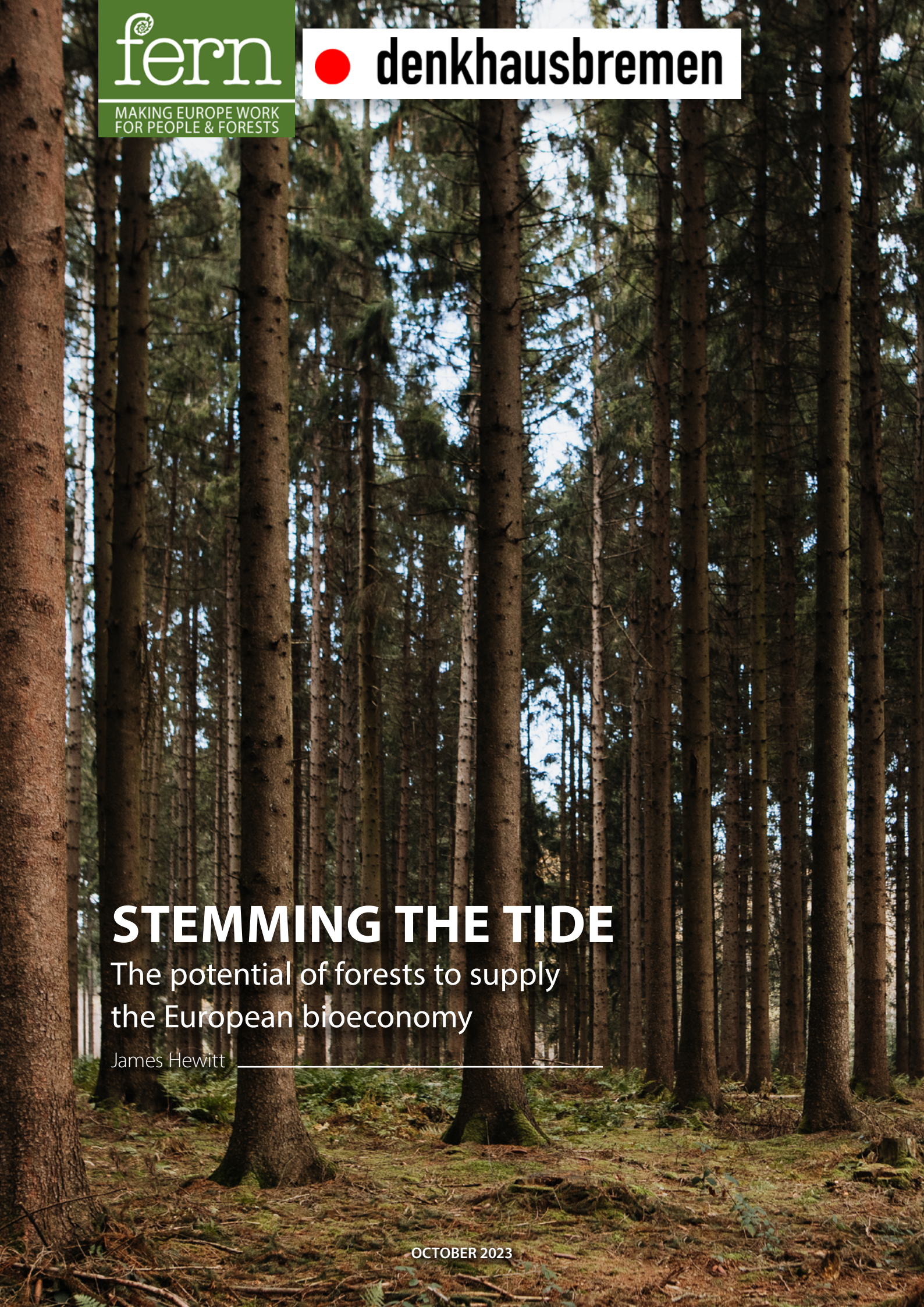

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STEMMING THE TIDE

The potential of forests to supply the European bioeconomy

James Hewitt

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Contents

1 Executive summary

This publication considers the potential for European Union (EU) forests to meet EU demand for wood-based products (specifically packaging and building material).

Broadly, it concludes that with regards to forests:

(I) roundwood production in the EU is increasing,
(II) disturbances (particularly from fire, pests and storms) are having a substantial and increasingly negative impact on biodiversity, soil, and the value of forests as an asset;
(III) net forest sequestration is reducing, making it harder for the EU to meet its climate commitments, and;
(IV) restoring natural forest ecosystems, so as to increase resilience to the rapidly changing climate, should have priority over woody biomass extraction.

With regards to demand for packaging:

(I) the changes in pricing and consumption needed to meet the challenges of the climate crisis are not yet reflected in expectations for the future market;
(II) the paper industry is increasingly looking to provide recycling services, and produce feedstocks for industrial chemicals and liquid biofuels (such as lignin, turpentine and tall oil) in addition to paper, and;
(III) in general, regulation is likely to be hindered by the proliferation of products with different characteristics and by confusion about terminology and environmental impacts including carbon storage.

With regards to demand for building materials:

(I) engineered (typically cross laminated) timber is gaining market share from reinforced concrete (although it is still small). Such timber is less dependent than sawnwood on the age that the trees were felled and is therefore more widely available, this could also lead to shortened rotations with knock-on effects on forest biodiversity;
(II) carbon is normally stored longer in building material (including wooden furnishings) than in paper; unless the product's design-life substantially exceeds the time available before the global carbon budget is exhausted, the duration of its storage should be reflected - along with associated emissions and forgone sequestration - in carbon accounts.

In addition, the following issues were noted:

(I) expansion of the woody biomass energy industry is being driven partly by subsidies based on flawed arguments concerning carbon, weak forest stewardship requirements, and confusion around definitions such as 'low grade material' and 'residues';
(II) only a small percentage of available woody biomass is presently used for chemicals (including bio-liquid fuels) and textiles and the market share of wood raw material in those products is also small;
(III) the EU is a net exporter of wood-based products (mainly from Finland, Germany and Sweden), and;
(IV) the lack of forecasts concerning the size of markets for socially, environmentally, and commercially acceptable production of roundwood, may hinder efforts to address the climate, biodiversity and waste emergencies.

1 - The "time available" is used with similar meaning elsewhere in the text.

2 EU production of woody biomass

2.1 - Wood raw material

Information about the amount of woody biomass extraction from forests is generally reported under the heading of roundwood, subdivided between wood fuel and industrial roundwood.[2] Estimates for wood fuel are likely to be least robust as much of it is produced informally for local use.

Figure 1 – Roundwood production within the EU[3]

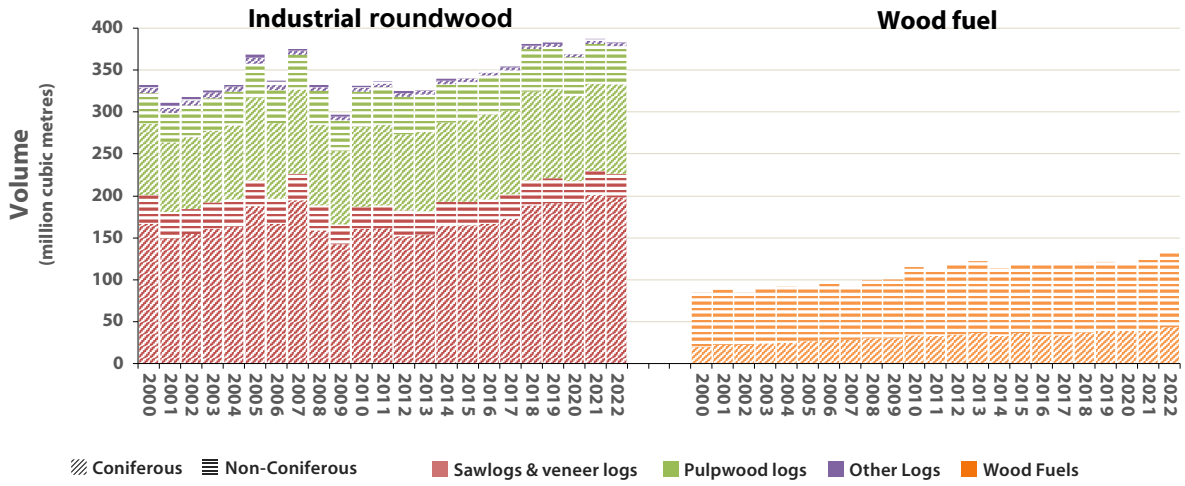


Figure 1 compares Food and Agricultural Organisation (FAO) data for wood fuel and the three categories of industrial roundwood. That data includes estimates, official figures, and figures from international organisations.

There are many problems with the data including that the estimated volume may be a large part of the total; and that official figures might differ by more than 10 per cent from other sources.

Whilst such data should therefore be treated with caution, Figure 1 indicates that, overall, production has increased during the last two decades. Headings "coniferous sawlogs & veneer logs" and, to a lesser extent, "coniferous pulpwood logs" contributed most to that increase and account for the majority of the total for industrial roundwood. In contrast, non-coniferous species are mainly used for wood fuel.[4] For more detail, the recent publication "Burning up the carbon sink" estimates how much biomass was burned in EU Member States during 2020, with data split by user group and type of biomass.[5]

2 - For example: "Forest products definitions" FAOSTAT (04 2017) endorsed by the European Commission, FAO, International Timber Trade Organisation (ITTO) and the United Nations Economic Commission for Europe (UNECE). The FAO's definition of "forest" is widely contested. Throughout this document, the EU refers to the 27 now current members of the European Union.

3 - "Forestry Production and Trade" FAOSTAT.
The data presented on this chart suggest that, for 2022, roundwood production for use as timber, paper, fuel and other purposes respectively was roughly 230, 150, 130 and 10 million cubic metres.

4 - The FAO definition of forest products deems that wood chips and wood pellets (also black liquor) have been derived from industrial roundwood. However, they may have been chipped in situ in the forest – perhaps from trees whose wood was not at that time sought by mills for other products (which the industry classifies as, for example, "waste", "residues", "unmerchantable", "low grade", or "low value").

5 - "Burning up the carbon sink: How the EU's forest biomass policy undermines climate mitigation, and how it can be reformed". M. Booth for Partnership for Policy Integrity (PFPI) (11/2022)

With an increasing number of industries hoping to move to woody biomass to replace everything from cotton to plastic to concrete, there has been increasing concern about the percentage of EU forests that could be commercially used.[6] In 2010, a major study found that it would be difficult by 2020 - and impossible by 2030 - to sustainably meet a high demand scenario.[7] Rhetoric promoting an EU bioeconomy tends to imply that policy expectations may have increased concerning the use of wood as a raw material and the adoption of cascading use principles.

The 2010 study estimated that the potential EU supply of forest biomass was likely to remain largely unchanged between 2010 and 2030.

2.2 - Threats to production

Figure 2 – Industrial roundwood production in EU Member States[8]

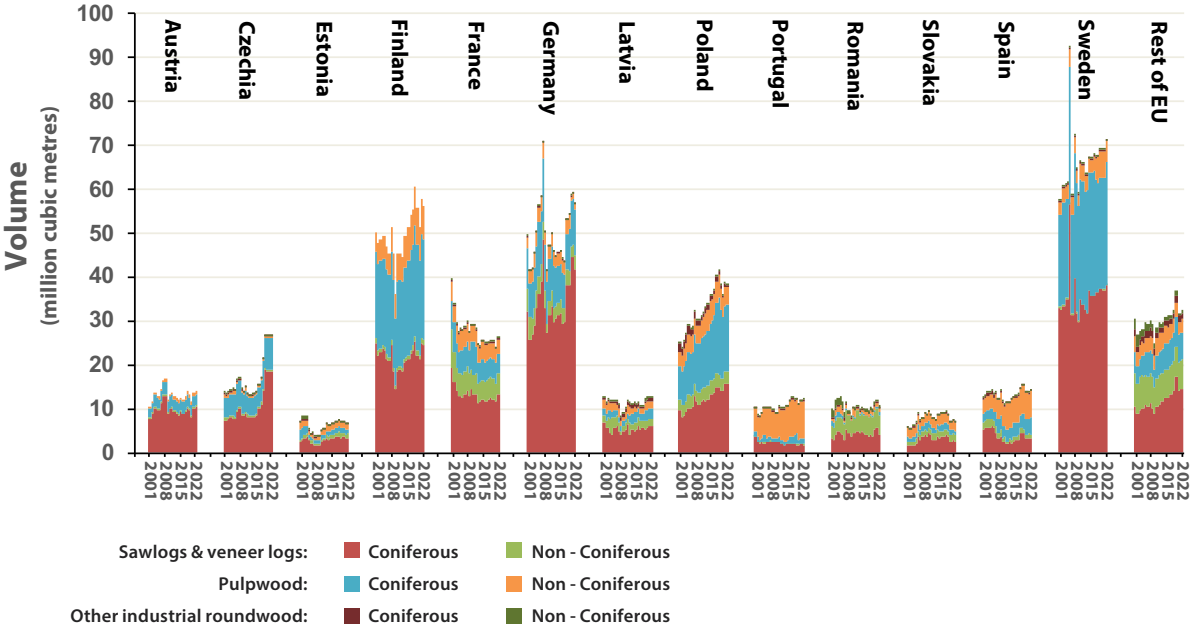


Figure 2 shows which Member States produce the greatest volume of industrial roundwood and the trend in volumes produced. Finland, Germany and Sweden have each tended to account for 15-20 per cent of the total. France and Poland likewise each accounted for 5-10 per cent. Together, those five Member States consistently account for two thirds of the total. Croatia produces most of the non-coniferous sawlogs & veneer logs attributed to the 'Rest of EU'.

