk-research-paper_0.pdf

[13] Booth and Mitchell 2020. https://forestdefenders.eu/wp-content/uploads/2021/05/RED-II-biomass-Paper-Tiger-July-6-2020.pdf

fundamentally, slowing emissions and rebuilding the forest carbon sink requires harvesting less wood.[14] Accordingly, real reform could be accomplished by removing primary woody biomass ("forest" biomass) as an eligible fuel from the RED altogether, thus disqualifying it from helping meet renewable energy targets and from being eligible for subsidies and other supports (such as tax breaks for purchasing wood-fired home heating appliances). This is particularly important to accomplish in conjunction with counting land sector carbon toward climate targets, since to the extent that EU member states do reduce harvesting to rebuild forest carbon, this will only increase pressure to import wood pellets from areas outside the EU, such as the Southeastern US, British Columbia, and Russia. Removing forest biomass from the RED could be accomplished with simple wording changes to the RED-PA and RED-2018, as has been previously proposed.[15]

3.1 Biomass provisions in the RED-PA and why they don't protect forests and the climate

Proposed change in LR-PA	Why the proposal falls short
Member states are no longer allowed to grant support for the use of saw logs, veneer logs, stumps and roots to produce energy.	By the EC's own data, such materials comprise only a small fraction of the forest wood burned for energy. This will not decrease pressure on forests.
From 2027 onward, member states can no longer grant subsidies to electricity-only installations burning forest biomass, unless it occurs in a region especially dependent on fossil fuels, or it is used with carbon capture and storage.	This provision continues to allow use of forest biomass in old coal power stations, specifically in countries with a high coal dependency. It is also not clear if the RED-2018 or RED-PA would consider wood pellets made from wood harvested for this purpose to be "forest biomass," since the manufacturing steps for pellet production might in an overly strict interpretation cause pellets to be considered "secondary" woody biomass, rather than "primary" woody biomass that is sourced directly from forests. The RED-2018 and RED-PA do not contain sufficiently detailed definitions of what qualifies as "forest biomass" to assess this risk.
The EC will adopt a delegated act on how to apply the cascading principle to biomass, and how to reduce the use of "quality roundwood" for energy production.	This is a step in the right direction if it recognizes the importance of prioritizing material use over burning wood for energy, but its relevance is diminished considering that the "quality" of wood is not relevant to the climate impact of burning it. About half the wood harvested in the EU is burned for energy, and the revisions do not do anything to reduce this.
Sustainability criteria in the existing RED are amended to require that harvesting consider how to maintain soil quality and biodiversity, avoid harvesting stumps and roots, avoid degradation of primary forests or conversion to plantation forest, minimize large clear-cuts and encourage retention of deadwood on-site.	These non-binding provisions apply to relatively little of the biomass actually burned in the EU, because primary forests only represent about 3% of Europe's forests, and stumps and roots are only sometimes burned for energy in any case. This provision will do little to nothing to reduce the total amount of forest wood burned in the EU.
The revised RED applies the "sustainability" criteria to installations above 5 MW – previously it was 20MW.	The sustainability criteria do not address the central issue with biomass, that harvesting and burning wood for energy increases emissions and degrades forests. Thus applying them to smaller facilities has little impact.

Table 1. The main proposed amendments concerning forest biomass in the RED-PA, and why they fall short of measures that would actually reduce biomass use and protect forests.

[14] Page 20 of impact assessment report accompanying the proposal to amend the Renewable Energy Directive, July 14 2021. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2021:0609:FIN:EN:PDF

[15] Proposed changes to remove primary woody biomass from the RED and introduce new sustainability criteria for secondary woody biomass. May 7, 2021. https://forestdefenders.eu/wp-content/uploads/2021/05/Memo-on-proposed-RED-biomass-revisions-May-7-2021.pdf

4 The role of the LULUCF Regulation in the EU's climate mitigation plans

EU policy recognizes the importance of the land carbon sink for meeting climate goals. As the impact assessment for the LR-PA states[16] (emphasis added)

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

The LULUCF Regulation sets out the rules governing how carbon in the land sector is counted – or not – toward the EU's climate goals. The general objective of amending the LULUCF Regulation in 2021 was to make it "*fit for reaching at least 55% net greenhouse gas emission reductions by 2030 compared to 1990, in line with the 2030 Climate Target Plan, as a staging post to achieving climate neutrality by 2050.*"[17] It is essential as well that the policy incentivizes action rebuilding land sector carbon stocks in a way that supports the EU's ecosystem restoration goals.

Unfortunately, as explained below, the LR-2018 and LR-PA set such weak targets that they arguably serve to incentivize *loss* of carbon from the land sector by 2030, and fall far short of what is needed to put the EU on a path toward carbon neutrality in 2050.

4.1 Historic data on carbon emissions and removals in the EU's land sector

Figure 1 shows historic data on CO_2e removals and emissions in the components of the EU's land sector, which currently offsets about 6% of the EU's emissions.[18]

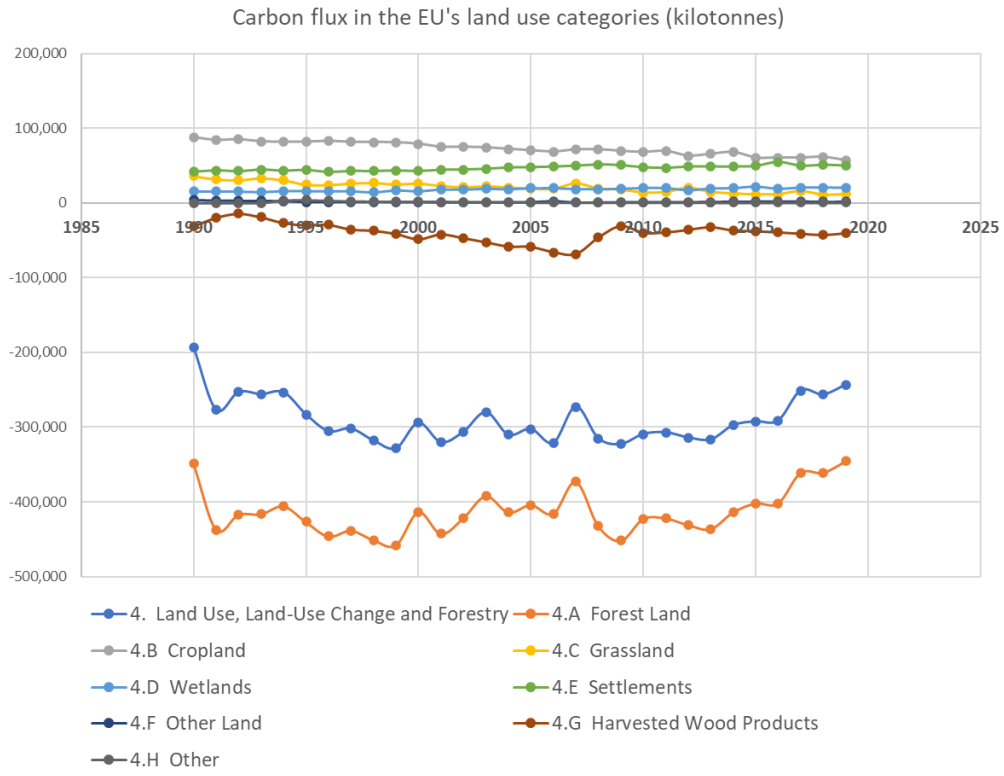

Figure 1. Carbon flux in various land use categories for the EU, as reported to the UNFCCC[19]

[16] Page 19 of LR-PA impact assessment
[17] Page 99 of LR-PA impact assessment
[18] https://di.unfccc.int/detailed_data_by_party
[19] https://di.unfccc.int/detailed_data_by_party

Regarding the data in Figure 1, the following observations are relevant to this discussion:

1. The land carbon sink is decreasing. This is the opposite of what needs to happen if the land sector is to play a meaningful role in achieving carbon neutrality.
2. Forests provide a net sink and comprise the overwhelming majority of the land sink overall, but the forest carbon sink is decreasing.
3. The overall land carbon sink is considerably weaker than the forest sink because several land categories are not sinks, but sources (cropland, settlements, grassland, wetlands).
4. It is worse that it looks. The data reported are based on what is observed in inventories of forests and other lands, which are extremely error-prone for a variety of reasons, such as the inability to represent the true magnitude of soil carbon flux (discussed below) and underreported emissions from peatlands. Therefore, the data shown probably over-represent net carbon removals by the land sector.
5. Harvested wood products (HWP) are a very weak sink for carbon – even doubling the amount of wood held in HWP would not provide much mitigation and would come at the expense of a much greater carbon loss from the forest sink (discussed below).

4.2 How the LULUCF Regulation values land sector carbon flux

The LULUCF Regulation proposes two accounting periods, 2021-2025 and 2026-2030. As shown in Table 2, the LR-2018 and LR-PA account for land sector carbon in the 2021-2025 period in the same way, accounting against a baseline (explained below), but for the 2026-2030 period, the LR-PA proposes to change to counting actual emissions as they are reported to the UNFCCC. This second period is capped off with an EU-wide land sink target of -310 Mt CO_2 by 2030.[20] Another important change (not shown in Table 2) is the proposal to merge the non-CO_2 greenhouse gases from agriculture into a new land sector "pillar" starting in 2031, with a goal of carbon neutrality for the new merged sector by 2035. This move has been widely opposed by environmental groups, due to fears it will serve to hide in the land sector significant non-CO_2 emissions from agriculture that are currently tracked independently.[21]

[20] The land sink targets for each member state were set taking into account the area of managed land. Page 108 of the IA describes the process: *Each Member State maintains its recent level of reported removals and emissions; in this assessment the average of the period 2016 to 2018 – the same start level as applied under the ESR59 – resulting in an EU starting level of 267.7 MtCO2eq. The remaining gap to the EU-target of 310 MtCO2eq in 2030 (e.g. 42.3 MtCO2eq of removals if compared to the average of 2016 to 2018) is allocated in proportion to the area of managed land in each Member State. Annex 10.4.2 provides more details on how the targets are computed.*

[21] See, e.g., WWF's statement: "*The LULUCF sector should retain its current scope, and not be extended to include non-CO_2 emissions from agriculture (to create an 'Agriculture, Forestry and Other Land Use' or 'AFOLU' sector).*" At https://wwfeu.awsassets.panda.org/downloads/wwf_position_paper_on_reform_of_the_eu_lulucf_regulation__july_2021_.pdf

