Strategic wood availability in Europe

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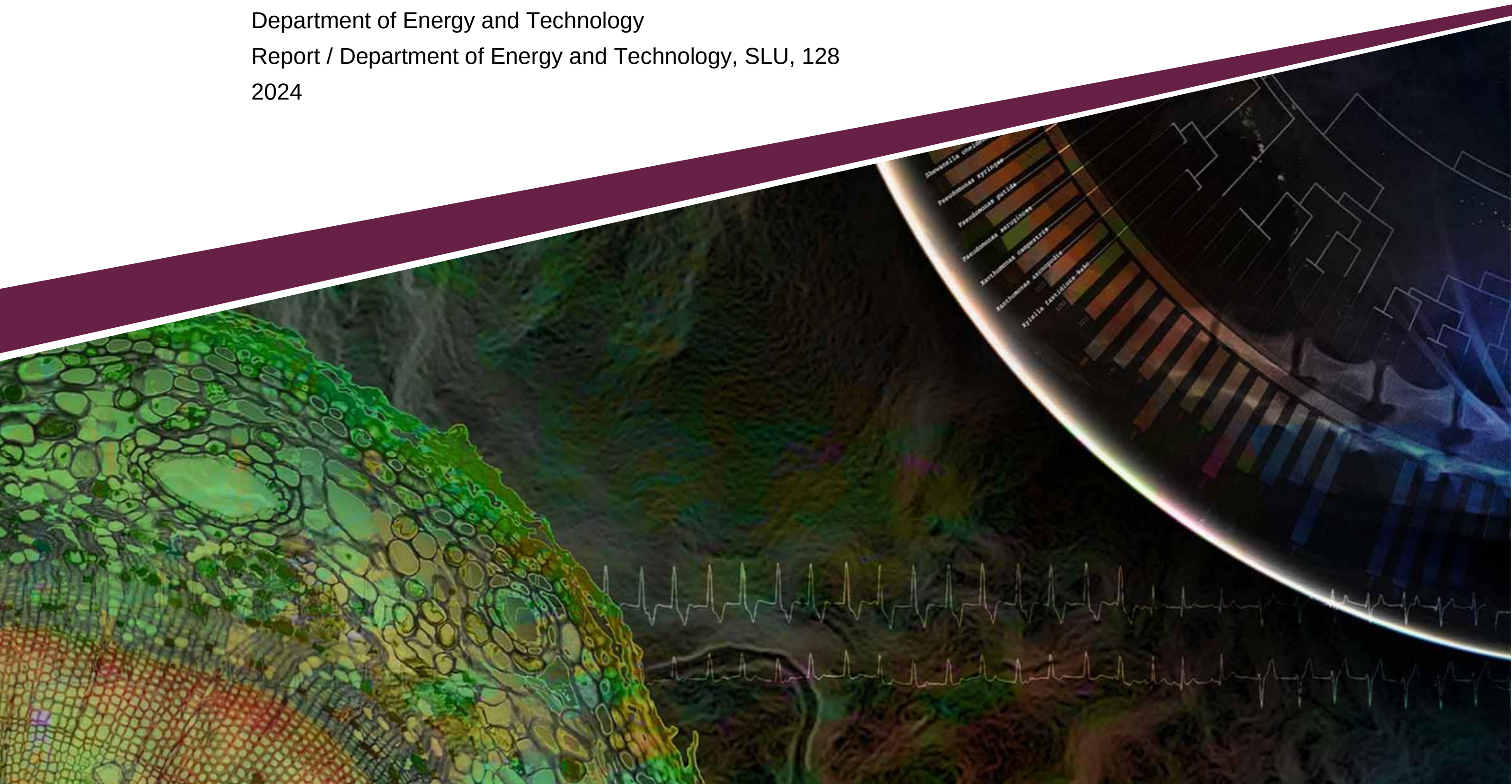

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Summary

The current situation and the outlook into the medium term as regards the availability of wood raw materials for wood-based manufacturing in Europe can best be described as the perfect storm. Hence, energy and climate policies imply increased competition for woody biomass from energy uses − notably through the recently revised renewable energy directive − while at the same time potentially restricting the fellings potential through the 2030 target of the revised Land-use, land-use change and forestry (LULUCF) regulation of net carbon removals of 310 million tonnes of CO_2 equivalent. Further, neither demographic trends − population decline, ageing and urbanization − nor bio-physical realities − stagnating forest increment − are conducive for an increased mobilization of wood. To make things worse, the Ukraine war further reduces the supply of wood through the import ban on Russian and Belarusian wood commodities, while simultaneously leading to higher European electricity prices and − as a consequence thereof − further increasing the competition for woody biomass from energy uses. These developments threatens the competitiveness of energy-intensive European forest-based industries, notably reconstituted wood-based panels manufacturing.