The recent steep increase in production of coniferous sawlogs & veneer logs shown on Figure 2 for Czechia and Germany follows a beetle infestation.[9] The 2005 spike in volume from Sweden follows storm damage, as did the spike for Germany in 2007. Production in Poland peaked between 2017 and 2018 in the aftermath of storm damage.[10] There is currently a beetle infestation in Latvia.[11] Figure 2 does not reflect the 2019 beetle infestation in France.[12]

7 - "EU wood: Real potential for changes in growth and use of EU forests" U. Mantau *et al* (06/2010)
8 - Based on "Forestry Production and Trade" FAOSTAT
9 - The great severity and persistence of recent insect and storm damage has led to the removal, on average, of more than 45 million cubic metres of damaged timber during each of the last five years https://www.destatis.de/EN/Themes/Economic-Sectors-Enterprises/Agriculture-Forestry-Fisheries/Forestry-Wood/forestry-wood.html. It has also led to recognition that risks from establishing monocultures of susceptible species have been underestimated. "European forests: Tackling climate change" Eustafor (09/2020)
10 - "Devastating outbreak of bark beetles in the Czech Republic: Drivers, impacts, and management implications" T. Hlásny *et al* (06/2021)
"Climate Change Damages German Forests" L. Rehder for the United States Department of Agriculture (USDA) (09/2020)
"Pervasive Growth Reduction in Norway Spruce Forests following Wind Disturbance" R. Seidl and K. Blennow (02/2012)
"How does silviculture affect storm damage in forests of south-western Germany? Results from empirical modelling based on long-term observations" A. Albrecht *et al* (2010)
"Poland 2021. Statement of the wood market review and prospects" UNECE (11/2021)
11 - https://www.lvm.lv/en/news/6892-state-of-emergency-to-control-the-dangerous-european-spruce-bark-beetle-will-also-affect-spruce-stands-in-latvia-s-state-forests
12 - https://www.reuters.com/article/us-climate-change-france-forests-idUSKCN1UE20S

The frequency and severity of damage from wildfires, pests, disease and storms is increasing.[13] The climate crisis is probably the leading contributory factor, not least because related increases in drought may weaken the trees' resistance to pests.[14] A further factor could be nutrient imbalances.[15] Wildfires, commonest in southern Europe, release carbon stored above and below ground. Clear-felling tends to make droughts worse. It also damages the soil ecosystem (on which subsequent planting depends).[16]

Plantations have for decades tended to be the focus of commercial interest.[17] In so far as plantations are less resilient to such disruptions (particularly because they tend to be monocultures), they are likely to be affected more than natural forest. This has implications for policy, insurance, funding, training and management.

Changes in forest biodiversity may contribute to forest land moving from being a carbon sink to a carbon source.[18] The changing climate may adversely affect growing conditions, thereby reducing the expected value of roundwood removals.[19]

The EU's climate change mitigation targets depend partly on the assumption that rising carbon dioxide (CO_2) and temperature levels will increase growth rates. However, the true picture may be different, especially in the context of declining biodiversity.[20] Although the volume of wood growing in a number of EU Member States is not increasing each year, losses and removals are. Figure A4 (in the Annex), for example, illustrates the situation in Poland and Sweden. In response, a number of forest companies have decided to reduce their felling rates,[21] which will be beneficial if done in a way to enhance ecosystem integrity.[22]

Given global failure to reduce anthropogenic greenhouse gas emissions, trees planted in the EU today will take longer to reach maturity than is available in the global carbon budget.

These increasing risks will inhibit investment in conventional forestry (including by increasing the cost of capital and depressing long-term asset valuations on corporate balance sheets). Unless wood raw material prices rise (sufficiently relative to other costs), government revenue from forestry may decline.[23] Pressure to restore habitats (a cost whose benefits might be undervalued) rather than extract wood raw material is likely to grow.[24] Funding this might be a challenge, especially given the implausibility of carbon offsets and other similar schemes.[25]

13 - "Significant increase in natural disturbance impacts on European forests since 1950" M. Patacca *et al* (11 2022). Greenhouse gas emissions from wildfire may have been lower during the 2010s than the 2000s – https://climate.ec.europa.eu/document/download/ec1acac9-10fe-4eeb-915f-cad388990e0f_en

14 - The attribution of extreme weather events to climate change is increasingly understood – see for example https://www.worldweatherattribution.org/faqs

15 - "Increased evidence of nutrient imbalances in forest trees across Europe" I. Kruger (10/2020)

16 - "The hidden life of trees" P. Wohlleben (08/2017)

17 - In so far as they are even aged, plantations account for roughly three quarters of forests in Europe. "State of Europe's Forests 2020" Forests Europe (12/2020)

18 - For example: "Increasing forest disturbances in Europe and their impact on carbon storage" R. Seidl *et al* (09/2014)
"Climate change induces multiple risks to boreal forests and forestry in Finland: A literature review" A. Venäläinen (05/2020)
"How has the forest-based carbon sink and stock evolved in the European Union?" H. Mauser for European Forest Institute (EFI) https://efi.int/forestquestions/q16 (accessed 06/2023)

19 - "Climate change may cause severe loss in the economic value of European forest land" M. Hanewinkel *et al* (09/2012)

20 - "Climate targets in European timber-producing countries conflict with goals on forest ecosystem services and biodiversity" C. Blattert (04/2023)
"The forest industry around the Baltic Sea region: Future challenges and opportunities" K. Liuhto (01/2020)

21 - One is state-owned and Sweden's largest forest owner https://projects.luke.fi/bsrforest/roundwood-markets-in-the-baltic-sea-region/forest-resources/"Annual and sustainability report 2022" Sveaskog (05/2023)

22 - "Using ecosystem integrity to maximize climate mitigation and minimize risk in international forest policy" B.M. Rogers *et al* (10/2022)

23 - In some EU Member States, much forestry is carried out on state land and/or by enterprises wholly or partly owned by the state.

24 - Investment in forestry tends not to be philanthropic – "Impacts of Chilean forest subsidies on forest cover, carbon and biodiversity" R. Heilmayr, C. Echeverría, E. Lambin (06/2020)

25 - For example: "The Commodity Futures Trading Commission is calling for whistleblowers to report "violations connected to fraud or manipulation in the carbon markets" REDD-Monitor (06/2023)

2.3 - Sustainability considerations

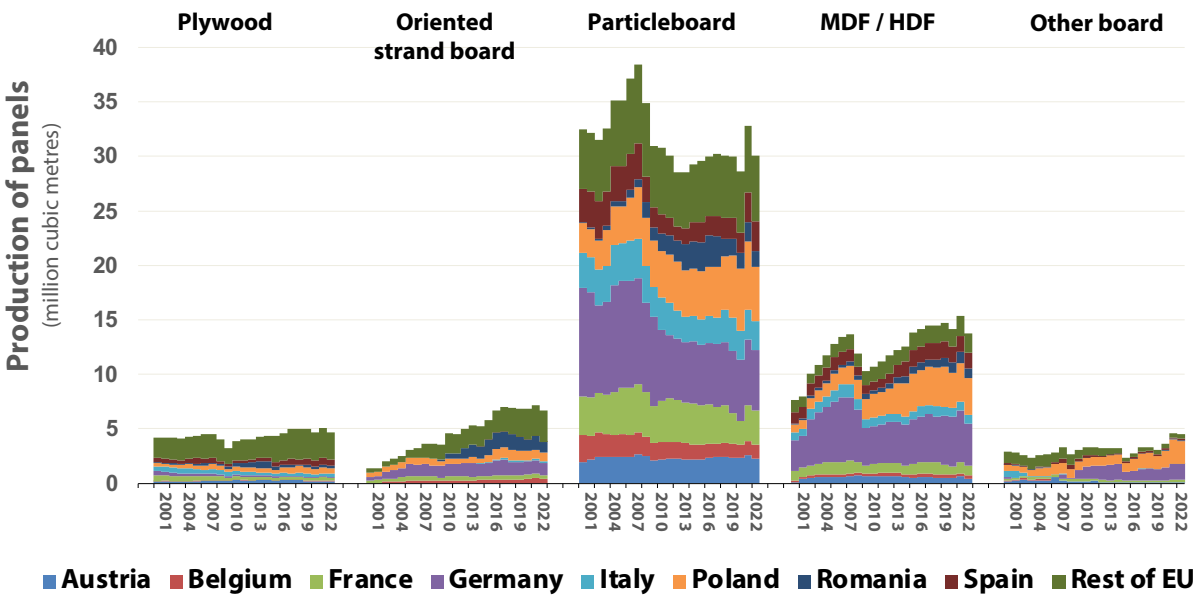
In the context of sustainable forest management (and compliance with the EU Regulation on deforestation-free products (EUDR)),[26] comparisons between the annual increment of wood growing in a given region and the volume of wood raw material extracted tend to be misleading.[27] In terms of quality, species, age, ownership, access, proximity of mills, etc., most of what is growing might differ from what is being extracted. Regional certification schemes are contested, especially in relation to subsidies for burning imported woody biomass[28] for power generation.[29]

How much industrial roundwood can be produced sustainably depends on availability of labour, accessibility, transport cost, quality of wood, market size, landowner choices, etc. Foresters are increasingly seeking to enhance biodiversity and the sustainability of their forest, implicitly recognising the benefits of doing so. If much of their forest has for several years been certified as sustainably managed, the need to now enhance biodiversity would imply that the certification schemes they adopted were/are insufficient.

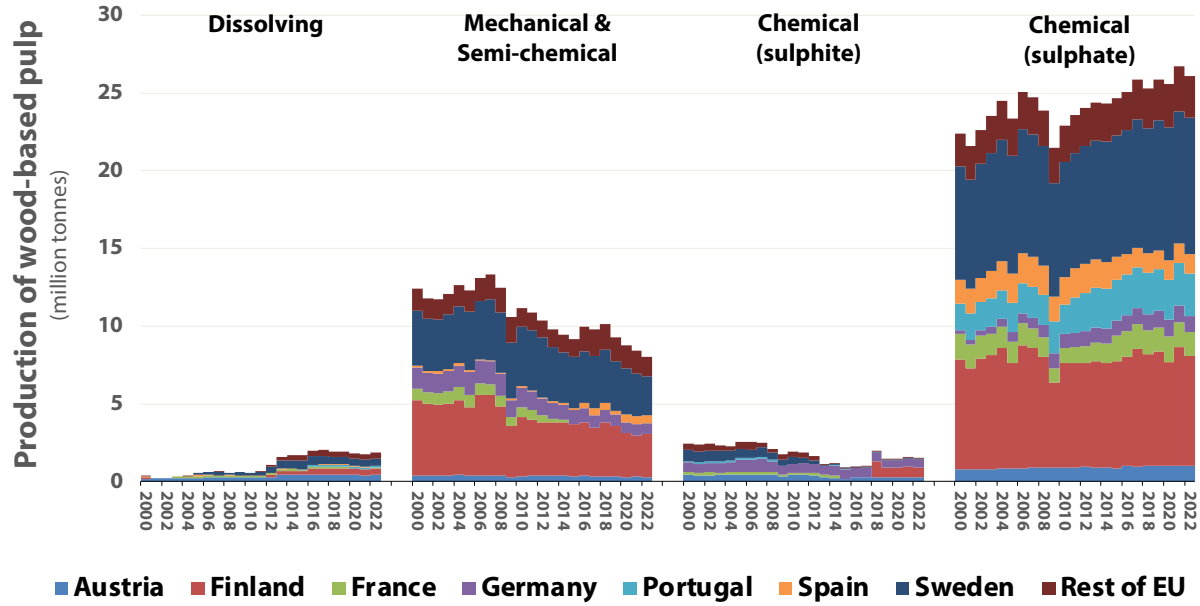
2.4 - The scale and location of initial milling