	LR-2018		LR-PA	
	2021-2025	**2026-2030**	**2021-2025**	**2026-2030**
Afforested and deforested land	Actual emissions, not accounted against a baseline (Article 6)	Same as in 2021-2025 period	Same as LR-2018	Same as LR-2018
Managed forests	Accounted emissions for whole period calculated as actual emissions flux minus 5x forest reference level flux. FRL is estimate of what forest flux would be if forest management in baseline period of 2000-2009 had been carried forward in time. (Article 8)	Same as in 2021-2025 period	Same as LR-2018	No more FRL's or forest-specific accounting; category subsumed into land target as a whole
Managed cropland and managed grassland	Accounted emissions for whole period calculated as actual emissions flux minus 5x average annual emissions in 2000-2009 baseline (Article 7)	Same as in 2021-2025 period	Same as LR-2018	No more baselines for cropland or managed grassland; categories subsumed into land target as a whole
Managed wetland	Accounted emissions for whole period calculated as actual emissions flux minus 5x average annual emissions in 2000-2009 baseline, but only for MS that have committed to include wetlands in commitments (Article 7)	Same as in 2021-2025, but now required for all MS	Same as LR-2018	No more wetland baseline; category subsumed into land target as a whole
Goal for whole land sector	**Target**: Actual emissions from whole land sector (forests, cropland, grassland, and wetlands for MS that included them) should not exceed removals as accounted, meaning sum of baselines plus actual emissions (Article 4)	Same as 2021-2015, with all MS including wetlands	Same as LR-2018	Accounting against baseline ends. Actual emissions from whole land sector (same as emissions reported to the UNFCCC) are now counted and compared to MS land sector targets set out in Annex IIa. Cumulative target for EU is -310 million tonnes.

Table 2. Land sector carbon accounting under the LR-2018 and LR-PA

5 A weak land sector carbon target undermines prospects for climate neutrality

Despite the major changes proposed in the LR-PA, the policy and the land sink target of -310 Mt which it proposes are unlikely to help deliver the EU's 2050 climate neutrality goal. Simply put, the weak land sector target means the mitigation modeling depends on successful large-scale mobilization of technological carbon dioxide removal (CDR) solutions such as biomass energy with carbon capture and storage (BECCS), alongside massive decarbonization of the entire economy. Achieving either, much less both, seems unlikely.

While climate modeling for the IPCC has included CDR of some kind in most (but not all[22]) of the models describing pathways to climate mitigation, the models do not necessarily specify BECCS. However, BECCS is generally understood to be the most favored form of CDR because it can (in theory) deliver energy generation in conjunction with carbon dioxide removal, whereas technologies such as direct air capture require energy but do not generate it.

[22] See https://www.pfpi.net/the-ipccs-recipe-for-a-livable-planet-grow-trees-dont-burn-them

The latest IPCC report contains several warnings about the hypothetical nature of BECCS and the huge impacts it could have on ecosystems. This report will not cover the issue of BECCS in detail except to note that the technology is speculative, unproven, and would require massive reallocation of land along with deployment of infrastructure and investments that would likely rival current fossil fuel infrastructure. Further, even if BECCS were a proven technology, upscaling it in a timely way seems unlikely. As one paper considering global BECCS deployment puts it,

> *"Taking the requirement of 70EJ p.a. of dedicated BECCS by 2050 and comparing this with the capacity of world's largest non-nuclear thermal power station (5.6GW) illustrates starkly the scale of deployment assumed. By 2050 there would need to be at least 500 fully-BECCS power stations of a size equivalent to the largest thermal plant currently in operation on the planet. Given the fledgling biomass and CCS industry, there is no prospect of a significant roll out of such large biomass plants before 2025 at the very earliest. Even under such unprecedented optimism, there would still need to be one BECCS power station (the size of the largest conventional thermal plant today) constructed and commissioned every eighteen days and for twenty five years in order to deliver the 70EJ of BECCS by 2050. Given that most large modern thermal power stations typically have a capacity of 1 to 2 GW, and again assuming a high annual load factor, a more realistic, but still highly ambitious, capacity for biomass plants would suggest construction and commissioning up to two large BECCS plants each week for a quarter of a century."*[23]

One of the UK's premier climate scientists has described BECCs and other CDR technologies as a "moral hazard" that "locks in humankind's carbon addition."[24] Given the risks and uncertainties associated with deployment of BECCS and other technological CDR strategies, the fact that the EU modeling assumes it *will* be deployed, and therefore there is less need for rebuilding the land sector carbon sink, is an extremely high risk approach.

Instead, the EU should adopt true "no regrets" policies to maximize the land sink and ecosystem resiliency immediately, assuming that BECCS will not ultimately deliver carbon removals.

However, instead of taking a precautionary approach, policymakers have employed modeling that bakes in BECCS and thus sets a land sink target that falls short even of what its own impact assessment requires. The LR-PA states,

> *"we need carbon removals to increase significantly if we are to achieve climate neutrality in 2050. Thus, to be on track for climate neutrality in 2050, the EU needs to reverse the recent decline in land-based removals and start implementing actions to increase removals already in this decade, in order to account for the long lead times of land-based climate mitigation."*[25](emphasis added)

Far from representing a significant increase, the 2030 goal of -310 Mt is a **weaker land sink than existed for the EU in 2013**, when the sink was -316 Mt (Figure 1). The Annex to this document, which contains graphs for each member state, demonstrates that the 2030 targets are mostly incompatible with the need to "increase removals in this decade." While the 2030 target for the EU-27 overall is stronger than the current sink, the target for many member states is either the same as the current land sector sink, or weaker.

5.1 The baseline approach in the LULUCF Regulation undercounts actual land sector emissions

Despite claims that the LULUCF Regulation fully counts land sector carbon flux, the framework for forest carbon accounting under the LR-PA actually ensures that emissions go uncounted in both the energy and lack sectors,

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[23] Mander, S., et al. (2017). "The Role of Bio-energy with Carbon Capture and Storage in Meeting the Climate Mitigation Challenge: A Whole System Perspective." Energy Procedia 114: 6036-6043. At https://reader.elsevier.com/reader/sd/pii/S1876610217319410?token=ED626457C8506E49854360CF9CB79D21F29C2B1C250776340203E7DE13EDC20219DF8A891508E0C645BFAA2FDCA33D7B&originRegion=us-east-1&originCreation=20211116033221

[24] Anderson, K. and G. Peters (2016). "The trouble with negative emissions." Science 354(6309): 182-183.At https://smartstones.nl/wp-content/uploads/2016/12/Kevin-Anderson-2016.10.13-the-Trouble-with-Negative-Emissions-Science-2016.pdf

[25] Legislative financial statement accompanying LR-PA proposal, page 32 at https://eur-lex.europa.eu/resource.html?uri=cellar:ea67fbc9-e4ec-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

because the LR-PA retains the baseline approach of the LR-2018, including the Forest Reference Levels (FRL), for the 2021-2025 period.

Instead of retaining the baseline approach, the LR-PA include an interim 2025 target as a staging post on the path toward the 2030 target, and the 2030 target should be significantly increased or even doubled.

Under the baseline approach, carbon flux from croplands, grasslands and wetlands are assessed against a "zero" baseline consisting of the historic average flux from 2000-2009. This means that "accounted" emissions and removals consist of only that carbon flux above or below average emissions from that period, with the baseline serving essentially as the "zero" level. Carbon flux from managed forests[26] is assessed somewhat differently. Instead of using the average flux from the 2000-2009 period as the baseline, a "forest reference level" (FRL) was developed for each member state that is a projection of what the forest sink *would* be if forest management practices during the 2000-2009 period had been continued forward in time. These projections frequently include an expectation that the forest carbon sink would decline, and indeed, a comparison of the member state FRLs does find that for many member states, the FRL anticipates a reduction in the forest carbon sink compared to average levels in 2016-2018 (see Figure 2 and the Annex, where the FRL for each member state is represented by the green dot on the graph). Again, the FRL baseline serves as "zero," so only flux above or below this level is counted.

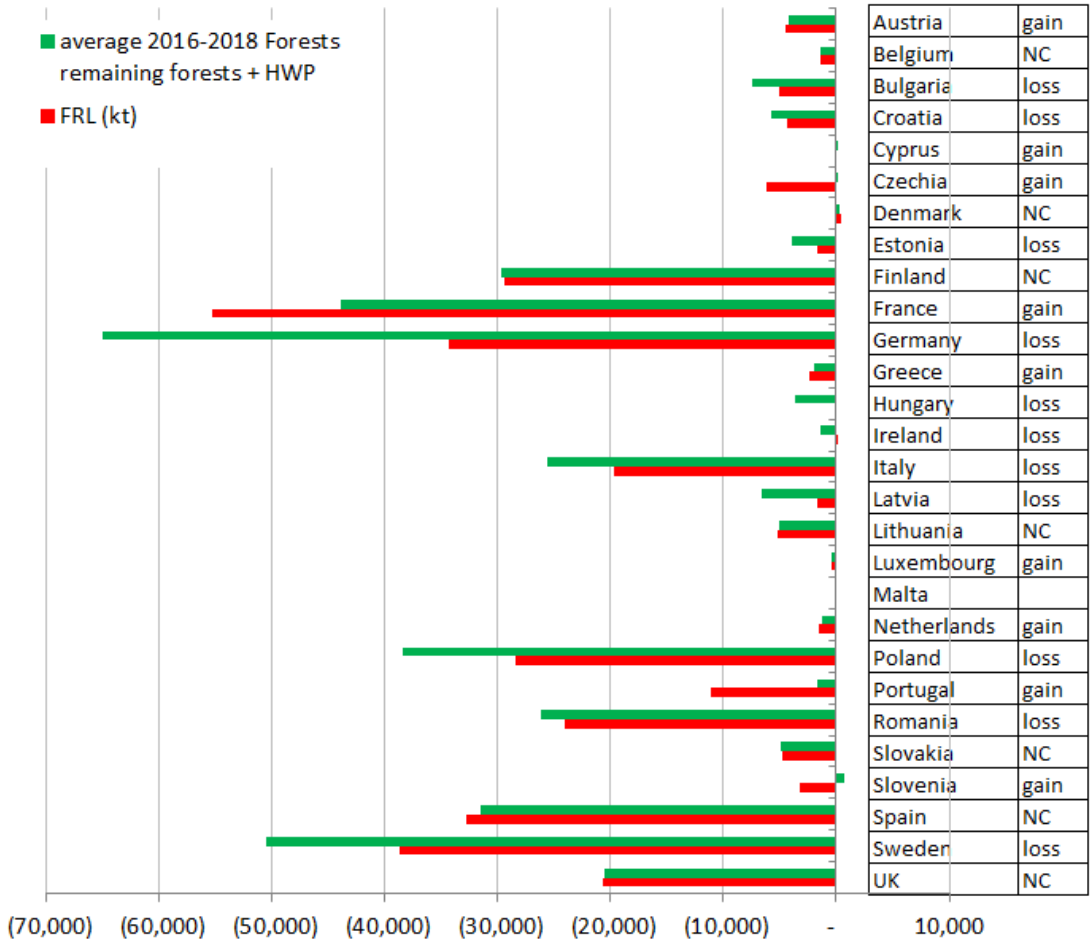

Figure 2. FRL levels compared to average CO_2 uptake by managed forests (the IPCC land category of "forests remaining forests," plus harvested wood products) for 2016-2018 for each member state, designated as gain, loss, or no change in the carbon sink if

[26] Managed forests carbon pool consists of the categories of "forests remaining forests" under UNFCCC reporting rules, plus harvested wood products.

the FRL is less than 5% different from the 2016-2018 average. The axis is in units of kilotonnes (divide by 1,000 to convert to millions of tonnes). A gain in the carbon sink means the number becomes more negative. The FRLs of almost half of member states allow a loss in the forest carbon sink compared to 2016-2018 levels; the cumulative loss for the EU as a whole is about 11%.