The current assessment, which applies the methods and data used by the European Commission Joint Research Centre (JRC) in setting up wood resource balance sheets and Sankey diagrams, clearly suggests that, even a future more favourable in the sense of wood availability − less ambitious RED targets and Europe finding replacements for wood imports from the Russian federation and Belarus − would be extremely challenging. Thus, increasing fellings to meet the demand for material and energy could not be accomplished without decreasing the forest carbon sink, thereby making it all but impossible to reach the 2030 LULUCF target. Indeed, in all European regions except region North forests would turn from a sink to a source of carbon before year 2040. Obviously the situation in a future with a higher demand for wood and lower supply − meeting the targets of the revised RED and Europe not being able to fill the gap resulting from the ban on wood imports from the Russian Federation and Belarus − would be worse still.

To remedy the situation, a number of potential options, and combinations thereof, do exist. Attempts could be made to increase net annual increment, by increasing gross annual increment and/or reduce natural losses. As has been evidenced by damages resulting from bark beetle infestations, this could prove difficult, at least in the short to medium term. Secondly, efforts could be made to increase imports of wood raw materials. However, it is difficult to see how imports could be substantially increased, given the geopolitical situation and policy instruments in place, notably the EU Timber Regulation. And, from a climate change mitigation perspective, this could in any case be considered a dubious, beggar-thy-neighbour type of approach, as it would imply increasing fellings or crowding out of wood uses elsewhere, which could negate any climate benefits achieved in Europe. Likely, the most promising avenue, along with increased efficiency in manufacturing and energy generation, is to enhance the circularity in the wood-based economy, i.e., increasing the cascading wood use. In this respect, the high share of primary woody biomass in wood used for heat and power in all European regions but region North − precluding any cascading − is problematic. This is a major factor explaining the circumstance that these regions fare worse in basic forest sustainability and carbon sink terms. Though it is beyond the scope of this report to provide policy advice, it seems as if climate and energy policies incentivize the use of woody biomass for energy at the detriment of material uses.

Keywords: wood resource balance, forest-based industry, climate, energy, policy

Abstract

Ambitious climate change mitigation policies are on one side increasing the EU demand for woody biomass, while on the other potentially restricting the supply thereof. Hence, the amended Renewable Energy Directive ("RED III") aims to increase the share of renewable energy in the EU's overall energy consumption to 42.5% by 2030 from the current share of 23%. Further, the updated land use, land-use change and forestry (LULUCF) regulation sets ambitious, binding, national target for the increase of net greenhouse gas removals for the period 2026-2030, which together will deliver the collective EU target of 310 Mt CO_2 equivalent of net removals in the LULUCF sector in 2030 (EU, 2023). For member states already using their forests intensively, these carbon sink targets are likely to hinder an increase in fellings; rather they will require lower levels of felling

Additionally, the ongoing geopolitical crisis related to the Ukraine war has changed the conditions as regards both the availability and demand of/for woody biomass in the EU. Hence, the Council of the EU banned the import of most of the timber and timber products from Russia and Belarus covered by the EU Timber Regulation from entering the EU in 2022, directly negatively affecting the supply of woody biomass on the EU market. In addition, elevated electricity prices within the EU have been reinforced by sanctions on Russian hydrocarbons and the sabotage of the Nordstream natural gas pipelines. This has further increased the competition for woody biomass from energy uses.

Accordingly, the overriding purpose of the study − applying the methods and data used by the European Commission Joint Research Centre in setting up wood resource balance sheets − is to provide an assessment of the future supply and demand of woody biomass within Europe. The results clearly suggests that, even a future more favorable in the sense of wood availability − less ambitious RED targets and Europe finding replacements for wood imports from the Russian federation and Belarus − would be extremely challenging. Thus, increasing fellings to meet the demand for material and energy could not be accomplished without decreasing the forest carbon sink, thereby making it all but impossible to reach the 2030 LULUCF target.