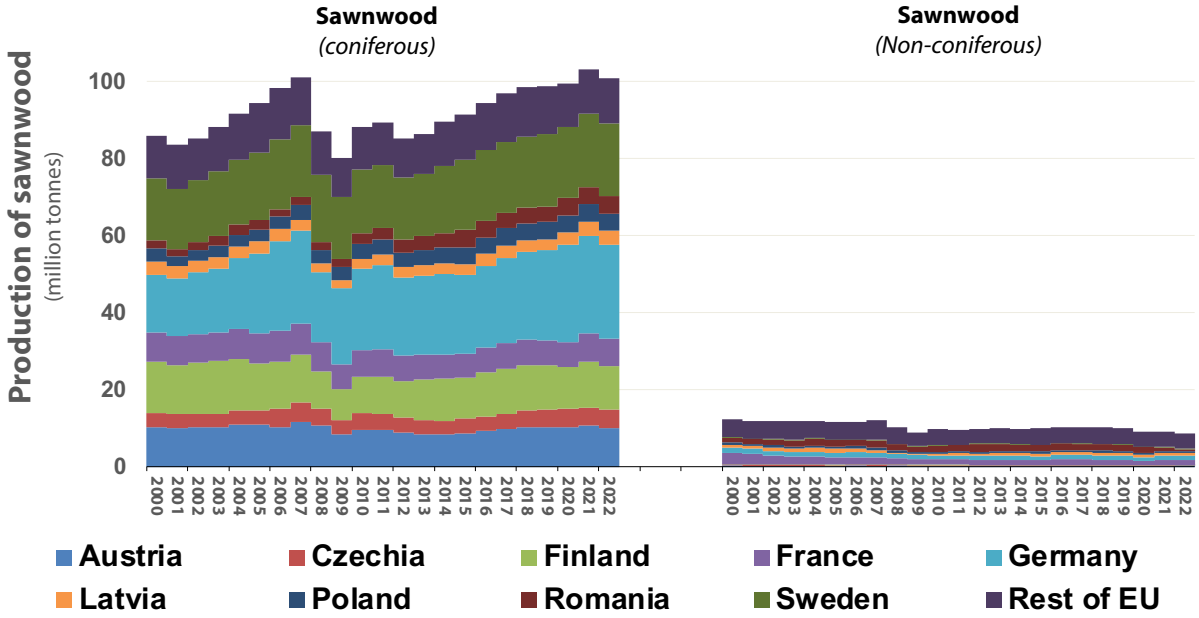
Capital intensive production of wood-based products tends to take place near enough to forested land to be able to meet mill needs. Figure 3 indicates the Member States in which production of wood-based panels and pulp is concentrated – Germany and Poland for panels, Finland and Sweden for pulp, Austria, Finland, Germany and Sweden for sawnwood.[31] The EU is a leading producer of machinery and services for both industries globally.

Figure 3 – Production of wood-based panels, pulp and sawnwood in the EU[32]



26 - "General approach on deforestation and forest degradation" Regulation (EU) 2023/1115" (05/2023)
27 - Greenwashing is increasingly being contested – see for example https://www.clientearth.org/what-we-do/priorities/greenwashing/
28 - "Sustainable Biomass Program: certifying paperwork without looking at the forest" Biofuelwatch et al (05/2023)
29 - "Quantifying the loophole and sustainability impacts of bioenergy being rated zero emissions in the EU Emissions Trading System and Effort Sharing Regulation" D Brack for Birdlife (05/2022)
30 - https://europanels.org/ provides insights into panel production within the EU.
31 - "plant" refers to pulp and paper milling machinery, "services" refers to design of pulp and paper mills
32 - Based on "Forestry Production and Trade" FAOSTAT
The data presented on these charts suggest that, in 2022, production of panels, pulp and sawnwood was roughly 60 million cubic metres, 40 million tonnes and 110 million cubic metres respectively.





Production of panels is dominated by a small number of enterprises, as is production of pulp. During 2020 and 2021, roughly 85 per cent of EU production of mechanical and semi-chemical pulp, and almost half the sulphate chemical pulp, was used to make paper at the same site (or a related one) as the pulp mill.[33]

33 - "Annual statistics 2021: European pulp and paper industry" Cepi

3 Trade in wood-based products[34]

The type of wood-based products that are consumed is not just shaped by availability of wood raw material. Trade patterns and issues related to the cascading use principle (re-use, recycling, etc.) are also important, as are the cost of transport[35] and the availability of waste management systems.

Figure 4 – Industrial roundwood production and trade of wood-based products[36]

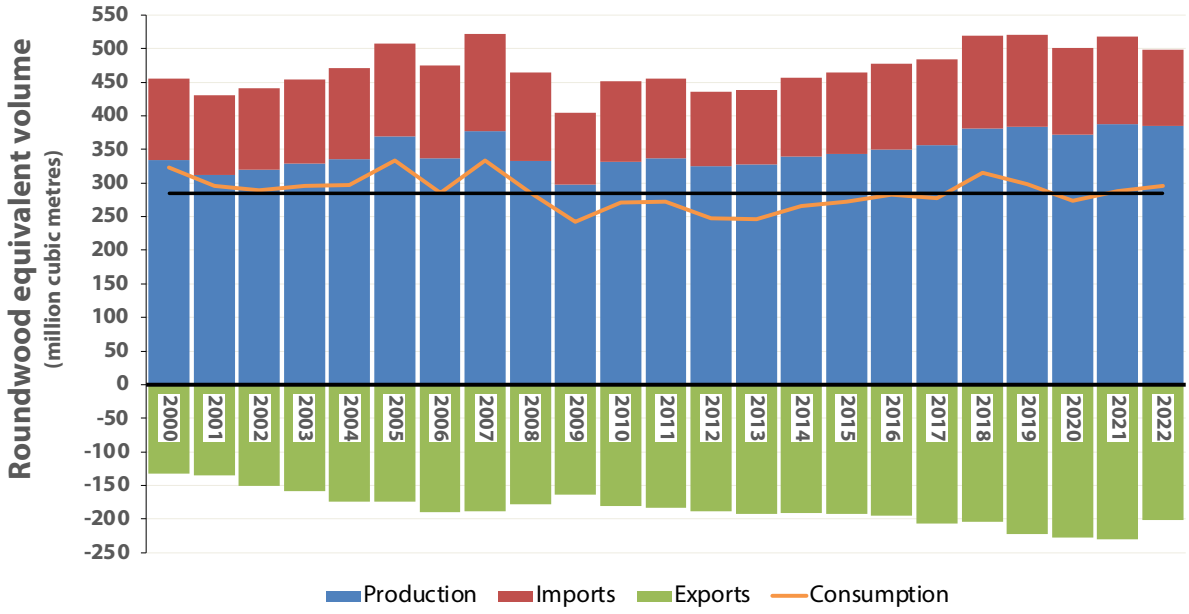
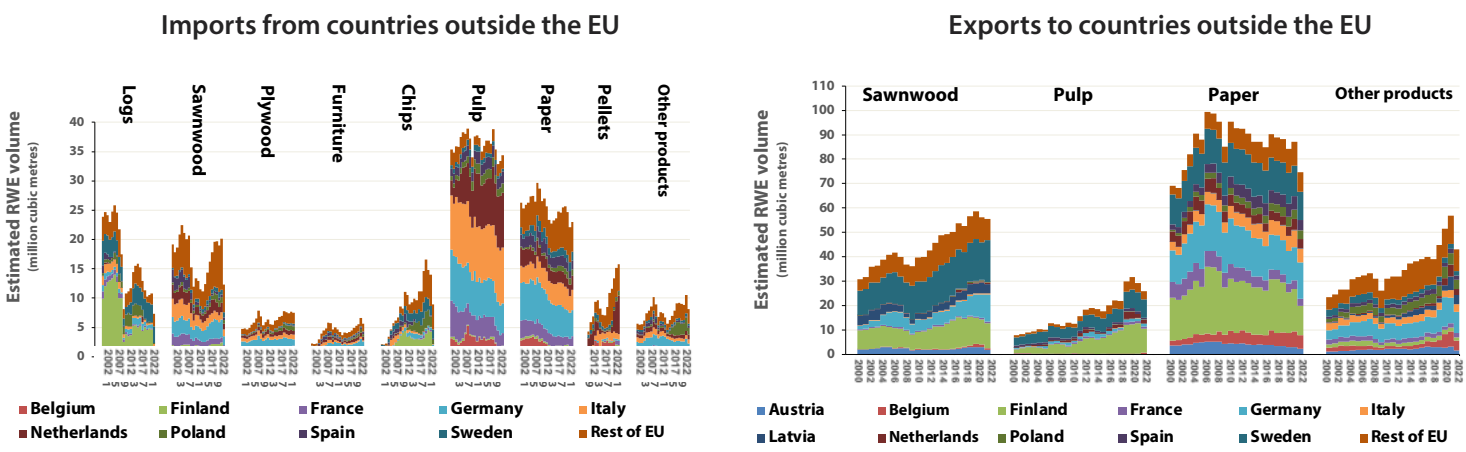


Figure 4 indicates that in terms of roundwood equivalent (RWE) volume, EU consumption[37] of wood-based products is increasing but remains lower than before the financial bubble burst in the late 2000s. Figures 4 and 5 indicate that, since then, exports have exceeded imports (in terms of estimated RWE volume). These long-term trends (coupled with climate-related factors) imply that market conditions are not ideal for an expansion of a wood-based bioeconomy within the EU sufficient to greatly reduce procurement of alternatives currently deriving from fossil fuel. Constraints include availability of wood raw material and pricing systems which help sustain (global) fossil fuel production and related harm.

34 - The parameter roundwood equivalent volume which is central to this section has been estimated from monthly data, adjusted where anomalous or incomplete, for example by assuming that for one cubic metre (m3) you would get the following amounts of product (in m3) - 1.4 (4410 particleboard), 1.8 (4407 sawnwood and 4411 fibreboard), 1.9 (4408 veneer and 4409 mouldings), 2.3 (4412 plywood) and, in m3 per tonne 1.6 (44012 chips), 2.8 (94 if explicitly wooden furniture), 3.5 (other value added timber and 48 paper), and 4.5 (4701 to 4705 inclusive pulp). These factors are intended as averages for each given category of product, some of which might contain an unspecified percentage of recycled fibre and fillers. RWE volume is a measure – necessarily estimated – of the volume of roundwood from which a given product derives.
Publications by the FAO and others are the source of a number of these. Other publications suggest a variety of other factors. Provided that the mix of products traded does not greatly change, the overall trade trend is likely to be similar whichever set of factors one adopts.
35 - "Shipping's Role in the Global Energy Transition" Tyndall Centre (11/2022)
36 - [Production] "Forestry Production and Trade" FAOSTAT [Trade] Eurostat
The data presented on this chart suggest that the estimated RWE volume of imports, exports and consumption during 2022 was roughly 110, 200, 300 million cubic metres respectively (production of roundwood amounted to 390 million cubic metres).
37 - Consumption is defined here as the sum of industrial roundwood production and the estimated roundwood equivalent volume of net imports of wood-based products.

Train with logs in Ljusdal, Sweden. Robert Larsson/UNSPLASH

Figure 5 - The EU's imports and exports of wood-based products[38]



The two charts of Figure 5 – which have different scales - show that the EU is a net exporter of wood-based products (in terms of RWE volume) and that pulp and paper comprise most of the RWE volume which Member States import from outside the EU and export to non-EU countries. Pellets and (until 2022) chips accounted for most of the increase in the total imported.[39]

Figure 5 also indicates that, with the exception of paper,[40] the RWE volume exported from the EU has been growing strongly.[41]

38 - The data presented on this chart suggest that (in units of million cubic metres) the estimated RWE volume imported during 2022 was approximately 120, of which 70 was for the paper sector (Chips, Pulp and Paper), 15 comprised Pellets, and the remainder was for the timber sector. The corresponding amount for exports was 200, of which 100 was for the paper sector (Pulp and Paper) and the remainder for the timber sector)

39 - Charts illustrating EU Member States' trade in pellets, chips and the other two categories of commodity code 4401 are available from https://www.globaltimber.org.uk/pellets.htm

40 - The market for newsprint (based mainly on recycled fibre) and graphic paper (based mainly on virgin fibre) is in long-term decline.

41 - Based on a comparison between Eurostat and China Customs Statistics, the large recent increase in exports from both Belgium and the Netherlands probably refers to logs from Germany and Czechia in transit to China (despite phytosanitary risk that the logs were from beetle-infested trees).