This accounting approach is particularly relevant to carbon emissions from burning forest wood for energy. When scientists and NGOs have pointed out that treatment of biomass as "zero" emissions in the RED incentivizes burning forest wood as fuel, a common response has been that "emissions are counted as zero in the RED because they are counted in the land sector under the LULUCF Regulation." Leaving aside the point that the RED is not a carbon reporting mechanism, and so should be less concerned with the sector where biomass emissions are reported than the fact that they occur at all and are incentivized with extremely lucrative renewable energy subsidies, in fact the baseline approach does *not* fully value carbon loss. This is because only losses in the carbon sink that are *additional* to those "planned for" in the FRL baselines are counted. Since the FRL baselines for member states bake in both existing levels of harvesting and anticipated future increases in harvesting, all emissions from such harvesting are counted as zero in the land sector under the LULUCF Regulation, as well as being counted as zero in the energy sector under the RED.

The FRLs are not targets *per se* but do provide a "floor" level for the forest carbon sink in the 2021-2025 period, because member states can increase harvesting and as long as they do not degrade their forest sink relative to the FRL level, they are not penalized. As Figure 2 shows, for almost half the member states, FRLs show a decrease in the managed forest carbon sink compared to the 2016-2018 average for a cumulative loss of about 11% in the EU as a whole. If this potential carbon loss under the FRLs were accounted using the approach to be employed in 2026-2030 period, meaning straight reporting of the actual flux rather than accounting against a baseline, it would constitute a loss of 43.5 million of tonnes of CO_2 removals per year by 2025 compared to the average removals in 2016-2018. However, because the anticipated carbon loss is "expected" and incorporated in the baseline, it will not be reflected in accounted emissions in the 2021-2025 period. Given the importance of forests to the overall land sink (Figure 1), any degradation in the forest carbon sink will make it harder to increase carbon uptake in the land sector overall after 2025.

Viewing the FRLs and the land sink targets for each MS in the context of historical data on carbon sinks is particularly illuminating because it shows how extraordinarily weak many of the targets are. The Annex includes graphs for each member state. Seeing these weak targets, it is difficult to imagine how the EU can achieve climate neutrality by 2050. While it is a welcome development that the LR-PA abandons the baseline approach for the 2026-2030 period, the negative impacts from its use in 2021-2025 are likely to linger beyond 2025. As noted above, the approach encourages loss of the forest carbon sink, or at least does nothing to discourage it. But additionally, as noted in the explanatory memorandum for the LR-PA, not only will most member states easily stay within the FRL limits, but in some cases they will even generate a "surplus" of carbon removals that can be used to compensate *other* member states that have not managed to stay within the FRL siderails:

> *A surplus after the first period is expected, given that currently forest net removals in major Member States are significantly larger than the adopted Forest Reference Levels. Consequently, nearly all forest rich Member States will likely meet their commitments for the period from 2021 to 2025 under the LULUCF Regulation without the need to use their flexibility. It is therefore probable that this would leave a significant share of the available flexibility unused, which can supply the newly established mechanism for the redistribution of any unused Managed Forest Land compensation for Member States hit by natural disturbances.*[27]

Thus to reiterate: under the FRL approach, member states are allowed to reduce their forest carbon sink relative to current levels (Figure 2), yet as long as their loss does not exceed that allowed by the FRL, a portion of land sector carbon uptake can be considered "surplus" that can be used by other member states to compensate losses elsewhere in the land sector. Far from representing climate mitigation, this is a pathway to less carbon stored in forests and more forest carbon entering the atmosphere.

[27] Explanatory memorandum for LR-PA, page 11

6 Why is the land carbon sink target so weak?

The discussion above has touched on the reasons for the weak land sector target, but given its importance to the planet's climate future, the topic deserves more exploration.

Fundamentally, the land sink target was developed using mitigation modeling, and like any product of modeling, it reflects the assumptions and data used to configure the model. Two such assumptions are particularly important: first, that biomass use overall and forest biomass harvesting will greatly increase, which prevents the model from significantly increasing the land carbon sink; and second, that BECCS will be deployed at scale sufficient to provide hundreds of millions of tonnes of carbon removals, thus reducing the need for an aggressive land carbon sink target.

6.1 The model can't produce a stronger forest sink when it assumes forest harvesting will increase

Of the land sector categories, forests are the only one that provides a net sink at the EU level. However, the forest sink is getting weaker, having declined 23 percent from 2009 to 2019 (Figure 1). The model takes into account that forest harvesting impedes accumulation of carbon in forests, and thus retards the ability of forests to act as a meaningful carbon sink. As the impact assessment puts it,[28] *"Overall, the possibility of harvesting approximately the same amount of wood and at the same time increasing the carbon sink in the forest biomass is limited."*

6.1.1 Overall bioenergy use is projected to double and forest biomass harvesting to significantly increase

Forest harvesting for biomass energy is a key driver of the EU's harvesting overall. Currently, about half the wood harvested in the EU is burned for energy,[29] and recent assessments, including using satellite monitoring, have concluded that biomass harvesting is degrading forests and eroding the forest carbon sink.[30] As this is occurring under *current* levels of logging, further intensification is likely to worsen the impacts.

Assumptions about the current and future role of biomass energy are indeed key inputs to the modelling for the land sink target: the LR-PA impact assessment acknowledges that "*important scenario drivers for the projections of the LULUCF emissions/removals are PRIMES bioenergy demand projections (biofuels and solid biomass use).*"[31] The risk of further degrading forests is noted; as a 2018 modeling document used in the assessment warns,[32] intensification of forest biomass use *"could potentially conflict with the production of wood material for other sectors and with other eco-services provided by the forest such as climate regulation (through carbon sequestration), pollution control, soil protection, nutriment cycle, biodiversity protection, water regulation or recreation."*(emphasis added).

Yet despite these warnings, the modeling for the LR-PA assumes that overall biomass use will more than double by 2050, and forest biomass use will increase by more than 50% over officially reported levels (though actual use of forest biomass appears to be significantly higher than reported use, as discussed below).

The LR-PA impact assessment states that regarding biomass use, it follows the assumptions of the "1.5TECH" scenario that is described in the 2018 Clean Planet for All modeling document.[33] The 1.5TECH scenario contains the most total bioenergy (for heat, electricity, and transport fuels) of any of the scenarios evaluated in that document, around 320 million tonnes of oil equivalent (Mtoe) overall by 2050. As the total supply of biomass in 2015 (including waste and agricultural feedstocks for biofuels) is reported as being around 150 Mtoe, a supply of 320 Mtoe would constitute a 228% increase by 2050.[34] The majority of this goes for generating electricity, in part to replace coal, with total biomass for electricity increasing from ~48 Mtoe in 2015 to ~120 Mtoe in 2050. Biomass sourced from forests

[28] LR-PA impact assessment, footnote at page 78

[29] Camia, A., et al (2018). Biomass production, supply, uses and flows in the European Union Ispra, Italy, Joint Research Centre.

[30] Ceccherini, G., et al. (2020). "Abrupt increase in harvested forest area over Europe after 2015." Nature 583(7814): 72-77; Ceccherini, G., et al. (2021). "Reply to Wernick, I. K. et al.; Palahí, M. et al." Nature 592(7856): E18-E23; Grassi, G., et al. (2021). "JRC study on harvested forest area: resolving key misunderstandings." iForest - Biogeosciences and Forestry 14(3): 231-235.

[31] Annex 4 of LR-PA impact assessment

[32] Page 187 at https://is.muni.cz/el/fss/podzim2019/HEN644/um/com_2018_733_analysis_in_support_en_0.pdf

[33] At https://is.muni.cz/el/fss/podzim2019/HEN644/um/com_2018_733_analysis_in_support_en_0.pdf

[34] Figure 84, Clean Planet for All modeling document

increases more than 50%, from ~43 Mtoe in 2015 to ~67 Mtoe in 2050, an increase that is anticipated to interfere with the ability to obtain biomass for material use: "*This increase implies an increase in primary production, and thus the residues, or otherwise, it will affect negatively the material sector*".[35] In part due to this harvesting, and also because BECCS is assumed to provide significant carbon removal (as discussed below), the scenario assumes "*limited enhancement of the natural sink*."[36]

It is important to note, however, that this modeling probably underestimates the impact of current forest biomass harvesting on the forest carbon sink. Recent work by the Joint Research Centre has shown that official statistics (such as that used in the 2018 modeling) estimate forest biomass is around 37% of total wood burned for energy (with the total including "secondary" woody biomass like mill residues and post-consumer waste wood – this material is not classified as "forest" biomass). However, the JRC employs data from usage surveys showing actual wood use is higher than indicated by the official harvesting data that is reported by member states. The gap between the usage and harvesting data translates to another 14% of wood use likely also coming from forests, meaning that forest biomass actually provided about 51% of total wood use for energy in 2016.[37] Because the 2018 modeling employed the lower "official" forest biomass value, it probably underestimates the impact of biomass harvesting on the forest carbon sink in both 2015 and 2050.