Keywords: climate, energy, policy, geopolitical, wood resource balance

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Abbreviations

CEU	Council of Europe
ECB	European Central Bank
EU	European Union
FW	Fuelwood
GDP	Gross domestic product
GFTM	Global Forest Trade Model
IEA	International Energy Agency
IRW	Industrial roundwood
JFSQ	Joint Forest Sector Questionnaire
JRC	Joint Research Centre
JWEE	Joint Wood Energy Enquiry
LULUCF	Land-use, land-use change and forestry
MS	Member state
NAI	Net annual Increment
NIC	National Intelligence Council
OECD	Organisation for Economic Co-operation and Development
RED	Renewable energy directive
SLU	Sveriges lantbruksuniversitet
UK	United Kingdom
UN	United Nations
UNECE	United Nations Economic Commission for Europe
WRB	Wood Resource Balance

1. Background

Ambitious climate change mitigation policies are on one side increasing the EU demand for woody biomass, while on the other potentially restricting the supply thereof. Hence, the amended Renewable Energy Directive ("RED III") aims to increase the share of renewable energy in the EU's overall energy consumption to 42.5% by 2030 — with a further indicative target of 2.5% to allow the target of 45% to be achieved (CEU, 2023). This is bound to further increase the use of wood for energy, as bioenergy contributes about 60% of renewable energy in the EU (Scarlat et al., 2019), and around 60% of the biomass used for energy is wood based (Camia et al., 2021). At the same time, the sustainability criteria concerning forest biomass harvesting are strengthened in RED III (CEU, 2023), potentially restricting the supply of woody biomass.

Further, the updated land use, land-use change and forestry (LULUCF) regulation sets ambitious, binding, national target for the increase of net greenhouse gas removals for the period 2026-2030, which together will deliver the collective EU target of 310 Mt CO_2 equivalent of net removals in the LULUCF sector in 2030 (EU, 2023). As an example, for Sweden, with the highest requirements, the target for 2030, removals of 47.3 Mt CO_2 equivalent (Ibid.), entails an eight percent increase compared to 2018 (see Swedish Environmental Protection Agency, 2022). For member states using their forests intensively, these carbon sink targets are likely to hinder an increase in fellings; rather they will require lower levels of felling. Actually, on the overall EU level, continuing past forest management practices is foreseen to further decrease the forest carbon sink (Korosuo et al., 2023).

Additionally, the ongoing geopolitical crisis related to the Ukraine war has changed the conditions as regards both the availability and demand of/for woody biomass in the EU. Hence, the Council of the EU banned the import of most of the timber and timber products from Russia and Belarus covered by the EU Timber Regulation from entering the EU in 2022 (CEU, 2022). Combined with, for obvious reason, reduced exports from Ukraine directly negatively affecting the supply of woody biomass on the EU market. Thus, Russia alone accounted for over 52% of extra-EU roundwood imports in 2019 (source: UN Comtrade, 2023). These EU trade sanctions thus further reduce the possibility of bridging a growing timber supply gap in Europe – exacerbated by an expected future reduced supply of softwood roundwood after bark beetle induced salvage loggings in (mainly) Central Europe have peaked ─ and of easily finding substitutes for (high risk) tropical wood commodity imports on the EU market.

The current geopolitical crisis also has other implications for the EU forest-based sector, by dampening economic activity and the demand for wood-based products. Further, the crisis seemingly reinforces the emerging trend of moving away from a truly globalized World towards a regionalized one, with an increased focus on self-sufficiency, dominated by two competing centers of influence, China and the USA respectively (NIC, 2021). Should this development continue, which does seem inevitable, it will have serious consequences for a highly export-oriented EU forest-based sector, not only as regards the sourcing of wood raw materials — inducing increased self-sufficiency — but also for exports of wood products. Hence, as an example, 35% ─ or 40 million m^3 ─ of the EU sawnwood production of some 113 million m^3 were exported outside the EU in 2021, of which the four largest Asian importers ─ China, Japan, Saudi Arabia, and South Korea ─ accounted for 23% (sources: FAOSTAT, 2023; UN Comtrade 2023).

Further, elevated electricity prices within the EU ─ stemming from a rebound in economic activity after the Covid-19 pandemic as well as an increasing reliance on intermittent, weather dependent, energy sources (ECB, 2022) ─ have been reinforced by sanctions on Russian hydrocarbons and the sabotage of the Nordstream natural gas pipelines. This situation is leading to a serious loss of competitiveness in energy-intensive industries relative corresponding industries in regions with lower energy prices (IEA, 2023). European forest-based industries are impacted to varying degrees. In general, pure paper mills, mechanical pulp producers, and reconstituted wood-based panels manufacturers are likely to be among the most negatively affected. These energy-intensive industries suffer not only directly from rampant energy prices but also from increased competition for wood-based raw materials from energy uses, at the same time as these manufacturing processes do not result in any sizeable amounts of residues that can be used for energy production (see, e.g., Jonsson, 2011). Indeed, in, e.g., Sweden there have already been — so far temporary — paper mill closures due to rampant energy prices (see, e.g., Tidningen näringslivet, 2022).