Figure 6 – EU imports of wood chips, wood-based pulp, logs and sawnwood [42]

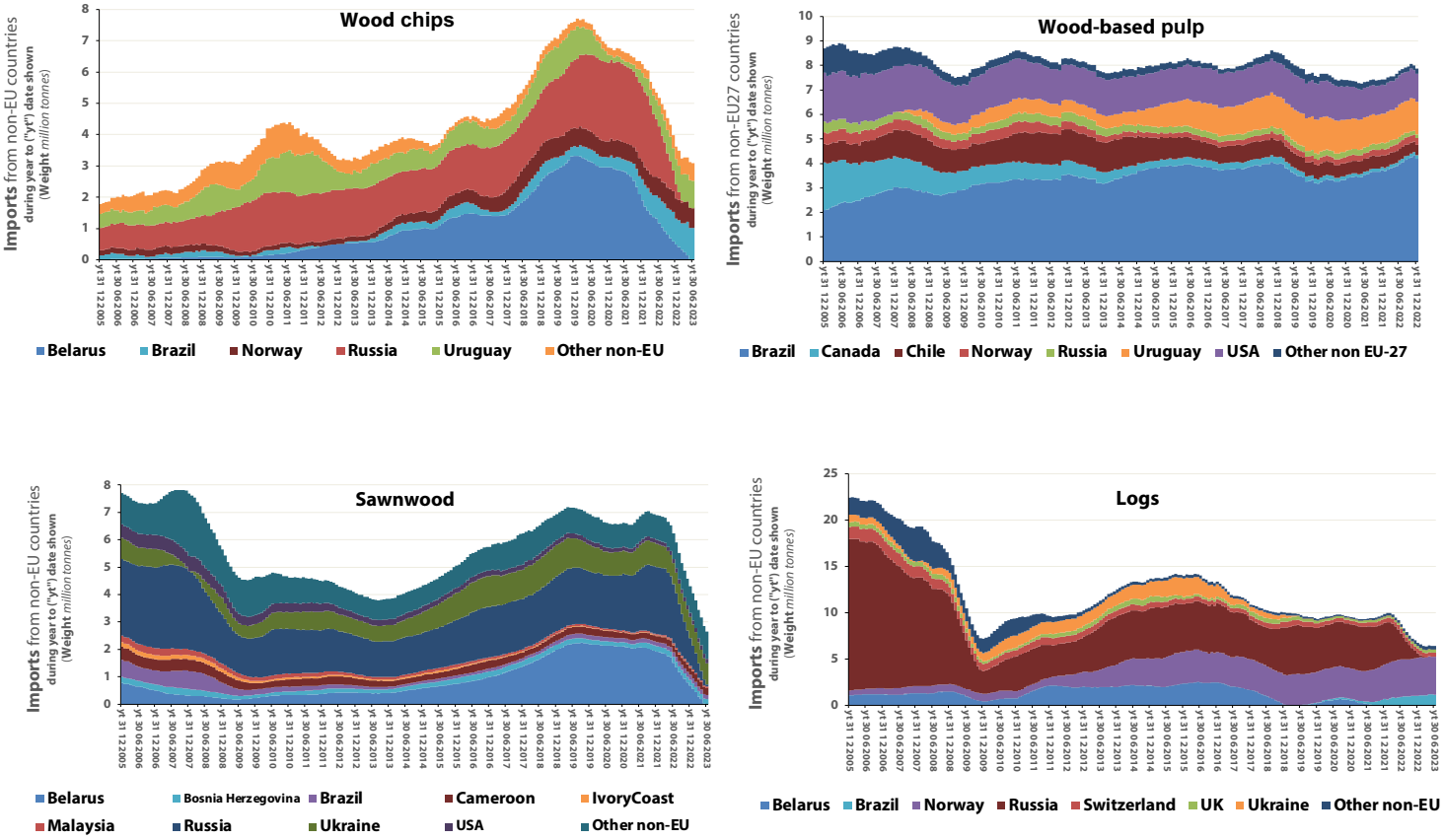


Figure 6 refers to imports of a selection of wood-based products that have the least "value-added". It indicates that:

- Until recently, Belarus and Russia supplied the great majority of the EU's imports of wood chips, logs and sawnwood.[43] The decline in those imports has not been matched by a discernible increase from elsewhere. EU imports of logs decreased during the early 2000s in response to export taxes imposed by Russia. The logs supplied from Brazil are mainly pulpwood.

- EU imports of pulp are tending to decrease in total. The rising share of that pulp wich is supplied from Brazil and, to a lesser extent, Uruguay partly reflects the development of plantations and mills driven by paper industry groups and equipment suppliers based in the EU.[44] The weight of pulp exported from the EU exceeds the weight imported into the EU.

Figures A1 and A2 of the Annex provide charts which illustrate the weight of Member States' imports and exports of logs and sawnwood by species category (coniferous and non-coniferous).

42 - Based on Eurostat.
43 - Depending on the destination, chips might be used more as pulpwood than as energy or panels.
44 - Undervaluation of Environmental, Social and Governance (ESG) factors will also have contributed – as is common not only in the paper sector (for example in Indonesia) but worldwide.

4 Building materials and other wood

There is a lack of information about how much timber is re-used or recycled once its initial life (for example, as building material, furniture, fencing or freight (such as pallets) comes to an end.[45] Estimates published in 2009 suggest that 10-20 million tonnes of construction and demolition waste was then being generated each year across the EU and that one third of this was for recycling while the rest was either incinerated (most with energy recovery) or sent to landfill.[46] One study estimated that post-service wood waste might rise from about 50 million tonnes in 2010 to over 60 million tonnes by 2030.[47] Recycling rates for (undefined) wood packaging waste generated in EU Member States during 2010 varied widely around an average of 40 per cent.[48]

Given the climate emergency, the in-use lifespan of that timber is significant. It is likely to be shorter for furnishings, freight and temporary construction works than for structural components.[49] It may be necessary to replace the fabric of buildings – and buildings themselves – less frequently in order to store embodied carbon (much) longer.[50] Occupancy rates in housing (and demand for new housing) may rise if anticipated increases in population, including from climate migration, occur.

End-of-life treatment depends on the nature and extent of any contaminants (such as preservatives, bonding agents, decorations, and fixings) which have been applied to it. It also depends on national regulations, enforcement and penalties; the cost of collection; and (safe) disposal. If the product is to be transformed for an alternative use in a different market, it needs to be commercially viable. This would depend on there being systems for collection and segregation, facilities capable of transforming the product, and a downstream market of sufficient scale within reasonable distance. Prices would need to be sufficiently attractive at each point in the value chain.

The EU market for wood-based building components assembled off-site and designed to be dismantled and reused is small but rapidly expanding – usually it will be cross-laminated timber (CLT) or laminated veneer lumber (LVL). This technology has led to changes in building regulations, including related to building height. The speed at which structures can be built using this technology is a competitive advantage over buildings using energy-intensive materials such as concrete and brick. Their lighter weight also decreases the cost of foundations. Fire risk in wood-based building materials, including insulation, requires careful consideration.

Of the EU Member States, France is taking a lead in adopting building regulations which require life cycle assessment of the carbon in a building, taking into account a crucial factor - time.[51] France also requires that a percentage of the material in certain new buildings is derived from wood (or other products of biological origin).[52]

Decision-makers need to weigh-up such benefits with the limited possible growth in the supply of wood-based products from forests in the EU and elsewhere.[53]

45 - Research is being carried out on using recycled material in fibreboard – through EcoReFibre. Data concerning some wood packaging waste is available from
46 - "Report on the management of construction and demolition waste in the EU" Bio Intelligence Service (for the EC) (02/2011)
47 - "EU wood: Real potential for changes in growth and use of EU forests" U. Mantau *et al* (06/2010)
48 - "Measuring progress towards circular economy in the European Union – Key indicators for a monitoring framework" European Commission (01/2018)
49 - The use of concrete is likely to decline, given the carbon emissions associated with production of one of its components – cement. Pouring concrete on construction sites tends to require temporary use of wood (or steel) shutters / moulds. Some furniture might be designed for rapid obsolescence.
50 - This might require improvements in design, training, quality and regulation.
51 - "How the emerging environmental regulations will apply to new buildings in France" F. Bourgeon and J. Giddins in Architects Can (07/2021)
52 - "New French public buildings must be made 50% from wood" Global Construction Review (02/2020)
53 - "Evaluation of the climate benefits of the use of Harvested Wood Products in the construction sector and assessment of remuneration schemes" Trinomics, VITO, Wageningen University, Technische Universität Graz and Ricardo (2021)

5 Paper and related packaging

When it comes to packaging, the fundamental issue is levels of consumption (and the cost of disposal), not whether it can or should be derived predominantly from natural raw material rather than fossil fuel.

Packaging tends to maximise consumption by making products cheaper to transport, appear attractive, and, for food and drink, more convenient and longer-lived.

5.1 - Paper

Material Economics has suggested that paper could be used to substitute a maximum of 25 per cent of fossil-fuel derived plastic packaging. Already roughly 40 per cent of packaging[54] production in Europe is fibre-based.[55]

However, most paper-packaging products, regardless of the number of times they are recycled, have a short lifespan. Their embodied carbon would be released (typically by incineration) well before any planted tree has sequestered enough carbon to account for its production. Their other life cycle energy costs (for example collection and transformation) should be taken into account.

As this report is looking at availability of wood-based resources to support the bioeconomy, no attempt is made here to compare the life cycle - or the product environmental footprint - of equivalent packaging products made from raw materials based on paper, agricultural crops, or fossil fuel. Comparisons which have been done tend to be contested due to lack of agreement about many issues, including the weighting given to product specific parameters such as the harm caused by microplastics, the reciprocal subsidies which plastics give to and receive from the fossil fuel market, the land area needed to grow trees (or agricultural crops), and water pollution from mills.

A major issue for this debate is definitions and terminology, especially when referring to products made from more than one type of raw material. Virtually anything can be described as 'compostable', 'recyclable' and 'sustainable' if you take a wide enough view of what these things mean. Paper cartons with a fossil-fuel based inner surface acting as a barrier against contamination and leakage have to be separated into their component materials if they are to be recycled, whether by chemical or mechanical means. Some paper is 'recyclable' but only through the use of specialised technologies, perhaps in conjunction with dedicated collection of waste streams.

The proliferation of packaging types is also an impediment to collection, sorting and recycling of waste – which therefore increases cost. Much packaging (including decoration applied to it) is not designed to be recycled. Incineration - 'energy recovery' - is sometimes referred to euphemistically as recycling, even though it deters recycling![56] Composting might only be feasible (in a modest time period) if carried out in an industrial facility, rather than at home – especially due to the risk of contamination.

Statistics for recycling may differ, depending on whether they refer to the amount received for recycling or to the amount recovered.[57]

54 - "EU Biomass Use in a Net-Zero Economy – A course correction for EU biomass" Material Economics (11/2021)
55 - "Fact sheet" European Bioplastics (02/2020). Roughly 4 per cent of global crude oil production is used in making plastic globally and a further 4 per cent is used in the supply chain and manufacturing process.
56 - https://ukwin.org.uk/oppose-incineration/
57 - "Sustainable Packaging - The Role of Materials Substitution" Material Economics (11 2018)

waste paper recycling in a mill factory, Moreno Soppelsa/SHUTTERSTOCK

Recycling rates are important for this study because recycled material is a feedstock which can be reused and can therefore increase the amount of material available for the bioeconomy. Roughly 25 per cent of paper and board consumption in the EU is not recycled after use.[58] It is unclear how much of that 25% comprises "single-use packaging".[59] Much goes to landfill, and although some is burnt for energy, this should be the very last step of the cascading use of wood.

Leading pulp and paper groups are increasingly establishing or converting mills to produce polymers (a feedstock for plastic) and chemicals from wood raw material.[60] Others are repurposing mills to make specialist packaging products. They are doing so to diversify and in response to the long-term decline in what used to be a major market, graphic paper. Packaging is now the largest component of the paper sector.[61] The mills' potential market will be constrained by the need to manage forest land to sequester CO_2, rather than to produce wood raw material.

The number of times paper can be recycled is finite (typically less than six times in packaging)[62] and recycled paper is likely to require at least some virgin fibre to maintain its function.