Given that *current* levels of forest biomass use are driving a decline in the forest carbon sink and contributing to degradation of the EU's forest ecosystems and biodiversity, it is clear that forest harvesting must be reduced from current levels for recovery to occur. But beyond the impacts on climate, increasing forest biomass harvesting as projected in the scenario would contradict other EU policies and priorities including the Biodiversity Strategy, which calls for "*reducing pressure on habitats and species*,"[38] the Forest Strategy,[39] which aims to protect more forest land and restore ecosystems, and the RED-PA, which promotes the "cascading use principle"[40] so that wood is prioritized for material use and recycled before it is ultimately burned for energy (the Forest Strategy also says this is "crucial")[41]. Critically, along with the increasing in forest harvesting for energy, the 1.5TECH scenario also includes a massive increase in energy crops including grasses and short rotation coppice that is anticipated to have "*significant impacts on land use and land use changes*"[42] that could also affect forests. (The scenario also assumes more waste-burning, with waste supplying about 100 Mtoe of feedstock by 2050[43]).

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[35] LR-PA impact assessment, page 113, Box 8. https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

[36] Page 56, Clean Planet for All modeling document https://is.muni.cz/el/fss/podzim2019/HEN644/um/com_2018_733_analysis_in_support_en_0.pdf

[37] Camia, A., et al (2018). Biomass production, supply, uses and flows in the European Union Ispra, Italy, Joint Research Centre. Official copy at http://publications.jrc.ec.europa.eu/repository/bitstream/JRC109869/jrc109869_biomass_report_final2pdf2.pdf; annotated copy at https://forestdefenders.eu/wp-content/uploads/2021/01/JRC-biomass-report-markup.pdf

[38] https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF

[39] At https://eur-lex.europa.eu/resource.html?uri=cellar:0d918e07-e610-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

[40] RED-PA at page 16: "*There is a growing recognition of the need for alignment of bioenergy policies with the cascading principle of biomass use, with a view to ensuring fair access to the biomass raw material market for the development of innovative, high value-added bio-based solutions and a sustainable circular bioeconomy. When developing support schemes for bioenergy, Member States should therefore take into consideration the available sustainable supply of biomass for energy and non-energy uses and the maintenance of the national forest carbon sinks and ecosystems as well as the principles of the circular economy and the biomass cascading use, and the waste hierarchy established in Directive 2008/98/EC of the European Parliament and of the Council.*" At https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

[41] Page 5 of Forest Strategy: "Respect for circular economy principles is also crucial. Priority should be on better using, reusing and recycling all wood-based products, including for example from construction and demolition sites, as enhanced circularity of products offers a possibility of maintaining all wood based products longer in the economy for the multiple uses." At https://eur-lex.europa.eu/resource.html?uri=cellar:0d918e07-e610-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

[42] Page 183 of Clean Planet for All modeling document.

[43] LR-PA impact assessment Box 8, page 113

It important to note that on the page prior to its statements about increasing use of forest residues, the LR-PA impact assessment reproduces[44] a chart from the EU's Joint Research Centre that summarizes findings on climate and ecosystem impacts of harvesting forest biomass for energy.[45] The chart shows that harvesting and burning coarse woody debris – essentially the "forestry residues" that the impact assessment states will meet future demand – increases CO_2 emissions relative to fossil fuels over the long term (decades to more than a century) and poses a "high risk" to ecosystem function and biodiversity. However, the impact assessment makes no mention of these findings, acknowledging that the JRC report found impacts for *some* pathways for biomass provision that "should be discouraged," but not admitting that use of forest residues is the most important such pathway:

> *"On the other hand, several pathways are categorized negatively on both biodiversity and climate counts, and should be discouraged. In this respect, it can be highlighted that the conversion of natural (primary) and old growth forests to plantations aiming to provide wood for bioenergy would be extremely negative for local biodiversity, and at the same time it would provide no carbon mitigation in the short-medium term. Similar considerations are valid also for the conversion of naturally regenerating forests to high-intensity management plantations: the impact on local biodiversity is highly negative while, even though wood production might increase, the benefits in terms of carbon mitigation are only accrued in the medium to long term."*

Despite the obfuscation by the impact assessment, policymakers need to acknowledge that the JRC has classified forestry residues, which provide a significant share of forest wood burned in the EU, as high risk for biodiversity and climate. It is also important to note that there is no fixed definition of "forest residues," and that this category of fuel can be opportunistically defined. For instance, the government of British Columbia, a key region supplying wood pellets for export, has defined whole trees that do not have value for sawtimber as "waste."[46]

6.1.2 Harvesting for durable wood products also degrades the land sink

Increasingly, the idea that the "bioeconomy" can help save the climate is promoted in EU policy documents like the draft Forest Strategy.[47] While the bioeconomy could in the future comprise many products, its main principle at present appears to be substituting carbon-intensive construction materials with wood, although a recent leaked draft of a new proposal for promoting and measuring carbon storage includes a goal of using biomass as the feedstock for 20% of plastics and chemicals in the EU by 2030.[48] However, the climate benefits of such substitution have been greatly overblown. First, it is an important but generally overlooked principle that substitution benefits only occur if the use of both wood and the non-wood product being substituted is capped.[49] Second, the harvested wood product (HWP) carbon sink is not only very weak compared to that of forests (Figure 1), but it turns out that trying to store carbon in HWP is a bit like trying to carry water in a leaky bucket. Staff from the EU's Joint Research Centre co-authored a modelling paper that found while a 20% increase in harvesting by 2030 (compared to 2000 – 2012 levels)

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[44] P. 112 of LR-PA impact assessment.

[45] Chart is at page 9 of annotated version of JRC report: https://forestdefenders.eu/wp-content/uploads/2021/01/JRC-biomass-report-markup.pdf

[46] See minute 3 of talk by Michelle Connolly of Conservation North, at https://www.youtube.com/watch?v=SyaVPopqfUw

[47] At https://eur-lex.europa.eu/resource.html?uri=cellar:0d918e07-e610-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

[48] Page 15 at https://www.pfpi.net/wp-content/uploads/2021/11/communication-carbon-cycle.pdf

[49] Leturcq, P. (2020). "GHG displacement factors of harvested wood products: the myth of substitution." Scientific Reports 10(1): 20752. **Abstract**: A common idea is that substituting wood for fossil fuels and energy intensive materials is a better strategy in mitigating climate change than storing more carbon in forests. This opinion remains highly questionable for at least two reasons. Firstly, the carbon footprints of wood-products are underestimated as far as the "biomass carbon neutrality" assumption is involved in their determination, as it is often the case. When taking into account the forest carbon dynamics consecutive to wood harvest, and the limited lifetime of products, these carbon footprints are time-dependent and their presumed values under the carbon neutrality assumption are achieved only in steady-state conditions. Secondly, even if carbon footprints are correctly assessed, the benefit of substitutions is overestimated when all or parts of the wood products are supposed to replace non-wood products whatever the market conditions. Indeed, substitutions are effective only if an increase in wood product consumption implies verifiably a global reduction in non-wood productions. When these flaws in the evaluation of wood substitution effects are avoided, one must conclude that increased harvesting and wood utilization may be counter-productive for climate change mitigation objectives, especially when wood is used as a fuel.

would increase annual carbon stored in HWP by 8%, it would *decrease* the much larger forest carbon sink by 37%, an extremely large decline in the forest carbon sink for a negligible increase in the much smaller HWP pool. The model found that only decreasing the harvest by at least 20% allowed the forest carbon sink to increase.[50] A JRC brief on the bioeconomy[51] cites a number of studies that conclude that within a short to medium time horizon (meaning out to 2050), "*the additional mitigation potential provided by the material substitution effect is unlikely to compensate for the reduction of the carbon sink in forest ecosystems affected by the increasing harvest*," a finding that was repeated in the EU's 2021 Forest Strategy.[52]

6.2 Technological solutions and missing emissions diminish the need for the land sink

To the extent that the model overestimates the efficacy of CO_2 removal by BECCS or other technologies, or underestimates land sector emissions, it will conclude that the EU can reach its goal of carbon neutrality even with a weak land sink.

6.2.1 Modeling assumes BECCS will be successfully deployed at scale in the future

The LR-PA impact assessment, which was published in July 2021, is not transparent about the role of technological carbon removal, with a single footnote at page 14 revealing that 2050 climate neutrality assumes a "*significant deployment of technology-based carbon removals*" in addition to net LULUCF removals of around -350 $MtCO_2eq$ per year[53] (somewhat greater than the proposed -310 Mt land sink target for 2030). It requires searching through the "Clean Planet for All " modeling document published in 2018[54] to determine how much the 2050 climate neutrality scenario relies on BECCS for carbon removals. As stated above, the LR-PA impact assessment employs assumptions from the 1.5TECH scenario in the 2018 Clean Planet for All modeling document; that scenario assumes BECCS will capture and store more than 250 Mt CO_2 per year by 2050,[55] supplementing a net land sink of around -350 Mt CO_2 per year.[56] The scenario assumes CCS "*reaches 5% of the total net electricity generation (mostly because of biomass power generation to generate negative emissions), with 66 GW of total capacity equipped with CCS installed.*"[57]

Though the 2018 modeling document admits that BECCS is a speculative technology, neither it nor the LR-PA impact assessment contain a scenario that excludes BECCS altogether. In contrast, the IPCC's 2018 report evaluating modeling pathways to stay below 1.5 degrees temperature increase did include a scenario that excluded BECCS. That scenario achieved mitigation soon enough to avoid overshoot of emissions targets, thus reducing the need for drawdown of atmospheric carbon, and concluded that biomass use would fall below 2010 levels.[58]

It is alarming that the modeling underpinning the climate neutrality target in the LR-PA depends so heavily on BECCS, a largely unproven and possibly unfeasible technology with unknown but potentially very significant costs and broader environmental and social impacts. As the 2018 modeling document states,[59] "*large ranges of possible costs and uncertainties are unavoidable since most of the options for carbon removals are only at an exploratory stage and none of them are sufficiently*

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[50] Pilli, R., et al. (2017). "The European forest sector: Past and future carbon budget and fluxes under different management scenarios." 14: 2387-2405. https://bg.copernicus.org/articles/14/2387/2017/bg-14-2387-2017.pdf

[51] At https://publications.jrc.ec.europa.eu/repository/bitstream/JRC124374/brief_on_role_of_forest-based_bioeconomy_in_mitigating_cc_online.pdf

[52] Page 5 at https://eur-lex.europa.eu/resource.html?uri=cellar:0d918e07-e610-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF

[53] The impact assessment concludes that with less dependence on technological solutions, a larger 2050 land sink of around -475 MtCO2eq would be required (along with changes in lifestyle, including diets).