Accordingly, the overriding purpose of the study is to provide an assessment of the future supply and demand of woody biomass within Europe, in light of policy developments and geo-political developments and the associated impacts on European forest-based industries, with a particular focus on wood-based panels markets. Forest-based industries and wood-based energy production are interlinked, displaying synergies as well as competition (Camia et al., 2021). Hence, sawmilling by-products are used for wood pulp (for paper as well as textile fibers) and wood-based panels manufacturing as well as for energy production (Jonsson & Rinaldi, 2017), while side-streams from chemical pulping are used for energy production as well as in the chemical industry (Hurmekoski et al. 2018). Energy and material use (mainly wood-based panels but also wood pulp manufacturing) also compete for primary sources (removals) of woody biomass (Jonsson & Rinaldi, 2017). This means that an assessment of sources and uses of woody biomass for energy needs to also consider forest-based industries and vice versa.

2. Scope

2.1 Definition of forest-based sector and forest-based industries

The forest-based sector is here defined as including wood resources as well as the use of these resources; material uses of wood, i.e., forest products, and energy uses — for heat and power — of wood. Wood-based products (intermittently termed wood products) include all of the primary products manufactured in the forest processing sector — sawnwood, wood-based panels, paper and paperboard — and the main inputs or partly processed products used in the sector — roundwood, wood pulp, wood residues, post-consumer recovered wood and recovered paper.

Secondary or value-added wood-based products (such as, e.g., wooden doors, window frames and furniture) are only covered indirectly, insofar as trends and future developments in these markets are considered in assessing impacts on forest-based industries.

2.2 Geographical scope

The study encompasses all EU member states (MS), Norway, Switzerland, and the UK. These countries are allocated to four regions: *Region North*, comprising Estonia, Finland, Latvia, Lithuania, Norway and Sweden, *Region West* in turn covers Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, Switzerland and the United Kingdom (henceforth the UK), while *Region East* consists of the countries Bulgaria, Croatia, Czechia, Hungary, Poland, Romania, Slovakia and Slovenia, and, finally *Region South* comprising Cyprus, Greece, Italy, Malta, Portugal and Spain.

2.3 Time horizon

The year 2019 is the base year for the outlook, with a time horizon in the year 2040. The analysis of historical trends in the use of woody biomass considers the last fifteen to twenty years.

3. Material and methods

The approach used for collating and analyzing uses and sources of woody biomass is the one used by the Joint Research Centre (JRC) in deriving wood resource balance (WRB) sheets (Cazzaniga et al., (2021). The Wood Resource Balance (WRB) is useful in providing an overview of sources and uses of woody biomass. The sources of woody-biomass are recorded on the left side of the main balance table. They are classified as primary sources (from forests and other wooded land), secondary sources (industrial by-products and residues, wood pellets, wood briquettes), and post-consumer wood. Both domestic production and net-trade of these items are considered, however, for black liquor and post-consumer wood only domestic production is considered. The right side of the main balance table shows the sectors where woody biomass is used: manufacturing of wood-based commodities and energy generation. All values are reported in a common measurement unit (cubic meters of solid wood equivalent).

The amounts of different types of woody biomass (primary and secondary) required for the manufacture of sawnwood, wood-based panels and wood pulp are derived from the Joint Forest Sector Questionnaire (JFSQ) production data, accessed through FAOSTAT (https://www.fao.org/faostat/en/#data/FO). Country- and sector specific input coefficients are applied to these production data, converted to solid wood equivalents using country- and sector specific conversion factors (Mantau, 2010). For projection purposes, Gross Domestic Product (GDP) growth rates and GDP demand elasticities are applied to the JFSQ production data. GDP demand elasticities used in projections of the production of wood products are from the Global Forest Trade Model (Jonsson et al., 2015), whereas GDP projections are from the Shell corporation Energy Security Scenarios (https://www.shell.com/news-and-insights/scenarios/the-energy-security-scenarios.html). Domestic industrial by-products (solid and liquid), part of the secondary sources of woody biomass, are estimated from production data converted to solid wood equivalents using country and sector-specific output coefficients (Mantau, 2010). The 2019 Joint Wood Energy Enquiry (JWEE) (https://unece.org/forests/joint-wood-energy-enquiry) is the main data source as to the energy use of woody biomass, whereas the EU Reference Scenario 2020 (https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en) is the chief source used for country projections of the wood energy use.

For historic data, primary sources of woody biomass – removals (production) and trade of industrial roundwood and fuelwood – are from JFSQ, as are the trade of chips, particles and other residues (net imports constitute a part of secondary sources of biomass), again accessed through FAOSTAT. Data on the productive function of forests are available from Eurostat European forest accounts (https://ec.europa.eu/eurostat/web/forestry). Information as to the relation between wood removals and fellings are from Pilli et al. (2024). UN COMTRADE (https://comtradeplus.un.org/TradeFlow) is the database used for bilateral trade analysis.