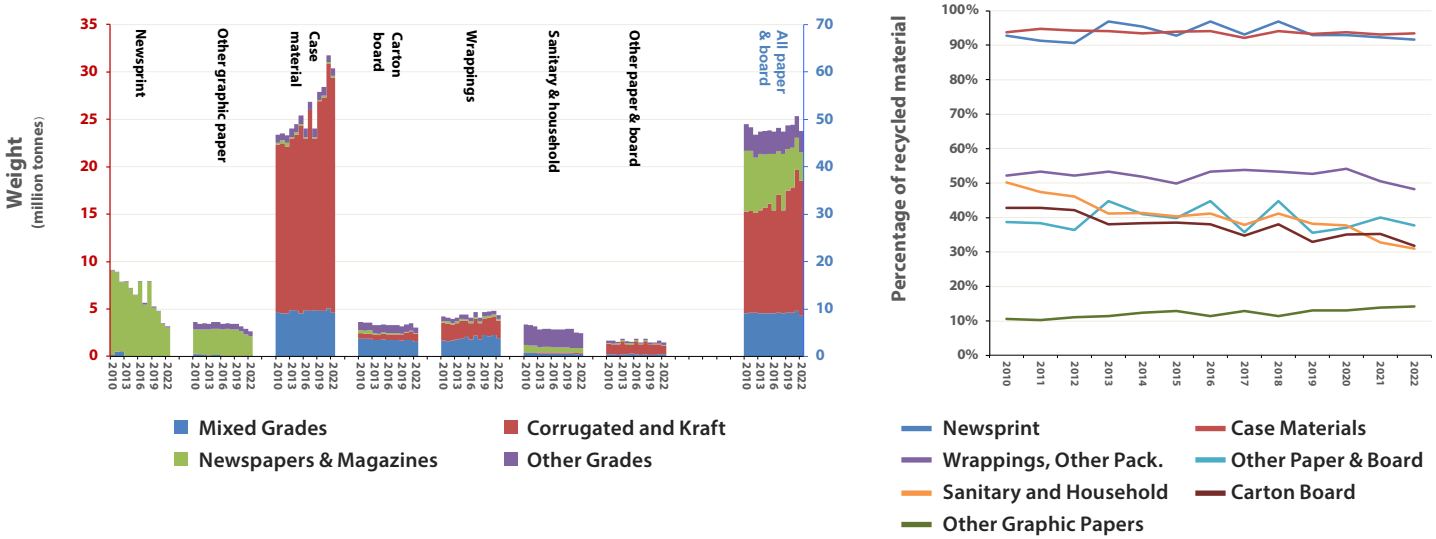
Although the weight of virgin fibre used in the manufacture of packaging and other grades of paper is not published, it can be deduced. For example, during 2021 in the European countries which Cepi represents, a little over 90 per cent of the 34 million tonnes of case material produced was derived from recycled paper and, implicitly therefore, the remaining two or three million tonnes comprised virgin fibre.[63] Similarly, roughly six million tonnes of virgin pulp were used in the production of carton board. Graphic paper other than newsprint accounted for nearly half the approximately 40 million tonnes of paper production which was derived from virgin fibre.[64]

A number of European paper companies are establishing facilities to recycle products which they and their associates made – including beverage cartons and cups.[65] Investment decisions would take into account the feasibility of establishing collection systems for the (segregated) waste, the cost of transportation, uncertainties about market size, and regulation. The additional cost of recycling might be small relative to the retail price of the product which the subsequent packaging conveys. Any price change might therefore not reduce the market's size.

58 - Page 6 "Key statistics 2021 European pulp & paper industry" Cepi
References to Cepi in this study assume that Cepi's member countries are representative of the EU as a whole.
59 - Statistics for "single-use packaging" of any material do not exist. The relevance of such a statistic would depend partly on the quantity of virgin raw material and the purpose of the packaging. The percentage refers to the difference between paper & board production and collection of paper for recycling.
60 - Much of this currently derives from black liquor – some or all of which might have previously been burned by the mill to generate heat and power. If so, then the mill might need make up for that loss of black liquor by procuring an equivalent amount of energy, perhaps from fossil fuel sources.
61 - Page 15 of "Key statistics 2021: European pulp & paper industry" Cepi (2022)
62 - "Cepi position on Commission proposal for a Packaging and Packaging Waste Regulation" Cepi (01/2023)
63 - "Case material" refers to the packaging – for example cardboard - which protects the contents during transport. storage and display. It excludes cartons, which, typically contain beverages.
64 - Page 21 of "Key statistics 2021: European pulp & paper industry" Cepi (2022)
65 - "Sustainability report 2021" Elopak (06/2022)
"Stora Enso, Huhtamaki Advance European Paper Cup Recycling Initiative" Indian Metals and Ferro Alloys Limited (IMFA) (12/2022)

The percentage of recycled paper varies considerably between grades of product. For example, it is greater in case material (typically cardboard boxes)[66] than in beverage cartons. A large majority of recycled paper is used to make case material.[67] As such, one might argue that the flow of paper within the EU market for case material (the largest category of the paper sector) reflects progress towards circularity and satisfying policy requirements concerning Extended Producer Responsibility. However, as with plastic made from fossil fuel, use of some virgin raw material feedstock will remain essential. Further, the percentage of case material made from recycled fibre has remained largely unchanged for several years. The proportion of recycled paper in other grades of paper is shown on Figure 7; that for carton board is decreasing.

Figure 7 – Recycled paper – quantities used and their proportion in new products[68]



As a raw material, paper is an established competitor of fossil fuels (also glass and metal) in the manufacture of beverage containers. The paper-based beverage carton industry has set targets for the percentage of production to be recycled by 2030.[69] Information about those cartons' share of the EU market for beverage containers is lacking. In terms of weight, EU production and consumption of paper-based cartons (not only beverage cartons) is increasing.[70]

Depending on the feasibility of doing so, the most persistent single-use plastics (such as expanded polystyrene) should perhaps be a target, first for prohibition or reduction and, only where absolutely necessary, for substitution.

66 - "Pulp and Paper Industry Definitions and Concepts" Cepi (12/2014)
67 - Page 22 of "Key statistics 2021: European pulp & paper industry" Cepi (2022)
That chart implies that the EU's recycling target for paper and board packaging – of 85 per cent - may have already been achieved.
68 - Based on "Key statistics: European pulp & paper industry" Cepi (annual editions for each of the years shown)
69 - "The beverage carton roadmap to 2030 and beyond" The Alliance for Beverage Cartons and the Environment (03/2021)
70 - Page 13 of "Key statistics 2021: European pulp & paper industry" Cepi (2022)

5.2 - Plastics

Some polymers used in packaging can be made from natural feedstocks that are being used as substitutes for fossil fuel. Brazil has become significant as a supplier of polymers based on sugar cane. Increased production would imply less land available for food production and forests. Such polymers might be referred to as bioplastics.

According to European Bioplastics, 2.9 million hectares of agricultural land (0.06 per cent of the total) would be required if all of the 6.3 million tonnes of bioplastic forecast to be produced in 2027 was derived directly from land.[71]

Plastic production in Europe (not only for packaging) reached 58 million tonnes in 2019 (roughly 15 per cent of the global total); this contrasts with 2.4 million tonnes of bioplastic globally in 2021.[72]

During 2020, roughly 50 million tonnes of plastic was purchased for use in the EU plus the UK. Of this, packaging and construction accounted for 35 per cent and 20 per cent respectively. Twenty-five million tonnes entered waste streams, 15 million tonnes were unaccounted for and 10 million tonnes added to the total in use. Of the waste, roughly 15 per cent was recycled, half was incinerated, a quarter went to landfill, and most of the remainder was exported.[73]

The plastics industry suggests that by 2030 the recycling rate for plastic packaging in the EU, Norway and Switzerland will be 60 per cent.[74] Such an increase would presumably contribute to the weight of plastic purchased for use in packaging, construction and some other segments of the EU plus UK market which one forecast suggests will rise by 30 per cent in aggregate by 2050.[75] Such growth might not reflect the change in economic paradigm which is now imperative - the probability of achieving the least demanding "well below 2°C" target of the United Nations Framework Convention on Climate Change (UNFCCC) 2015 Paris Agreement was estimated two years ago to be less than 5 per cent.[76]

5.3 - Other products deriving from wood-based pulp

Some large pulp and paper groups refine biofuel from tall oil[77] (from pulp mill residues), typically to produce diesel, methanol and naphtha for road and marine transport. Production within the EU is increasing and, by 2030, might supply 5-10 per cent of the global marine market and/or the transport biofuels obligation of a number of EU Member States.[78] Production is constrained by the availability of feedstock from pulp mills.[79]

There is a lack of information concerning the quantity of aviation fuel deriving from wood.[80] The quantity being produced globally is probably small relative to the size of the market for aviation fuel.[81]

Globally, approximately six per cent of textile production is derived from viscose or other wood-based feedstock - ten times less than comes from fossil fuel.[82] Some of that raw material is produced within the EU (including for export). Increasing the share of textiles made wholly or partly from wood raw material does not seem to be a major aspiration within the EU – including in bioeconomy strategies.

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71 - https://www.european-bioplastics.org/bioplastics/feedstock/
72 - "Approaches in Sustainable, Biobased Multilayer Packaging Solutions" K. Eissenberger *et al* (02/2023)
73 - "ReShaping Plastics: Pathways to a circular, climate neutral plastics system in Europe" SystemIQ (04/2022) That study also suggests that, under the EU's Single-Use Plastic Directive, production of single-use plastics will reduce by roughly one million tonnes (by 2030).
74 - "Plastics 2030: PlasticsEurope's Voluntary Commitment to increasing circularity and resource efficiency" PlasticsEurope (01/2018)
75 - "ReShaping Plastics: Pathways to a circular, climate neutral plastics system in Europe" SystemIQ (04/2022)
76 - "Climate change risk assessment 2021 The risks are compounding, and without immediate action the impacts will be devastating" D Quiggin *et al* for Chatham House (09 2021)
77 - "Thermal and Rheological Properties of Crude Tall Oil for Use in Biodiesel Production" P Adewale and L P Christopher (10/2017)
78 - https://www.upmbiofuels.com/traffic-fuels/test-results/
79 - "The crude tall oil value chain: Global availability and the influence of regional energy policies" V Aryan and A Kraft (10/2020)
80 - https://www.neste.com/neste-oil-and-stora-enso-join-forces-biofuel-development Conversely, see https://www.nipponpapergroup.com/english/news/year/2023/news230203005395.html
81 - https://www.dogwoodalliance.org/2022/10/wood-based-aviation-fuel-is-a-bad-idea-heres-why/ and https://www.neste.com/releases-and-news/renewable-solutions/neste-enable-production-500000-tonsa-sustainable-aviation-fuel-its-rotterdam-renewable-products
82 - "Wood-based textiles & modern wood buildings" T. Orfanidou *et al* for EFI (01/2023)

6 Carbon accounting

6.1 - Greenwashing

Initiatives which promote a bioeconomy across the EU tend to be underpinned by assertions about the carbon credentials of wood. Because they tend not to fully reflect reality, they risk being regarded as greenwash. Typically, these include:

a) sustainable forest management increases forest growth and CO_2 sequestration - *but **(I)** in the time available, forest growth from carbon sequestration might be less than the foregone sequestration and loss of soil carbon which are associated with clear-felling, **(II)** CO_2 is more likely to be stored permanently in a natural forest if left undisturbed than if replaced by plantations whose purpose is to maximise accumulation of carbon above ground in the tree trunk; **(III)** forests in the EU are becoming a source (no longer a sink) – implying that forest management certification schemes are insufficient, **(IV)** plantations tend to be less resilient than natural forests against the impacts of the climate crisis (young ones might not reach maturity given the time available);*

b) carbon is stored in wood-based products - *but **(I)** this ignores the foregone sequestration and loss of soil carbon associated which clear felling to produce those products, and **(II)** the storage is unlikely to be permanent.*[83]

c) using wood avoids production of fossil fuel alternatives - *but **(I)** it doesn't necessarily displace an equivalent quantity of fossil fuel feedstock, **(II)** if used as a composite with other feedstock, it might make recycling less viable, and **(III)** markets would contract if carbon prices rise, and;*

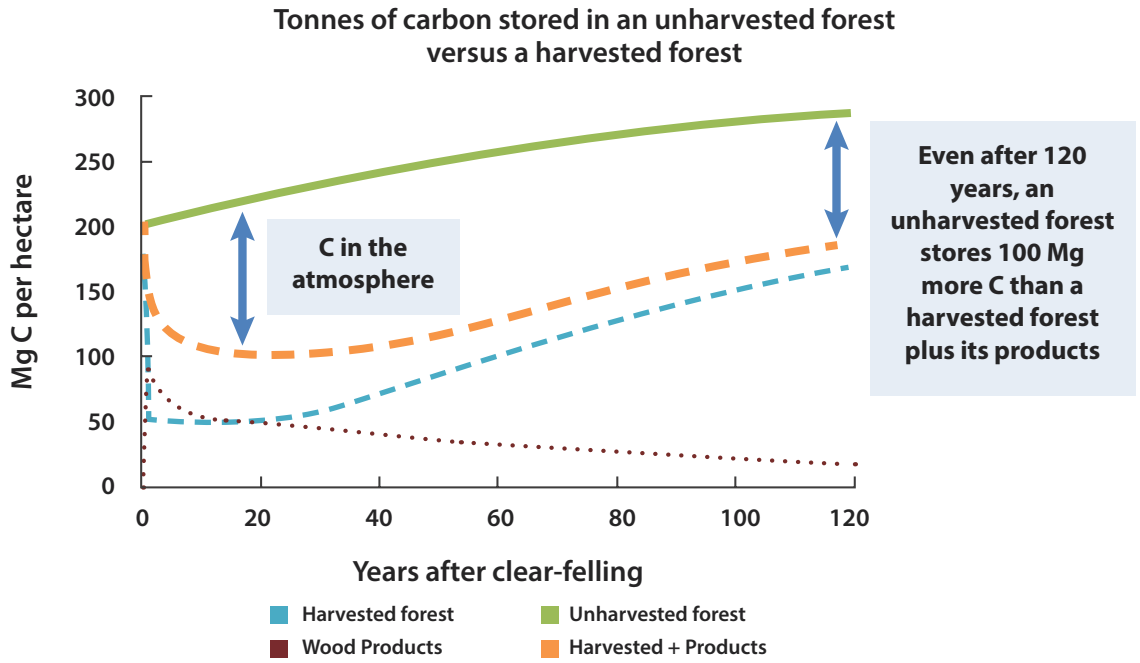
d) using wood as energy avoids the use of fossil fuel - *but **(I)** it might not displace fossil fuel, **(II)** fossil fuel use must rapidly decline to near zero, and **(III)** subsidies for burning biomass depress prices and increase consumption.*

Adding these supposed sequestration, storage and substitution benefits together may offer the illusion of a total carbon benefit that greatly exceeds the real benefit that could be estimated based on the products' full life cycle.