[54] At https://is.muni.cz/el/fss/podzim2019/HEN644/um/com_2018_733_analysis_in_support_en_0.pdf

[55] Figure 91, Clean Planet for All modeling document https://is.muni.cz/el/fss/podzim2019/HEN644/um/com_2018_733_analysis_in_support_en_0.pdf

[56] Figure 87, Clean Planet for All modeling document

[57] Page 78, Clean Planet for All modeling document

[58] See https://www.pfpi.net/the-ipccs-recipe-for-a-livable-planet-grow-trees-dont-burn-them

[59] Page 187, Clean Planet for All modeling document

mature for large deployment (except afforestation, reforestation and ecosystem restoration)."[60] Note that the proposal acknowledges that "ecosystem restoration" can be deployed at large scale – but this option is not explored.

The modeling does not specify the feedstock assumed to be used in BECCS facilities so it is not clear how much forest biomass would be used versus energy crops such as perennial grasses, which the model assumes will increase massively. However, given the large uncapturable carbon emissions and foregone sequestration associated with harvesting and burning forest biomass, there is no reason to believe that deploying CCS at biomass power stations burning wood would be capable of producing net negative emissions. As the latest IPCC report points out, BECCS only delivers negative emissions if the bioenergy generates carbon neutral energy,[61] which forest biomass generally does not. Whatever the feedstock used, including BECCS or other such technology in the modeling, and thereby reducing the apparent need for an aggressive and early land carbon target, violates the precautionary principle that is a pillar of Article 191 of the Treaty of the Functioning of the EU,[62] which lays out the principles to underpin EU policy on the environment.

6.2.2 The models underestimate ecosystem carbon loss

To the extent that modeling underestimates true emissions, including from the land sector itself, it will also underestimate the need for an a land carbon sink target based on ecosystem restoration. One potentially very large source of unknown emissions is soils. As the LR-PA impact assessment states,[63]

> *"Analysis carried out to support this Impact Assessment estimated that very large carbon gain and losses from soils go unreported; accurate estimates of emissions and removals, based on good information on land use activities and local emission factors, cover at most 37% of EU cropland, because most Member States use default IPCC methods. As long as soils remain such a 'blind spot' of climate policies, it is challenging to design effective policies and incentives."*

The impact assessment also states that emissions from drained peatlands are thought to be around 220 Mt per year,[64] higher than figures reported under country-level inventories.[65] Since soil and peatland emissions are potentially much greater than estimated or reported, this would suggest that the land sink target should also be increased to compensate.

6.2.3 Models don't discriminate among carbon storage solutions

Another potential factor contributing to a weak land sink target is that climate mitigation models are not set up to value ecosystem functioning. Natural biodiverse forests store carbon in plants and soils, and they also offer the most ecosystem services in terms of water retention, soil protection, nutrient retention, structural resiliency, and other societal benefits like helping avoid flooding. Such ecosystem infrastructure and services are literally invaluable, since once they are lost, they are unlikely to ever be fully replaced. Yet models that focus on carbon balance will not "see" a difference between a forest carbon sink provided by an natural forest versus one provided by afforestation with a monoculture pine plantation, or even a carbon sink provided by BECCS. The model is preconditioned to downplay the importance of ecosystem restoration in favor of deployment of BECCS, a hypothetical technology.

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[60] The modeling does not specify the feedstock assumed to be used in BECCS facilities so it is not clear how much forest biomass is assumed to be used. However given the large uncapturable carbon emissions and foregone sequestration associated with harvesting and burning forest biomass, there is no reason to believe that deploying CCS at biomass power stations burning wood would be capable of producing net negative emissions. As the latest IPCC report (WG) points out, BECCS only delivers negative emissions if the technology used with it is capable of producing carbon neutral energy, which forest biomass use is generally not.

[61] IPCC 6th Assessment Report, Chapter 5 at 5-108. At https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_05.pdf

[62] At https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2012:326:FULL&from=EN

[63] Page 97, LR-PA impact assessment

[64] At p. 101, LR-PA impact assessment

[65] https://greifswaldmoor.de/files/dokumente/GMC%20Schriften/18-02_Barthelmes_GMC.pdf

6.3 Cost-effective solutions to restore forests and the land carbon sink

Just as the 2018 IPCC report contained a modeling scenario that excludes BECCS,[66] the European Commission should also explore a true "no regrets" scenario that does not depend on as-yet-nonexistent technological solutions like BECCS for climate mitigation. It's likely such a scenario would resolve on a significantly stronger land carbon sink, perhaps closer to the -600 Mt target[67] that is endorsed by environmental organizations.[68]

The EU needs a land sink target that supports both climate action and other ecosystem goals. Redirecting bioenergy subsidies toward rebuilding the land sink in full respect of ecological principles could be extremely cost-effective compared to current and future expenditures on bioenergy subsidies and development of BECCS. The RED-PA impact analysis shows that EU citizens paid €10.3 billion in subsidies for bioenergy in 2018,[69] or about €23 for every citizen of the EU. A more recent analysis indicates that subsidies for biomass were €17 billion in 2019,[70] in which case the per capita figure would be around €38. Meanwhile, the modeling conducted for the LR-PA impact assessment concluded that *"significant increases in the land sink can be achieved at relatively low costs (5-10 EUR/tonne of CO_2)."* The total subsidy allocation for biomass of €10 billion per year could therefore clearly support a large amount of additional land carbon uptake at a range of costs. It is important to note that the cost of deploying (and potentially subsidizing) BECCS would probably dwarf current bioenergy subsidies.

These analyses are obviously extremely simplistic, but are still useful because they can illustrate the relative magnitude of trade-offs. Another approach is to consider the cost in subsidies for emitting biomass CO_2. Considering an electricity-only biomass powerplant that receives €50 per MWh in renewable energy subsidies (a figure in line with typical biomass electricity subsidies in the EU), each tonne of CO_2 emitted costs the public about €36 in renewable energy subsidies. For that same €36, the carbon sink modeling suggests it would be possible to sequester 4 to 7 tonnes of additional CO_2.

Or considering that a landowner might receive around €200 – €300 for 100 tonnes of chipped trees as a harvest from a hectare of forest land, realizing this in a single payment after logging. Instead of paying power plants to burn that wood, subsidies could be reallocated to pay landowners to enhance forest carbon uptake. One hundred tonnes of *standing* trees could sequester CO_2 at 2% yearly and yield ongoing payments of €20 per hectare per year (plus ecosystem benefits) if the landowner were paid €10 per tonne of CO_2 sequestered. As Recital 10 of the LR-PA states, *"In order to enhance greenhouse gas removals, individual farmers or forest managers need a direct incentive to store more carbon on their land and their forests."* Would such payments tempt forest owners? If it were left up to the public how to allocate the funds, it's likely many people would rather direct the money they now pay for burning biomass toward restoring forests. Isn't it time to find out?

7 Annex: Graphs of member state land sector and forest carbon flux (kilotonnes of CO_2)

The following graphs employ data from the whole land sink, plus data on managed forests, which consists of the UNFCCC subcategory of "forests remaining forests" plus harvested wood products.

[66] See https://www.pfpi.net/the-ipccs-recipe-for-a-livable-planet-grow-trees-dont-burn-them

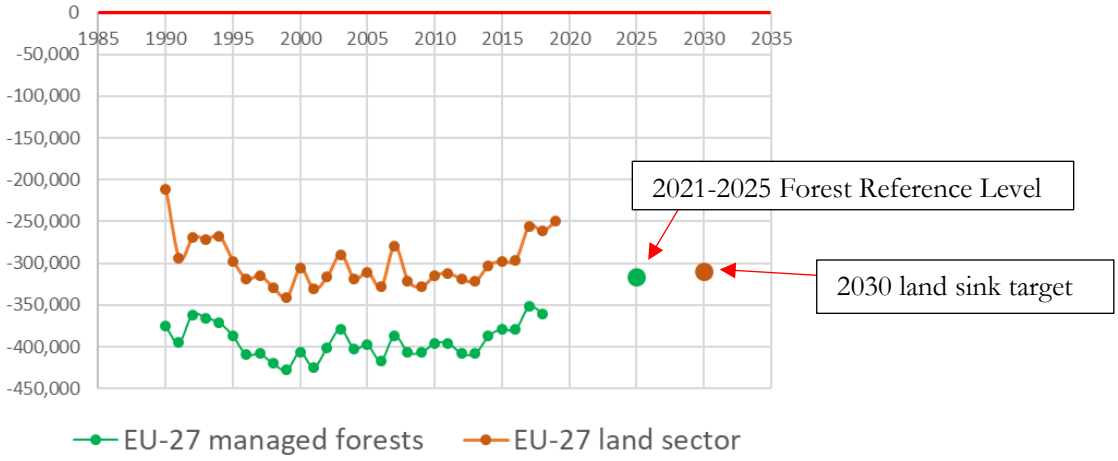
[67] Böttcher, H. and A. Frelih-Larsen (2021). Options for Strengthening Natural Carbon Sinks and Reducing Land Use Emissions in the EU. Freiburg, Oko-Institut e.V. At https://www.oeko.de/fileadmin/oekodoc/Options_natural_sinks_EU.pdf

[68] See https://caneurope.org/position-paper-on-the-revision-of-the-eu-lulucf-regulation/

[69] Page 20 of RED-PA impact assessment.

[70] Report commissioned by the Directorate General for Energy, page 35, downloadable at https://op.europa.eu/en/publication-detail/-/publication/be5268ba-3609-11ec-bd8e-01aa75ed71a1/language-en.