Considerable uncertainties even in the midterm make scenario analysis the most appropriate approach for an outlook on the future use and availability of wood. Two scenarios are set up, one − Higher availability (HA) − with a lower future level of wood use and a higher level of import availability of roundwood, and the other − Lower availability (LA) − considering a higher level of wood use and lower level of import availability of roundwood, so as to make the scenarios as different as possible in a quantifiable sense, to best span the whole set of feasible scenarios.

The HA uses the GDP projections of the Shell corporation Energy Security Scenarios Archipelagos, where Global sentiment shifts away from managing emissions and towards energy security, the drive for energy security still includes the greater use of low-carbon technologies though. The rate of change of biomass and waste in gross available energy in the EU Reference Scenario 2020 are used for the projections of wood used for energy (heat and power) for EU member states. For Norway and Switzerland, projections are based on historic developments in JWEE data, while the rates of change used for UK projections of wood used for energy are the average of the French and German ones. The proportions of the different categories of wood used for energy (direct, indirect and unknown) are assumed to remain constant, as is the share of woody biomass in biomass and waste. Trade is assumed to remain unchanged from year 2019 values.

The LA uses the GDP projections of the Shell corporation Energy Security Scenarios Sky 2050, where the future it is aimed at achieving net-zero emissions by 2050. The rates of change of biomass and waste in gross available energy in the EU Reference Scenario 2020 are used for the projections of wood used for energy (heat and power) for EU member states, corrected for the raised binding renewable target for 2030 of a minimum of 42.5% of the revised Renewable Energy Directive EU/2023/2413 as compared to the 32% set in 2018 used in the EU Reference Scenario 2020. For Norway and Switzerland, projections are based on historic developments in JWEE data, using periods of higher usage, while the rates of change used for UK projections of wood used for energy are the average of the French and German ones for the LA. The proportions of the different categories of wood used for energy (direct, indirect and unknown) are assumed to remain constant, as is the share of woody biomass in biomass and waste. Trade in roundwood are year 2019 values minus year 2019 values of imports from the Russian Federation and the Belarus.

4. State of play in the use and supply of wood

In per capita terms, removals and consumption of fuelwood (FW) in the EU27 + the UK (EU28) outgrew[1] industrial roundwood (IRW) removals and consumption[2] as well as GDP in the period 2007 to 2019, with a particularly marked increase just after the adoption of the renewable energy directive in 2009 (Figure 1). This even as detailed analysis indicates that FW removals are underestimated. The region is more or less self-sufficient when it comes to FW, with limited trade.

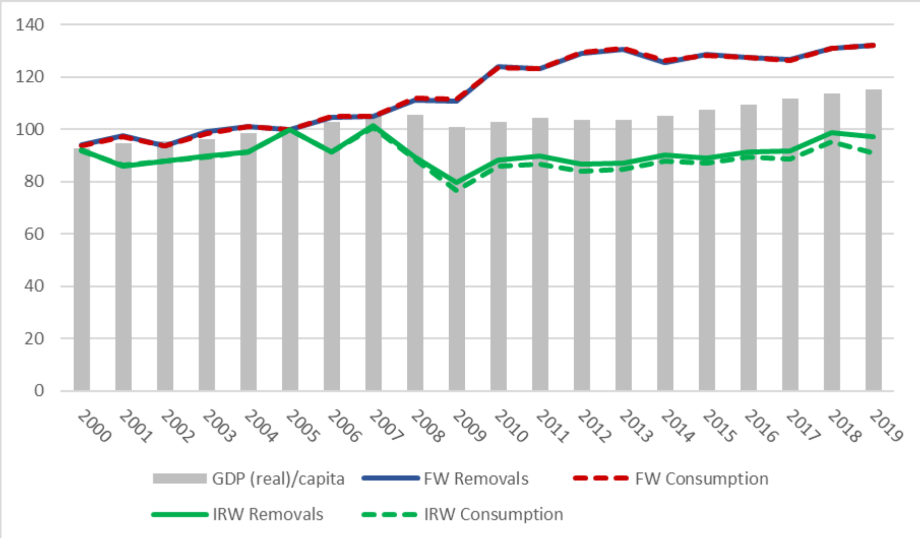

Figure 1. EU28 removals and consumption of industrial roundwood (IRW) and fuelwood (FW) per capita, and GDP per capita. Index 2005 = 100 (source: Camia et al., 2021).

The EU has traditionally been a net-importer of IRW. Before the financial crisis, imports ranged from 20 to 26 million m^3. Since then they have never exceeded 16.5 million m^3. In 2019 even minor net-exports were recorded, mostly spruce logs from salvage logging due to bark beetle infestations. The Russian Federation has been the single most important supplier of roundwood to the EU28; Finland has dominated EU imports of roundwood from the Russian Federation (Figure 2).