83 - This is particularly the case for paper - even if recycled – and, to a lesser extent, furnishings whose materials might not be easy to recycle or re-purpose. The storage period needs to be longer than the decade or two remaining to achieve Net Zero globally, especially if, as likely, the global carbon budget (which should be equitably apportioned) is exhausted before achieving Net Zero.

6.2 - Carbon accounting

Natural forests existed in equilibrium with natural carbon emissions long before anthropogenic emissions began to impact the climate. Consequently, land which is currently, or was until recently, forested should be assumed to sequester as much natural CO_2 as it did historically. Any remaining sequestration which occurs can then be attributed to anthropogenic emissions. Short rotation coppicing and annual crops differ fundamentally from wood chips and wood pellets in this respect. Their rotation period – a proxy for carbon life cycle - is much shorter than for tree plantations in the EU.[84]



The chart above[85] notionally illustrates the probable net loss of carbon attributable to exploitation of forests for wood raw materials.

The most relevant time-frame for policies to consider is up until the global carbon budget for keeping global average temperatures "well below 2°C" will be exhausted (probably well before 2050).

The upper (solid) line indicates that sequestration would continue (at a declining rate) if the forest area was not clear-felled. The lowermost (dotted) line reflects the rate at which carbon would be released by a mix of short-lived and long-lived products deriving from the clear-felled area (including what is left or burned in the forest and lost during transformation, for example the burning of wood waste from mill processes).[86] The lower middle (short dashed) line illustrates the immediate loss of soil carbon – this is the (initially slow then accelerating) rate of net sequestration that would be achieved if the area subsequently becomes a plantation or natural forest. The upper middle (long dashed) line reflects the sum of carbon remaining in products and net sequestration of the recovering land. The rates of sequestration and loss will vary depending on, for example, the harm which clear felling and exposure does to the soil ecosystem, the success of planting, the resilience of the young trees in the changing climate, and subsequent thinning.

84 - As with the EDR, it is important that fuel deriving from short rotation coppicing and annual crops has not displaced natural biomes (or food crops).
85 - Based on Figure 2 "Creating Strategic Reserves to Protect Forest Carbon and Reduce Biodiversity Losses in the United States" Law, B.E., W.R. Moomaw, T.W. Hudiburg, W.H. Schlesinger, J.D. Sterman, G.M. Woodwell, Land 11, 721 (05/2022) https://doi.org/10.3390/land11050721 (NB x-axis modified slightly)
86 - The initial increase from zero represents the creation of those products' feedstock from the clear-felled trees.

The chart demonstrates the long carbon payback period (carbon debt) of burning woody biomass – and the importance of ensuring that forested land exploited for woody biomass fuel is managed sustainably for at least that full payback period (something which certification, necessarily retrospective, cannot guarantee).[87] This questions whether bioenergy with carbon capture and storage (BECCS) can deliver negative emissions. The poor performance (including abandonment) of facilities to capture post-combustion CO_2 from power stations, the energy penalty of operating those facilities, and negligible success concerning the permanent, geological storage of captured CO_2 further question the feasibility and cost of BECCS.[88]

Carbon accounting rules allow governments (as distinct from companies – including those which are state-owned) to exclude from their accounts the post-combustion carbon emissions of woody biomass burned for heat and/or power – but only if the woody biomass is imported.[89] As such, proponents of biomass-fired power stations assert that burning imported woody biomass is "decarbonisation". Suggesting that those combustion emissions are immediately sequestered – in preference to emissions from other sources - would also be implausible (not least because the countries of origin tend to be net emitters of greenhouse gases).[90] Woody biomass fuel is perhaps the shortest lived of all wood-based products.[91] Markets for this tend to both bring forward and maximise carbon emissions.[92]

According to the report "Future on fire", failure to account for CO_2 emissions from burning woody biomass across the EU underestimates the EU's actual emissions by an amount similar to the sum of all reported emissions from Italy and Poland.[93] Accounting for energy input rather than energy usefully delivered from combustion of woody biomass further distorts measurement.[94]

Assessments of the amount of carbon stored in buildings may also be misleading unless they highlight the sequestration foregone and loss of soil carbon attributable to their provenance and unless they emphasise the likely duration for which the carbon will be stored. Promoting the use of wood in a circular bioeconomy[95] without a steep reduction in virgin fibre usage might be counterproductive given the time available.

87 - Being a greenhouse gas, the climate debt caused by CO_2 emissions from the supply and burning of woody biomass should perhaps be more of a concern than carbon debt.
88 - "Carbon capture from biomass and waste incineration: Hype versus reality" Biofuelwatch (11/2022) "Norway's Sleipner and Snøhvit CCS: Industry models or cautionary tales?" G Hauber for IEEFA (06/2023)
89 - Those post-combustion emissions are accounted for in the land use, land use change and forestry sector (LULUCF) not the energy sector. For an assessment of the supply chain emissions of wood pellets, including foregone sequestration and emissions from clear felled forest land see "Greenhouse gas emissions from burning US-sourced woody biomass in the EU and UK" D. Brack, R. Birdsey and W. Walker for Chatham House (10/2021)
90 - Woody biomass should perhaps be regarded as a scarce resource rather than renewable.
91 - If it is said to derive from unmerchantable trees, this might refer to trees for which the only entity currently willing to pay for them are pellet mills and merchants who supply chips as fuel or bedding.
92 - They also tend to accelerate clear-felling – especially if the biomass derives from the residues of sawmills whose commercial viability substantially improves from the sale of those residues.
93 - "Future on fire: How the EU burns trees in the name of bioenergy" L. Chamberlain, C. Grommerch and M. Booth for Forest Defenders Alliance (04/2022)
94 - "Burning up the carbon sink: How the EU's forest biomass policy undermines climate mitigation, and how it can be reformed" M. Booth for PFPI (11/2022)
95 - https://wood4bauhaus.eu/

Aerial view of Warmeston Oü pellet plant in Sauga, Pärnu County, Estonia/FORESTDEFENDERS

6.3 - Carbon pricing

There is no obligation on the country which burns the biomass either to report the related emissions to the country of origin of that biomass or to consider whether the carbon accounting which the latter carries out is credible. No payment is made either as compensation for the foregone sequestration or to sequester an amount of CO_2 equivalent to the post-combustion emissions of that woody biomass.[96]

In addition to that implicit subsidy, the generation of electricity by burning woody biomass may not only be exempt from carbon taxes but also eligible for subsidy (on the perhaps false assumption that it is from a sustainably managed forest tract). If these market distortions persist, they would greatly increase pressure on EU forests – central estimates for the price of carbon anticipated for 2030 and 2050 by one European government are (in Euro per tonne of CO_2 at 2020 prices) approximately 300 and 400 respectively.[97]

The carbon prices and the discount rate one assumes for future emissions have a substantial impact on the result of assessments of a product's carbon-related life cycle or environmental footprint. Such assessments are increasingly being attempted to justify the choice of materials for packaging and building material. The price of carbon will presumably increase at least as fast as the rate at which greenhouse gas emissions must decrease globally.

96 - Security of supply would be threatened if such payments and/or levies (for example, carbon border adjustments) substantially increase the cost of burning those pellets. Prior to the recent energy price hiatus, the import value of pellets was roughly Euro 120 to 150 per tonne (a little more than double the subsidy provided to keep the world's leading biomass power station financially viable). The price of carbon on the EU Emissions Trading System (EU ETS) has averaged roughly Euro 90 per tonne since early 2022 - https://ember-climate.org/data/data-tools/carbon-price-viewer/. Investors may be misled by ratings which assume that the Scope 1 emissions of power stations which burn woody biomass vary (by the amount of their post-combustion emissions) depending on whether that fuel is imported.

97 - https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation

7 Targets for the EU bioeconomy

There is too little agreement on the definition of "the bioeconomy" as an expression to suggest a clear vision of how to achieve an economy which meets the imperatives of the climate, biodiversity and waste emergencies –without fossil fuel and with substantial changes in pricing (and aspirations). Continuing down the present path may therefore actually serve to delay required action.[98]

"Low hanging fruit" such as taking robust action to halt the rapid loss of old-growth forest does not seem to be a priority for EU leaders.[99] Nevertheless, that forest is crucial not least for biodiversity and because it is more resilient against climate change and disruption than managed forest. Roughly half of the area of primary forest lies outside strictly protected areas, often as small, fragmented tracts.[100] Promoting a bioeconomy is unlikely to relieve pressure on these and other forests.

The EU – including some relevant industries – does not seem to have targets for roundwood production or the use of wood-based products. There is also a lack of published forecasts. Estimates of the potential sustainable level of industrial roundwood production for use in different sectors are lacking.

That said, the EU panels industry anticipates 20 per cent growth by 2030 under "business as usual" and a further eight million cubic metres of feedstock (of which none would comprise roundwood) in response to the European Green Deal and related initiatives.[101]

Of the few forecasts which do exist, some anticipate that, overall, industrial roundwood production will or can increase only a little,[102] perhaps 10-15 per cent.[103] Another is based on historic trends rather than the likely future and, in relation to production of paper, does not distinguish between recycled and virgin feedstock.[104] On a similar basis, another forecast suggests that roundwood production in the Nordic Baltic region might increase by approximately 20 per cent between 2020 and 2030.[105]

Use of CLT in the EU is forecast to rise from 1.6 million m^3 in 2022 to 2.9 million m3 by 2028. The volume forecast for 2028 is approximately 15 times less than the volume of damaged wood extracted from German forest over the last few years.

Forecasts concerning the burning of wood pellets by the industry might be biassed.[106] It is unclear how much woody biomass is expected to be burned in the EU in order to help renewable energy production account for 40 per cent of EU energy consumption by 2030 and 55 per cent by 2050. The climate emergency may oblige a steep (at least temporary) decline in energy consumption. The amount of woody biomass burned by mills to meet their own operating requirements depends on whether mills close, new mills are constructed, and how much the supply of feedstock for production of industrial chemicals will reduce availability of black liquor. The burning of woody biomass in power stations will tend to decline once subsidies are by and large withdrawn (from 2026) – and when payments by industrial users are required to compensate for sequestration foregone and loss of soil carbon. As such, most of any increase in the burning of woody biomass would presumably be for (widespread) small-scale use – tending to worsen public health by correspondingly increasing fine particle (PM2.5) air pollution. Given competing needs, the scarcity of wood raw material may cause prices to rise (inducing opportunistic forest exploitation), perhaps to the disadvantage of other industries.