7.1 EU-27



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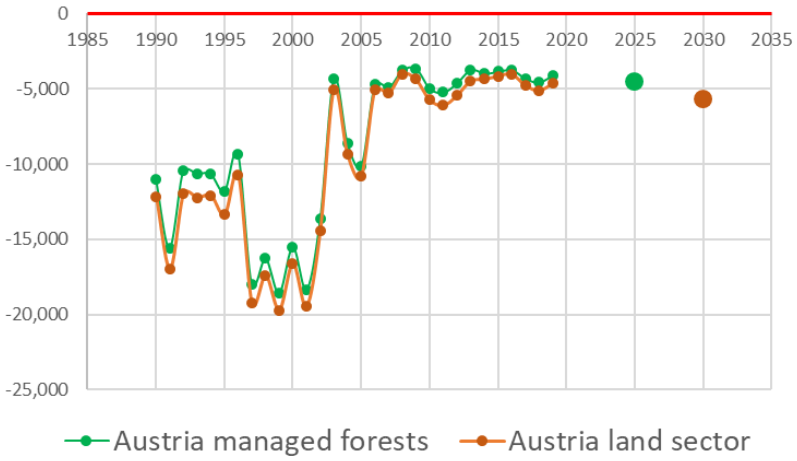

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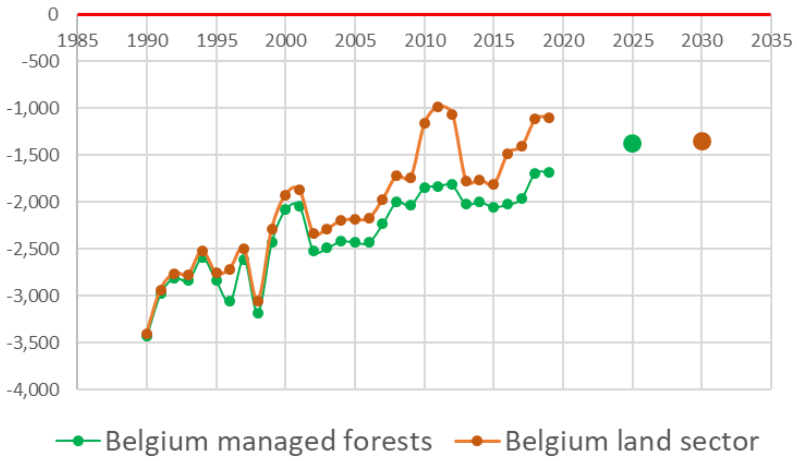

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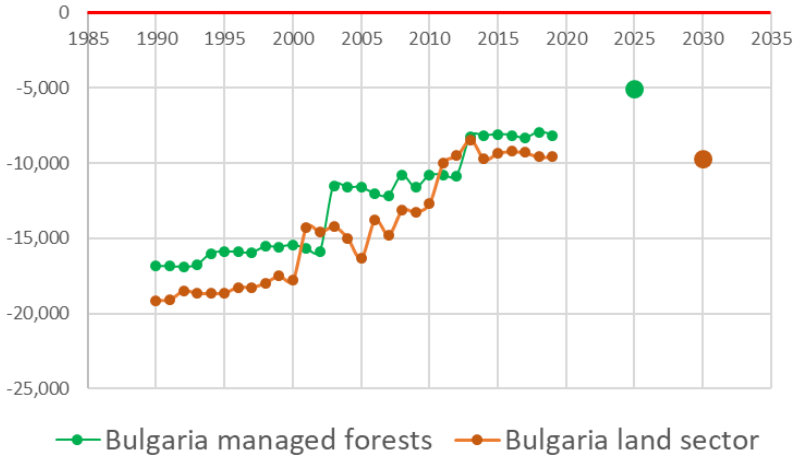

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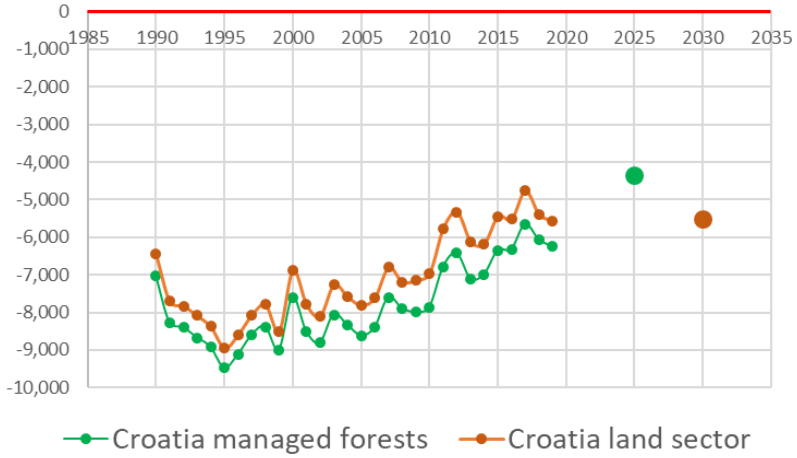

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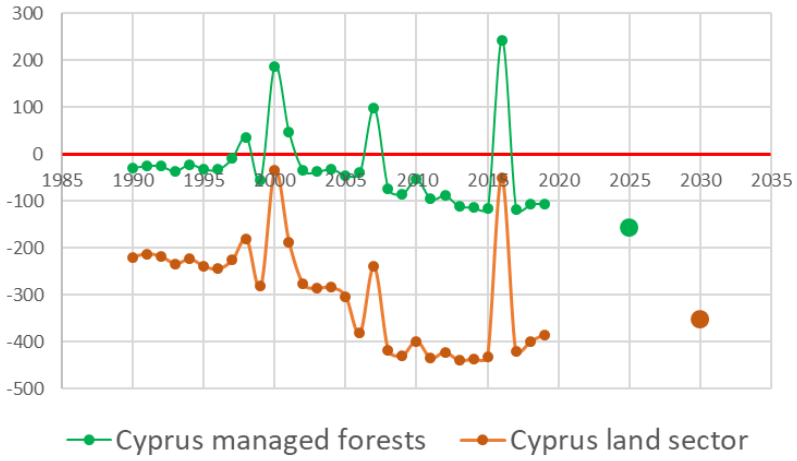

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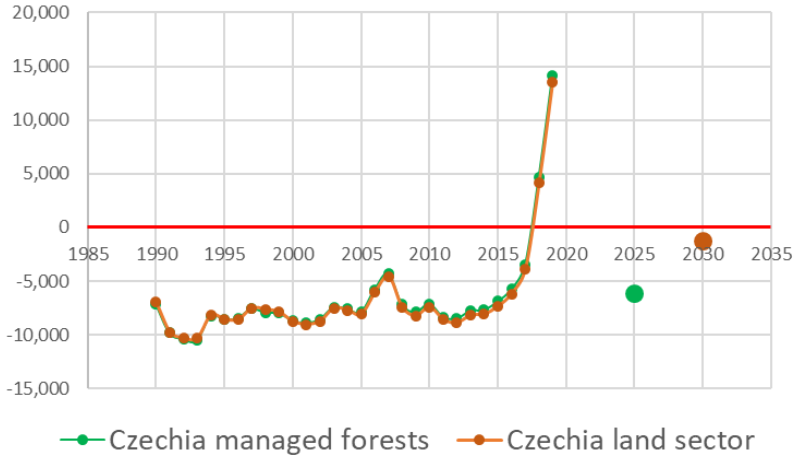

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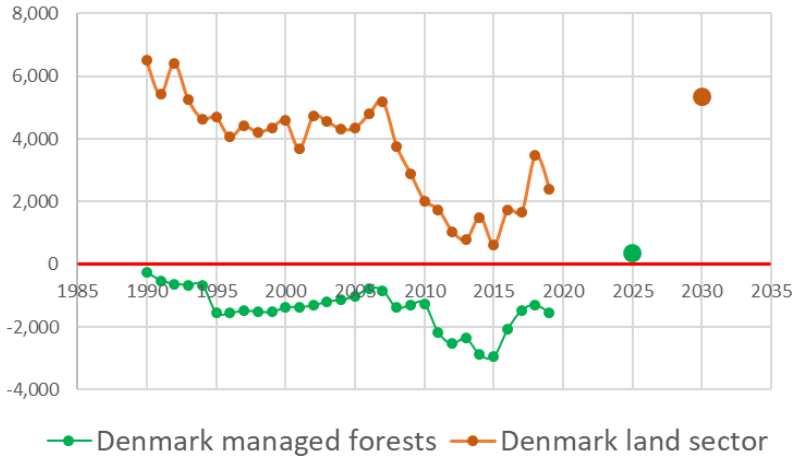

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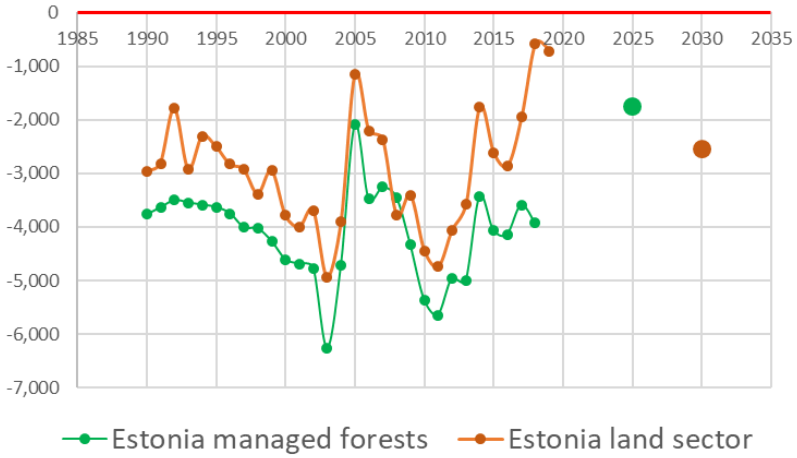

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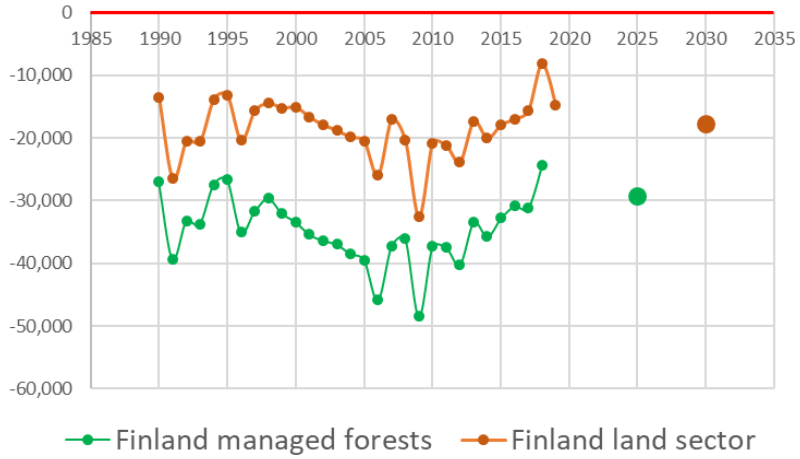