[1] The graph illustrates growth rates, not absolute values. Comparisons can only be made as to growth rates. Hence, the EU was actually a net-importer (consumption larger than removals) of IRW for all the years except 2019.

[2] Apparent consumption, i.e., production + imports -exports

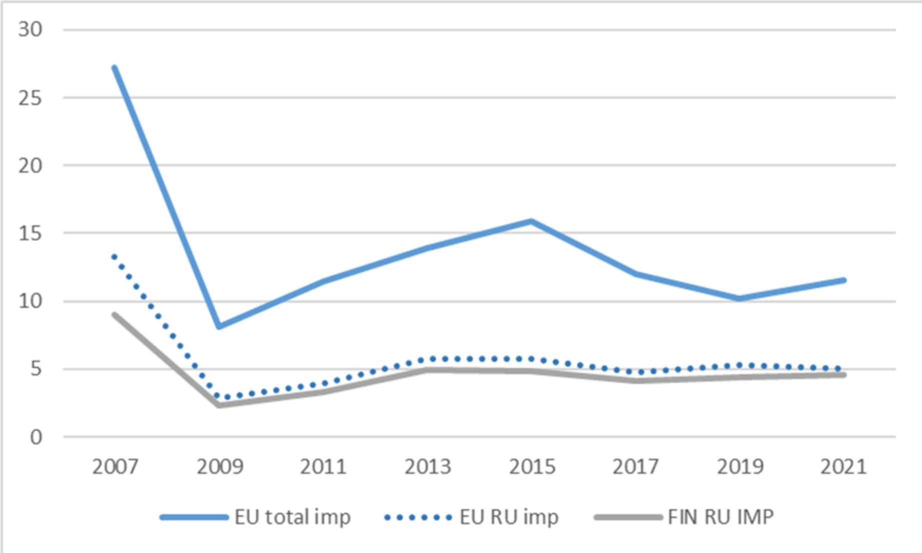

Figure 2. Imports of roundwood, million m³ (source: UN Comtrade, 2023)

Table 1 and Table 2 depicts WRB sheets for EU28 for the years 2009 and 2019 respectively. The overall use of woody biomass for energy in the EU28 increased by some 48%, or 159 million m^3, between 2009 and 2019, clearly reflecting the renewable energy directive, introduced in 2009. The overall use of woody biomass for material purposes increased by 25% only, or 102 million m^3, during the same period, notwithstanding that production levels were on a low in year 2009 due to the financial crisis. The share of material uses, including manufacturing of wood pellets, in total uses of woody biomass decreased from 55% to 51% (Figure 3 and Figure 4). Secondary woody biomass ("indirect wood") is the largest reported source for wood-based bioenergy, and its share increased from 46% to 52%. A noteworthy circumstance here is the strong increase in domestic production and net imports of wood pellets, the UK being the main wood pellets importer.

Table 1. Wood resource balances for EU28 for year 2009, 1 000 m³ solid wood equivalents (sources: European Commission, 2021).

	Sources	1 000 m³	1 000 m³	Uses	
PRIMARY	Industrial roundwood removals (conifer)	241 822	150 107	Sawmill industry (conifer)	MATERIAL
PRIMARY	Industrial roundwood removals (non-conifer)	63 326	16 507	Sawmill industry (non-conifer)	MATERIAL
PRIMARY	Fuel wood removals (conifer)	31 320	3 152	Veneer sheets industry	MATERIAL
PRIMARY	Fuel wood removals (non-conifer)	70 280	7 386	Plywood industry	MATERIAL
PRIMARY	Net-import industrial roundwood (conifer)	4 315	54 112	Particle board industry	MATERIAL
PRIMARY	Net-import industrial roundwood (non-conifer)	4 677	24 049	Fiberboard industry	MATERIAL
PRIMARY	Net-import fuel wood	518	23 845	Mechanical pulp industry	MATERIAL
PRIMARY	Bark	57 681	104 139	Chemical pulp industry	MATERIAL
SECONDARY	Sawmill residues	74 896	3 065	Semi-chemical pulp industry	MATERIAL
SECONDARY	Other industrial residues	9 800	3 446	Dissoving pulp industry	MATERIAL
SECONDARY	Wood pellets	19 043	19 043	Wood pellets industry	MATERIAL
SECONDARY	Black liquor	57 441	137 820	Direct wood	H&P
SECONDARY	Net-import wood chips and particles	4 027	149 687	Indirect wood	H&P
SECONDARY	Net-import other wood residues	4 727	41 245	Unknown wood	H&P
SECONDARY	Net-import wood pellets	-338			
SECONDARY	Post-consumer wood	31 952			
	Total sources	**675 487**	**737 603**	**Total uses**	
		62 116 **Unreported sources**			