98 - The increasing turbulence which continued failure in that regard may justify targets to be set and publicly reviewed in an apolitical process at least once every year. Guidance concerning likely changes in price might be needed in order to (equitably) reflect the impact of consumption on those emergencies.
99 - "Protect old-growth forests in Europe now" M. Mikolāš (05/2023)
"The fight is on for a game changing EU Nature Restoration Law" A Brunner for Green Alliance Blog (06 2023)
100 - Where are Europe's last primary forests? F. M. Sabatini *et al* (05/2018) (see also https://www.eea.europa.eu/publications/european-forest-ecosystems-key-allies)
101 - Including "A Renovation Wave for Europe" and "New European Bauhaus". https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en
102 - "The Swedish wood and biomass market: Roundwood markets in the Baltic Sea region – now and tomorrow" J. Carlsson (09/2017)
103 - "EU Biomass Use in a Net-Zero Economy – A course correction for EU biomass" Material Economics (11/2021)
104 - Section 3.3.5 "Forest Sector Outlook Study 2020-2040" UNECE (2021). The text does not indicate how much of the mentioned 20 per cent is derived from recycled paper or from virgin pulp.
105 - "The forest industry around the Baltic Sea region: Future challenges and opportunities" K. Liuhto (01/2020)
106 - Slide 21 "Investor presentation" Enviva Biomass (05/2022)

Modern wood pellet production plant in operation, Zigmunds Dizgalvis/ISTOCK

Concerning CO_2, more than one assessment suggests that mitigation by forests alone will not contribute sufficiently to the Land Use, Land Use Change and Forestry (LULUCF) component of the EU's climate targets.[107] One assessment in particular exposes a major flaw in the target for 2050 – which relies implausibly on BECCS.[108] Another estimates that net removals of CO_2 by EU forests will decline by 45 per cent between 2021 and 2030.[109] The aging of growing stock might partly account for any decrease.[110]

107 - "Forest-based climate change mitigation and adaptation in Europe" P. J. Verkerk *et al* for EFI (09/2022)
108 - "Burning up the carbon sink: How the EU's forest biomass policy undermines climate mitigation, and how it can be reformed" M. Booth for PFPI (11/2022)
109 - "ClimWood2030 'Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030' Final Report" S. Rüter *et al* for Thünen-Institut (04/2016)
110 - "Annual European Union greenhouse gas inventory 1990–2021 and inventory report 2023" European Environment Agency for UNFCCC Secretariat (04/2023)

8 Conclusions

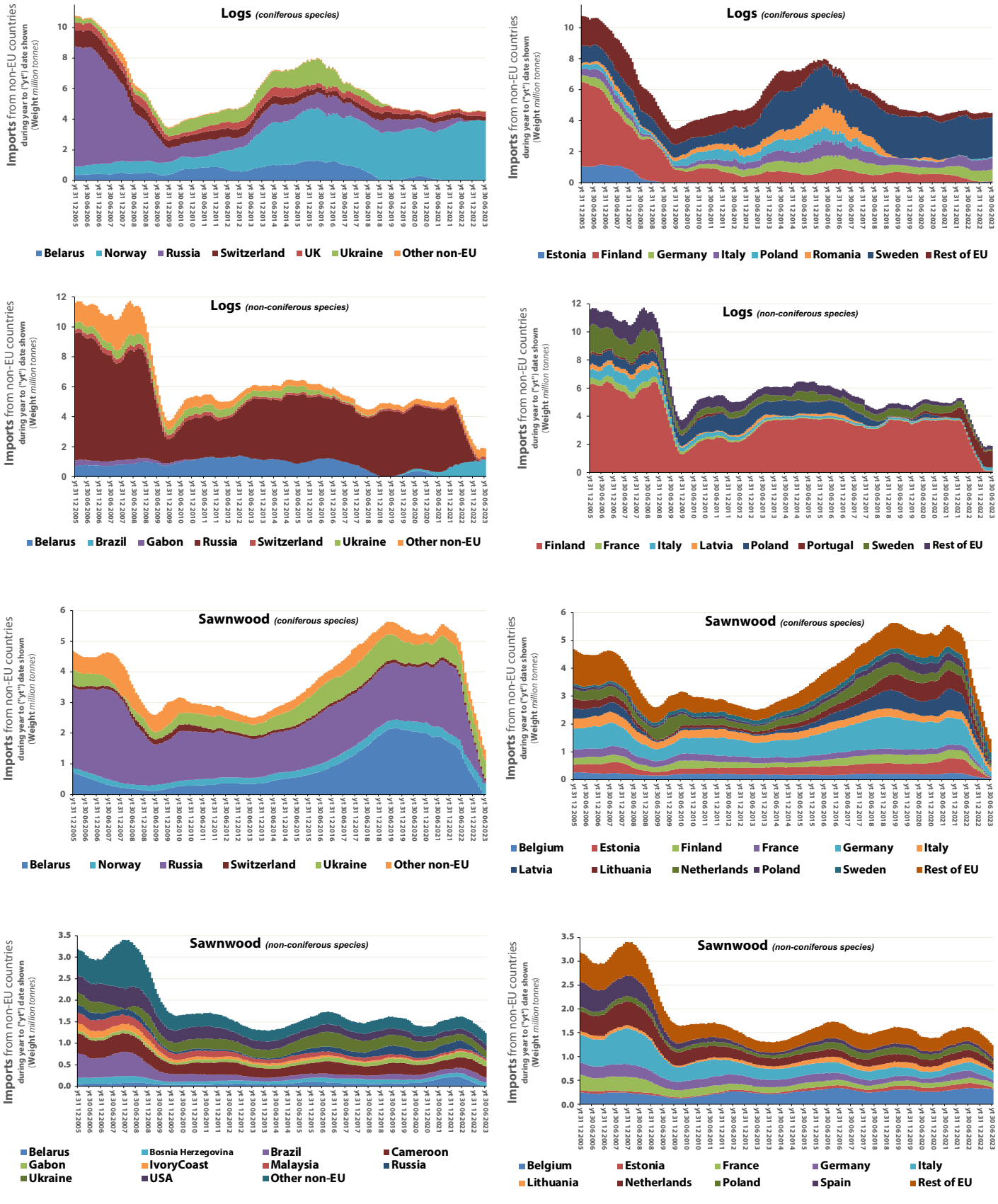
This study sought information about current and forecast production and consumption of wood-based products, and about the ability of forest in the EU to supply this sustainably, without harming the carbon sink. Forecasting is difficult as the amount of forest will depend on the rate of climate change and responses to it (including in prices) across the economy. Given the insufficiency of the response to the climate crisis and evidence that EU forests are becoming a net source of CO_2, a shift towards restoration of natural forest and away from mono-culture plantations would be the most positive approach. This would require a decrease in planned roundwood production (offset partly by increased salvage logging), an increase in recycling (requiring products to be designed, priced and used accordingly), less wood being burned for electricity and heat, and a decline in net exports.

The study notes that greenwashing concerning the carbon credentials of wood-based products may be hampering progress towards real solutions. Even the term "bioeconomy" is being used as greenwash, compounding the problem by reducing focus on forest ecosystems, conservation, legality, and the need to reduce consumption in the economy.

The study finds that although positive changes are being made with regards to forest management, and some components of the building industry, the pace is slow given the time available. Unless prices rise sufficiently, the carbon value of forests (and the value of related businesses) may decline given the risk that trees newly planted might not reach maturity before the global carbon budget is exhausted (if they survive that long). Addressing inessential consumption and the life cycle of related packaging (both being low hanging fruit in the context of the emergencies) should be a priority – without change we will be unable to stem the tide.

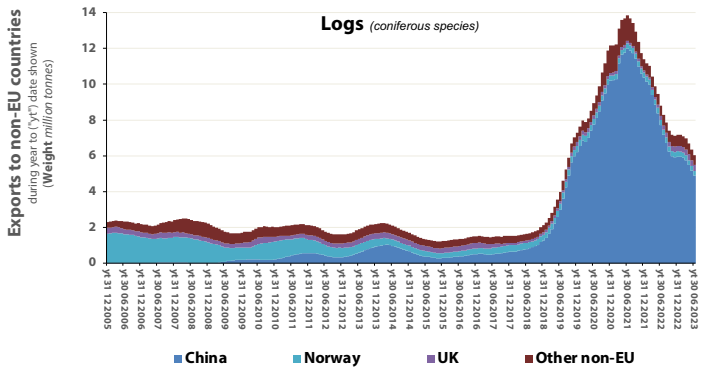
Annex [111]

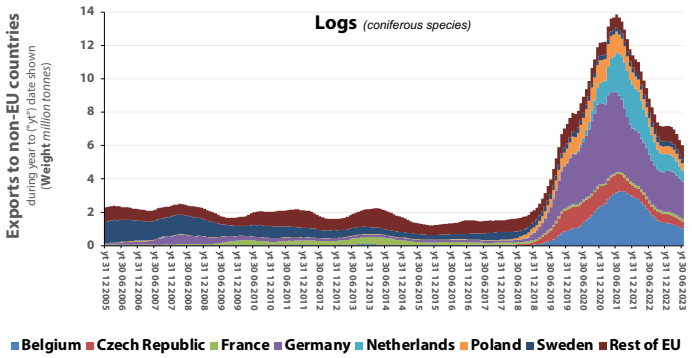
Figure A1 - EU imports of logs and sawnwood by species category

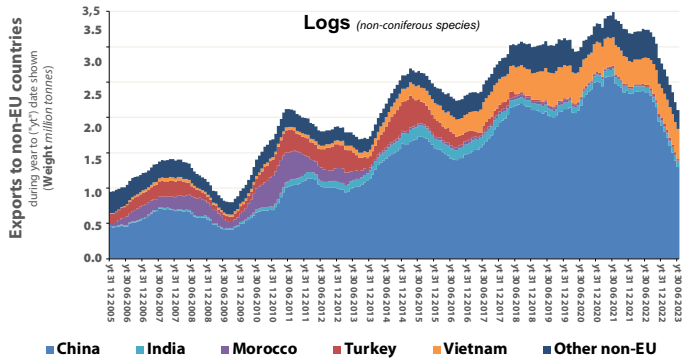


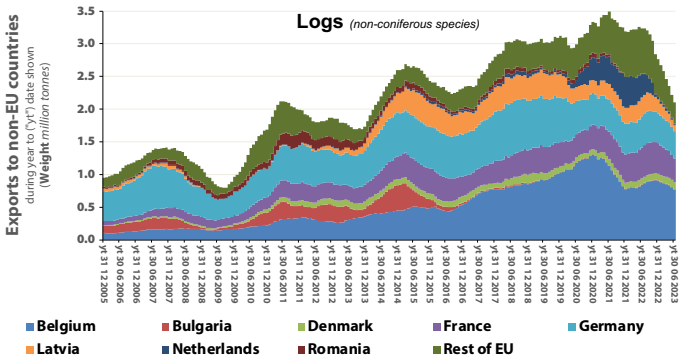
111 - The charts presented under Figures A1, A2 and A3 below are based on Eurostat.

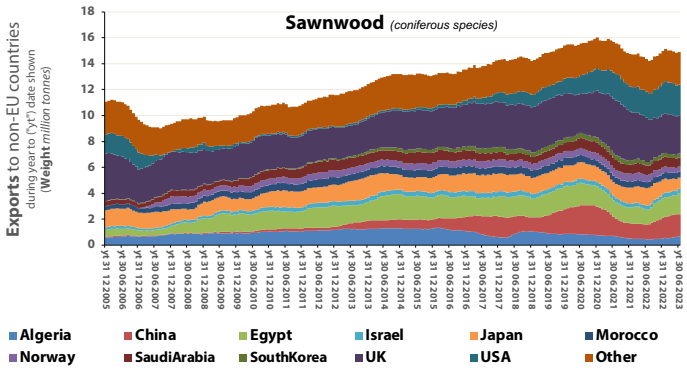
Figure A2 - EU exports of logs and sawnwood by species category