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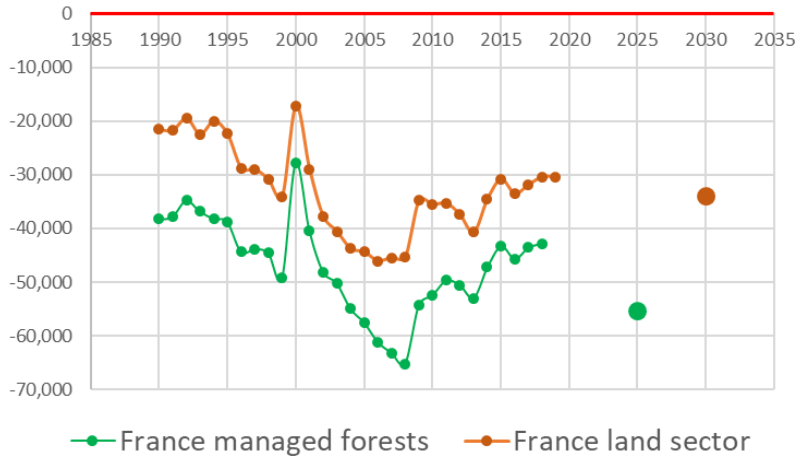

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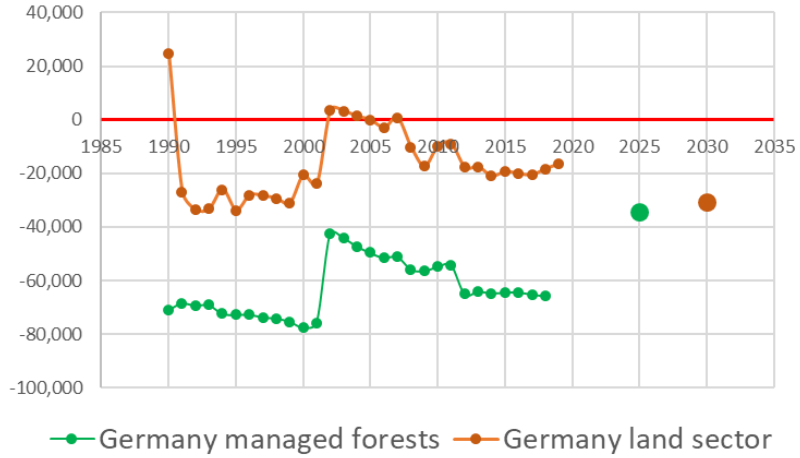

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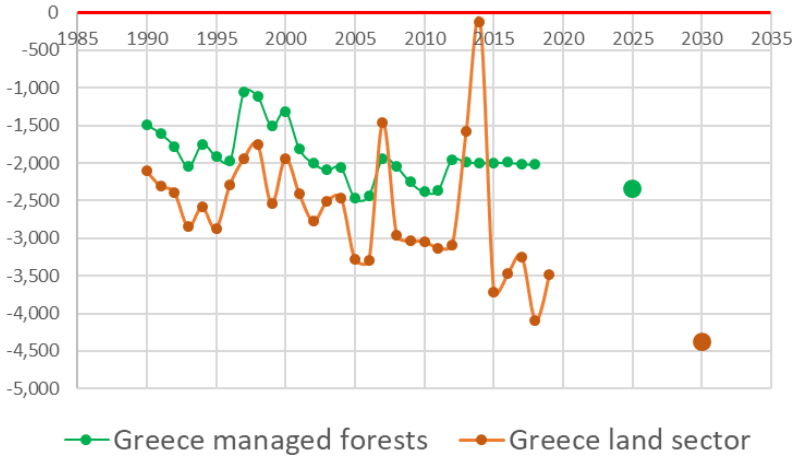

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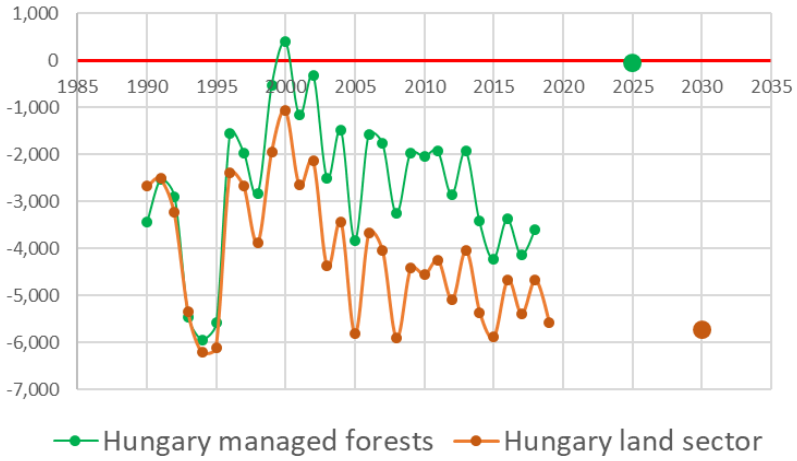

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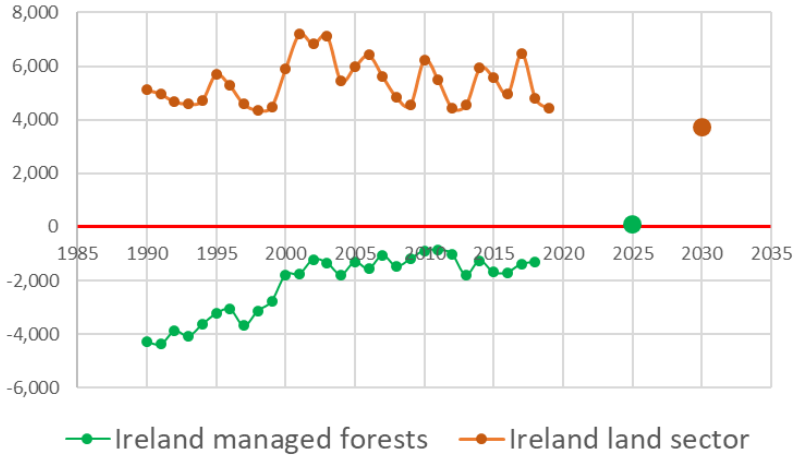

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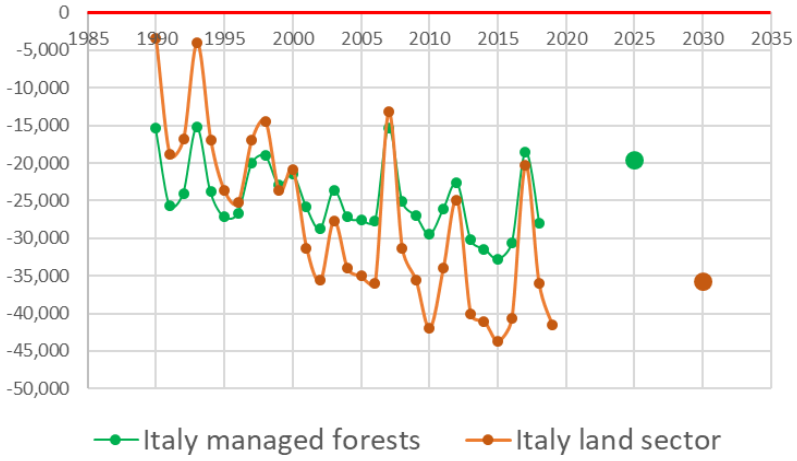

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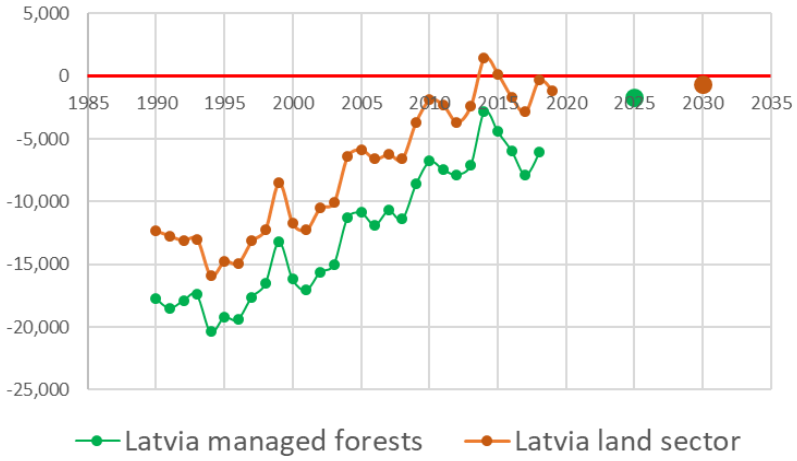

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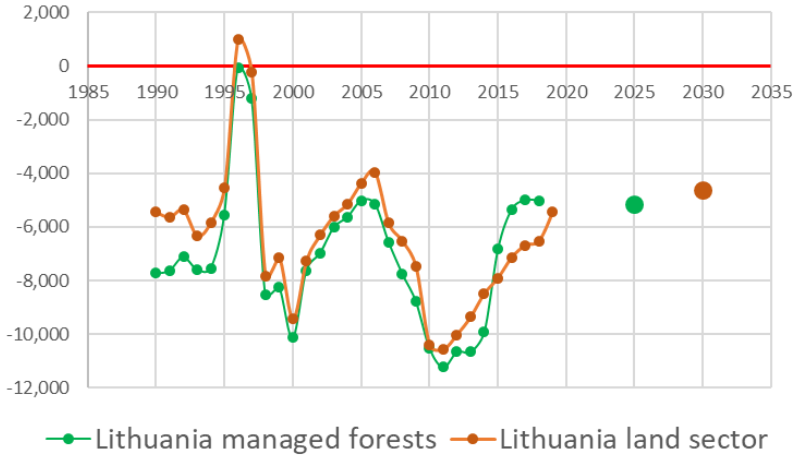