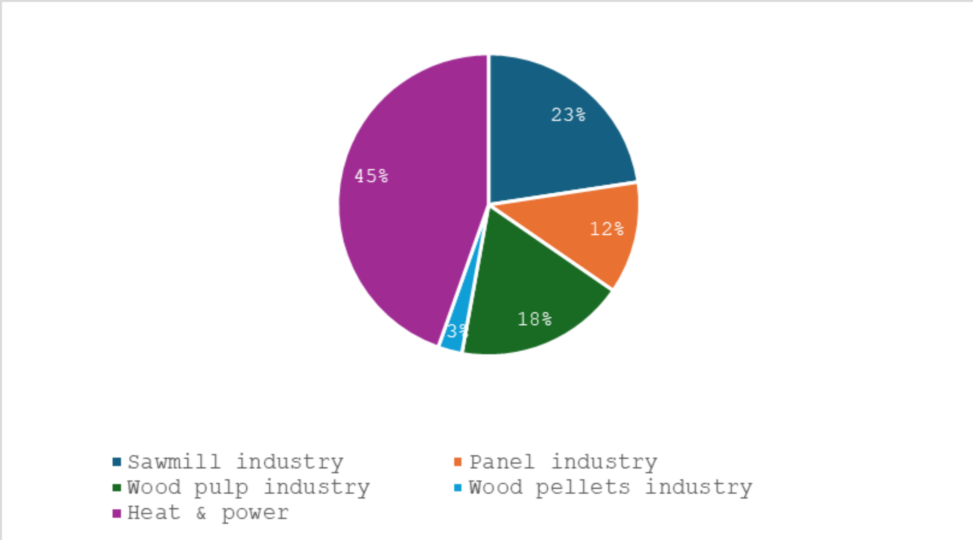

Figure 3. Wood uses by sector in the EU28 for year 2009, % (sources: European Commission, 2021).

Table 2. Wood resource balances for EU28 for year 2019, 1 000 m^3 solid wood equivalents (sources: European Commission, 2021 and own calculations).

	Sources	1 000 m^3		1 000 m^3	Uses	
PRIMARY	Industrial roundwood removals (conifer)	310 555		185 624	Sawmill industry (conifer)	MATERIAL
PRIMARY	Industrial roundwood removals (non-conifer)	82 085		18 838	Sawmill industry (non-conifer)	MATERIAL
PRIMARY	Fuel wood removals (conifer)	40 657		2 782	Veneer sheets industry	MATERIAL
PRIMARY	Fuel wood removals (non-conifer)	83 525		11 347	Plywood industry	MATERIAL
PRIMARY	Net-import industrial roundwood (conifer)	-3 703		58 145	Particle board industry	MATERIAL
PRIMARY	Net-import industrial roundwood (non-conifer)	5 144		31 760	Fiberboard industry	MATERIAL
PRIMARY	Net-import fuel wood	-59		19 880	Mechanical pulp industry	MATERIAL
PRIMARY	Bark	71 755		122 978	Chemical pulp industry	MATERIAL
SECONDARY	Sawmill residues	92 255		3 418	Semi-chemical pulp industry	MATERIAL
SECONDARY	Other industrial residues	12 403		11 236	Dissoving pulp industry	MATERIAL
SECONDARY	Wood pellets	45 272		45 272	Wood pellets industry	MATERIAL
SECONDARY	Black liquor	72 368		198 804	Direct wood	H&P
SECONDARY	Net-import wood chips and particles	9 636		253 540	Indirect wood	H&P
SECONDARY	Net-import other wood residues	3 339		34 920	Unknown wood	H&P
SECONDARY	Net-import wood pellets	22 138				
SECONDARY	Post-consumer wood	50 184				
	Total sources	**897 556**		**998 543**	**Total uses**	
		100 765				
		Unreported sources				