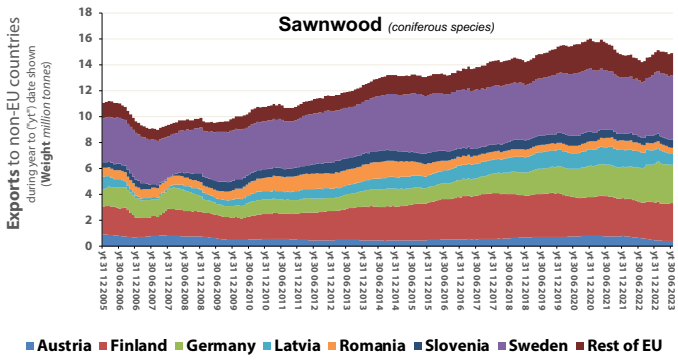


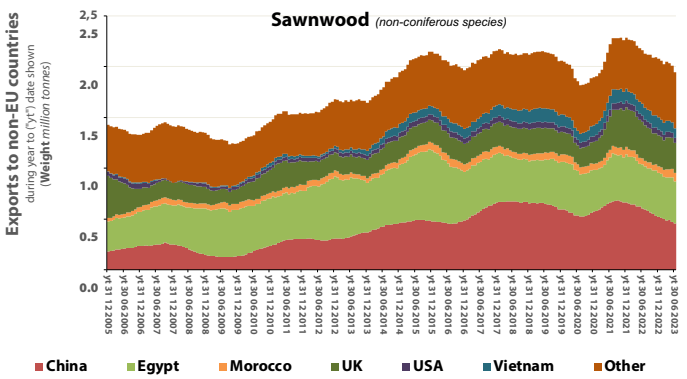












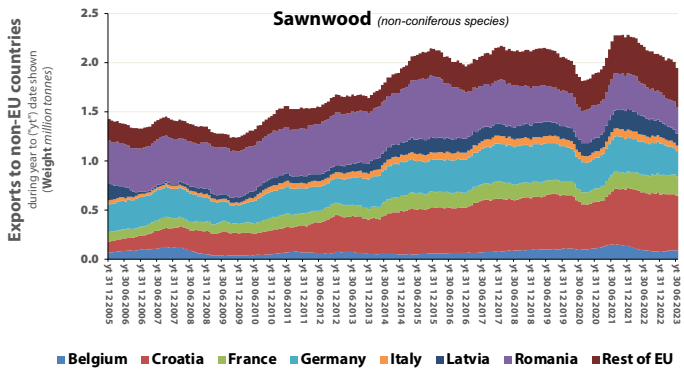


Figure A3 - EU imports of wood chips and wood-based pulp

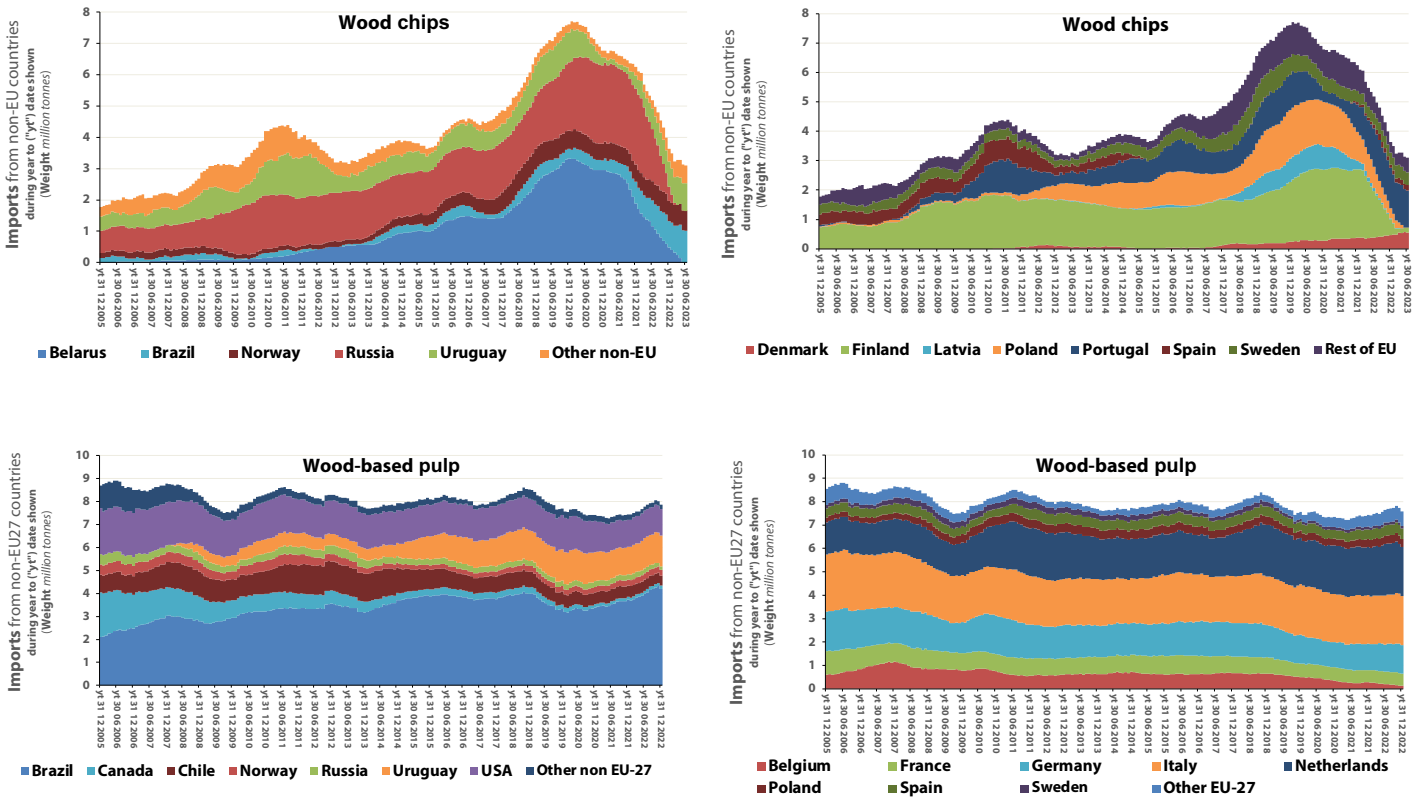
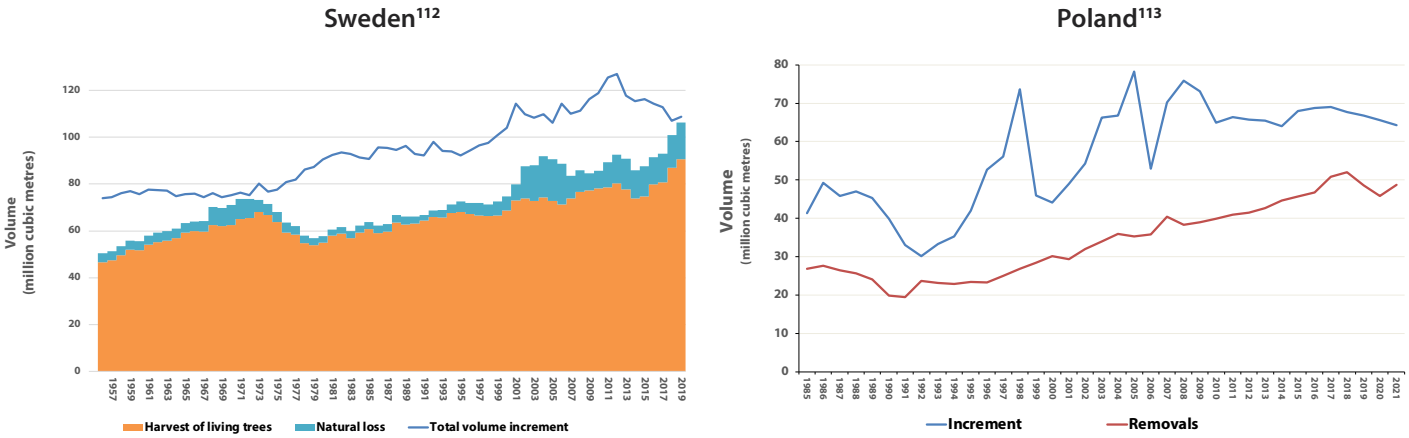


Figure A4 – Increment versus "drain"

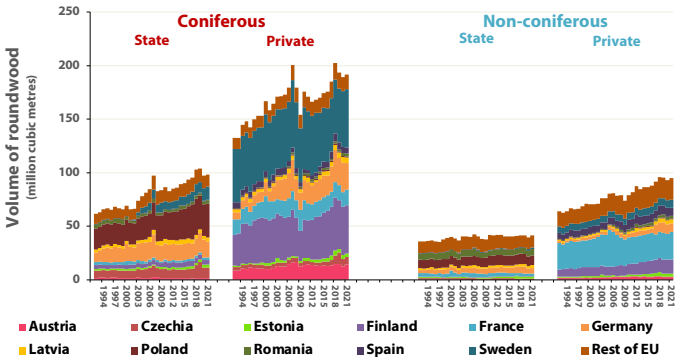


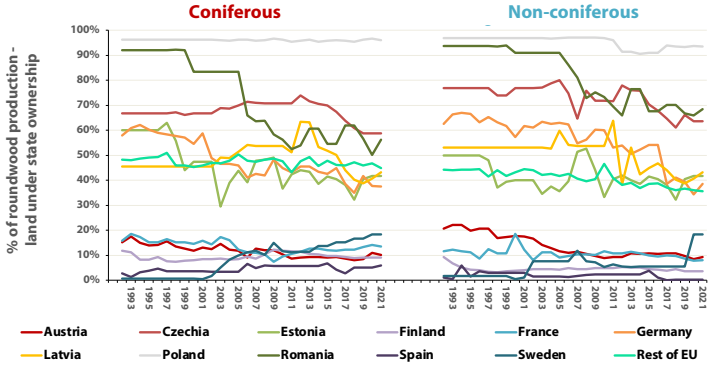
Statistics for increment are not necessarily comparable with those of drain (removals and other losses) – as indicated in Section 2.3 above. For example, the former might primarily comprise wood of less commercial value than the latter.

112 - Based on https://skogsstatistik.slu.se/pxweb/en/OffStat/OffStat__ProduktivSkogsmark__Tillvaxt/PS_Tillvaxt_avverkning_fig.px/
113 - Removals here refers to "gross large timber" http://bialystok.stat.gov.pl/download/gfx/bialystok/pl/defaultaktualnosci/752/9/1/1/rocznik_statystyczny_lesnictwa_2022.pdf

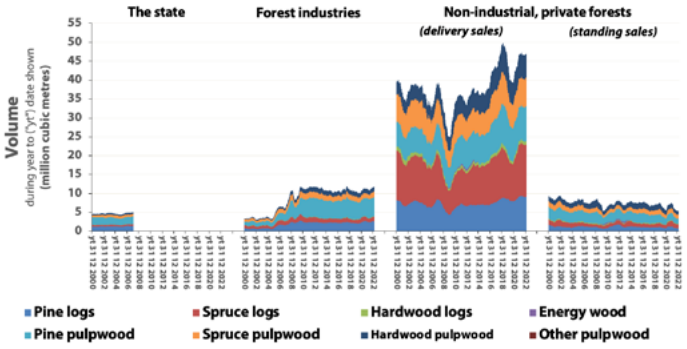
Figure A5 – Industrial Roundwood (IRW) production in selected EU Member States, by ownership category[114]

Roundwood production from land under state ownership[115]

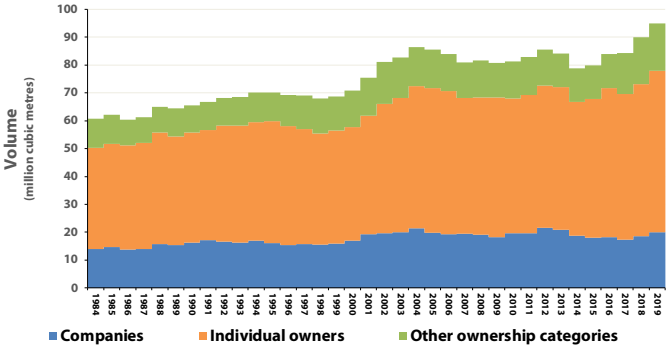




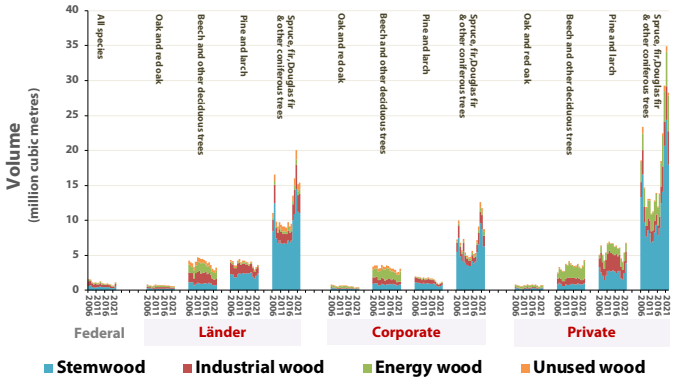
Finland[116]



Sweden[117]



Germany[121]



The upper right chart of Figure A5 suggests that, in general, roundwood production from state-owned land is declining relative to the volume produced on other land.
The share attributable to state-owned land is particularly large in Czechia, Estonia,[118] Germany, Latvia,[119] Poland,[120] and Romania. The other charts of Figure A5 provide further insight into ownership in three leading producer countries.

114 - IRW – abbreviation for industrial roundwood
115 - Based on Eurostat (adjusted for missing or seemingly anomalous data; data quality and definitions might explain at least some of any discrepancy with other charts presented in this publication) https://ec.europa.eu/eurostat/databrowser/view/FOR_OWNER__custom_6976365/default/table?lang=en
116 - "Industrial roundwood" based on https://statdb.luke.fi/PxWeb/pxweb/en/LUKE/LUKE__04%20Metsa__02%20Rakenne%20ja%20tuotanto__06%20Puun%20markkinahakkuut__02%20Kuukausitilastot/01_Teollisuuspuun_hakkuut_kk.px/table/tableViewLayout2/
117 - "Annual felling" based on https://skogsstatistik.slu.se/pxweb/en/OffStat/OffStat__Avverkning/AVV_arlig_avverkning_agargrupper_tab.px/table/tableViewLayout2/
118 - "Annual Report 2022" RMK (05 2023)
119 - "Facts and figures 2023" Latvias Valts Meži (06 2023)
120 - "Statistical Yearbook of Forestry 2022" Głównego Urzędu Statystycznego (11 2022)
121 - "Logging" based on https://www-genesis.destatis.de/genesis//online?operation=table&code=41261-0002&bypass=true&levelindex=0&levelid=1688310502863#abreadcrumb

harvester working in forest, KelaVi/SHUTTERSTOCK

fern

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