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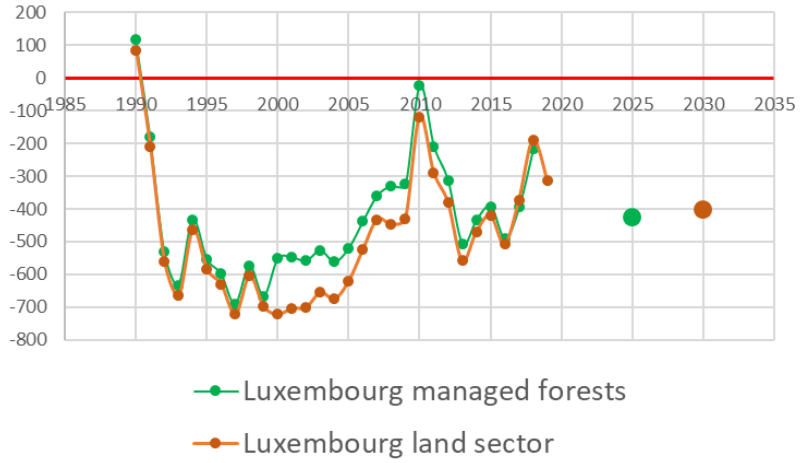

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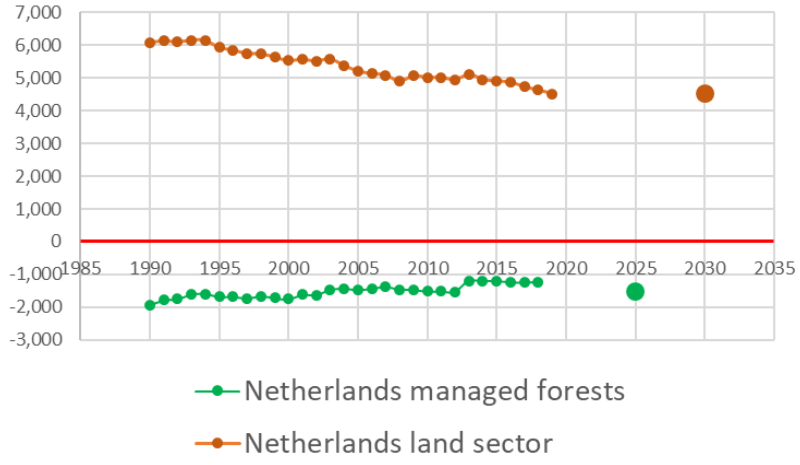

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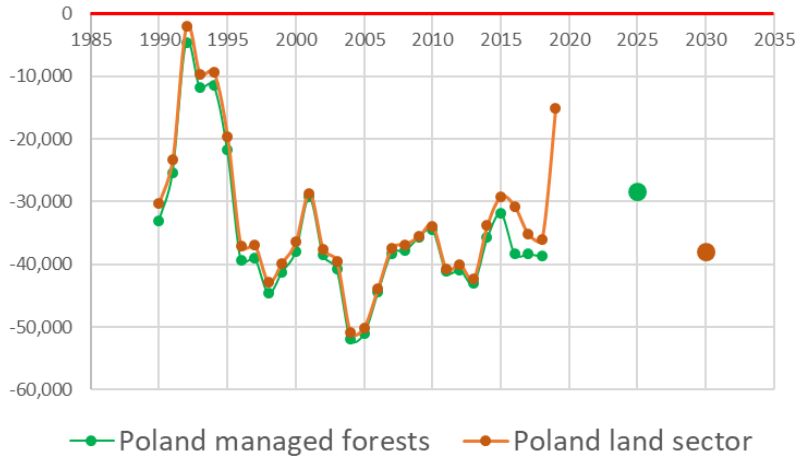

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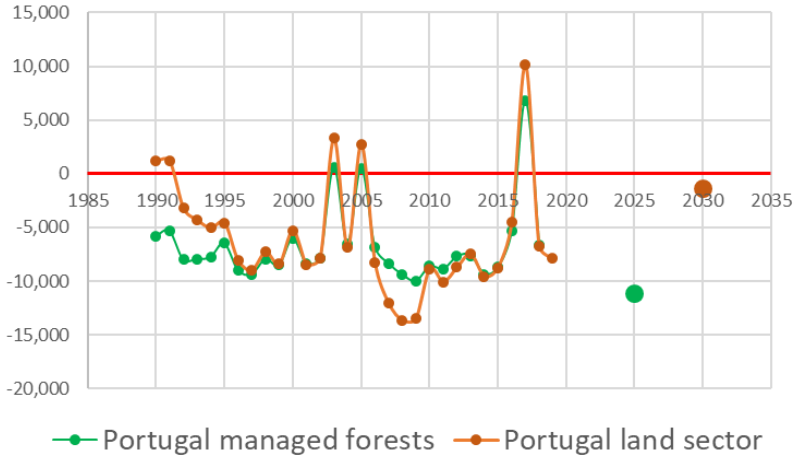

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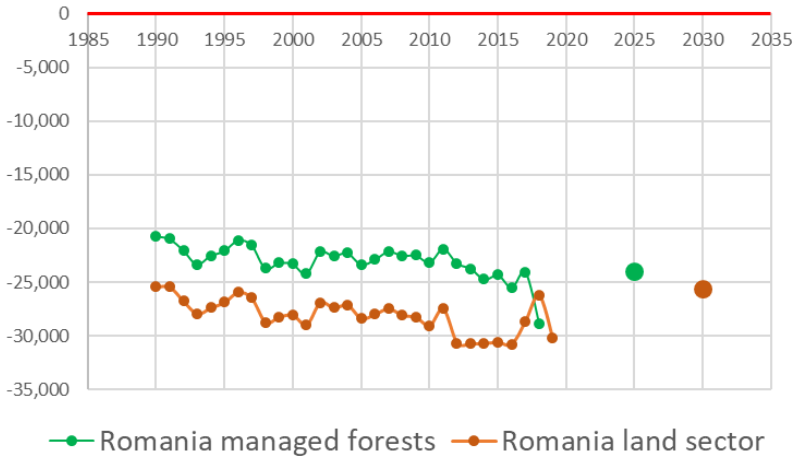

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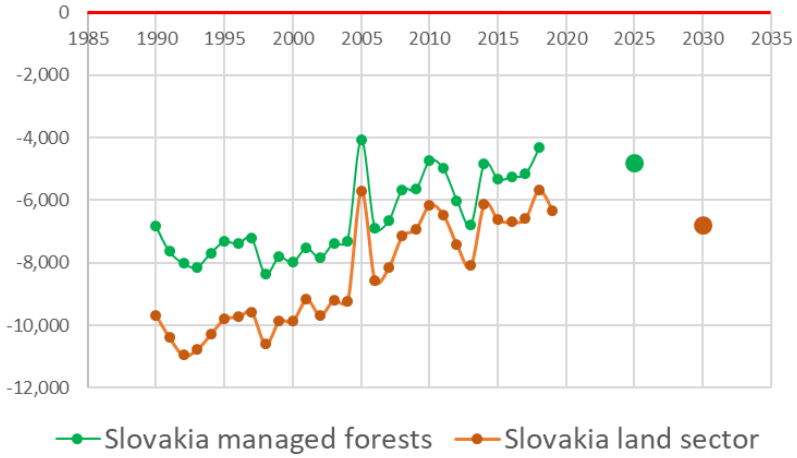

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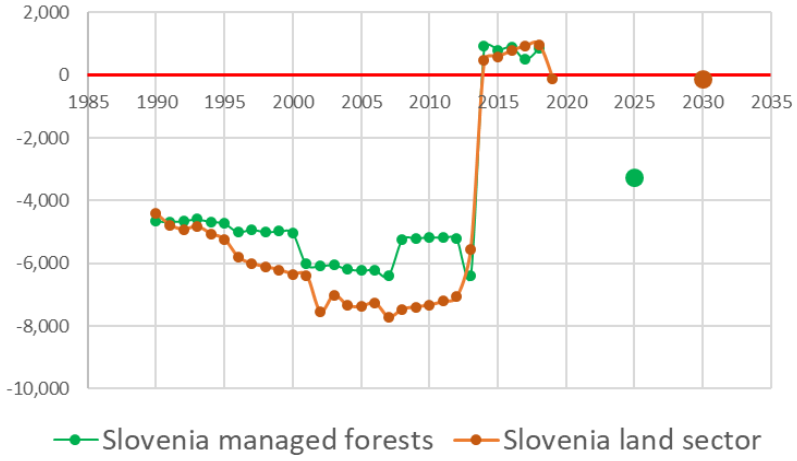

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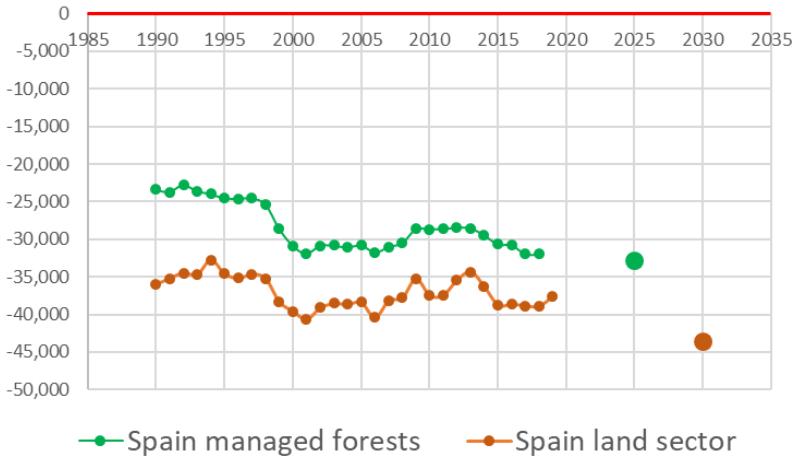
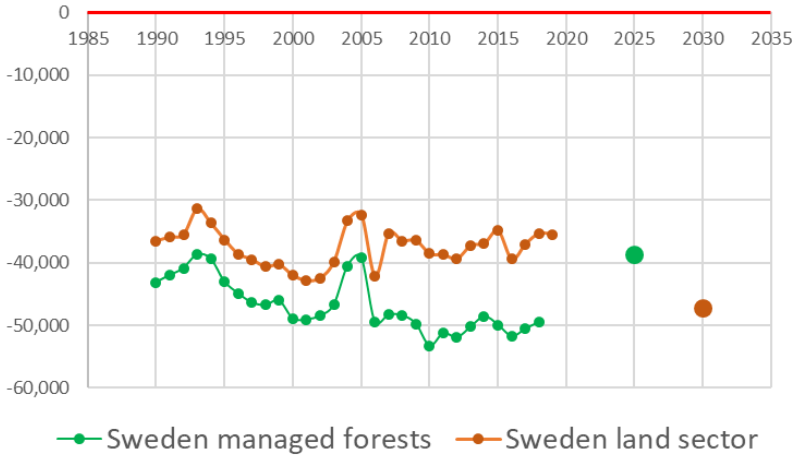
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