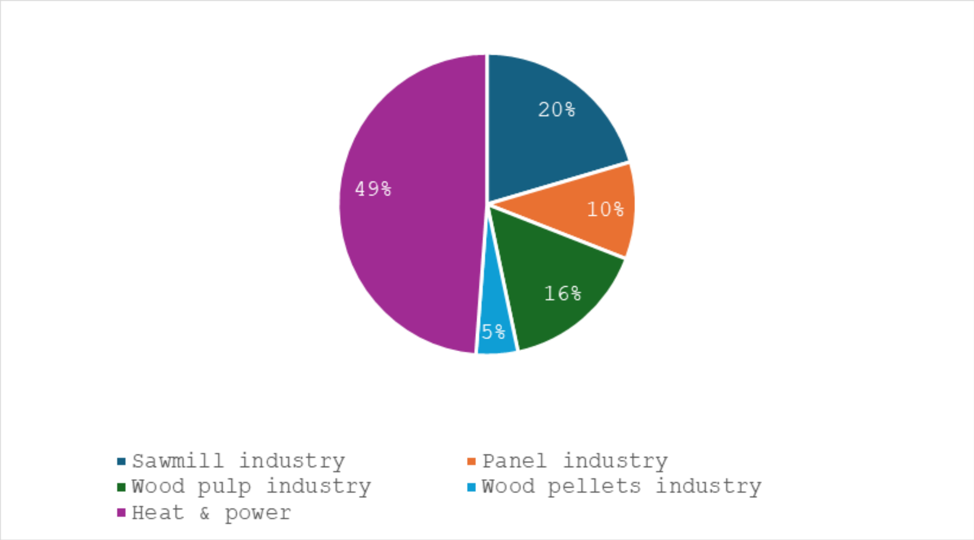

Figure 4. Wood uses by sector in the EU28 for year 2019, % (sources: European Commission, 2021 and own calculations).

Total domestic wood removals[3] within the EU28 increased from 487 million m^3 under bark (ub) in 2009 to 668 million m^3 ub in 2019, a 37% increase. Roundwood used for manufacturing of sawnwood, wood-based panels and wood pulp accounted for the major part, 68% in 2009 and 66% in 2019. A basic indicator of the sustainability of wood supply is the comparison of net annual increment (NAI) of forests and fellings, with a fellings to increment (F/I) ratio lower than one indicating an increasing growing stock. For the period in question, the level of fellings[4] was lower than NAI (Figure 5). However, data indicate that fellings are growing faster than net annual increment. As a matter of fact, net annual increment decreased over the period, and NAI and fellings are seemingly converging, with the F/I ratio increasing from 0.60 to 0.86 over this ten-year period. This obviously has climate ramifications, as fellings growing faster than NAI entails a shrinking forest carbon sink.

[3]The sum of indirect wood for energy and estimated roundwood use of wood for material (based on production data, solid wood equivalents and input coefficients) minus total net imports of roundwood.

[4] Removals + bark + logging residues

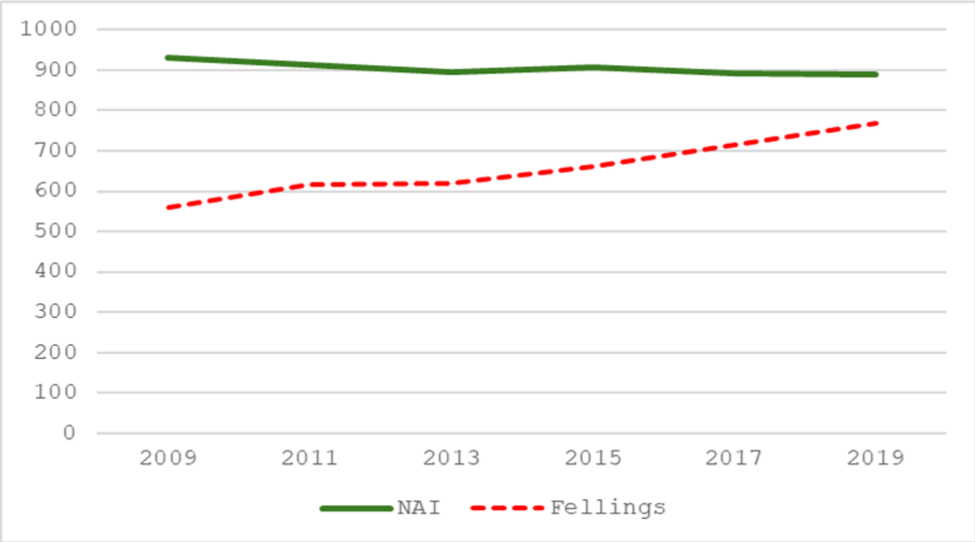

Figure 5. EU28 net annual increment and fellings, million m³ over bark (sources: fellings are calculated from removals using Pilli et al. (2024) and a conversion factor of ub to ob volume of 0.88. NAI data are from Eurostat European forest accounts, https://ec.europa.eu/eurostat/web/forestry).

Looking more in detail, table 3 depicts the WRB for region North – comprising Finland, Norway, Sweden and the Baltic countries – for year 2019. This is a relatively sparsely populated region, well endowed with forest resources and forest industries. Notwithstanding being forest rich, the region is a net importer of industrial roundwood and forest industry by-products, but a net exporter of wood pellets. Trade in fuelwood is insignificant. The WRB is well balanced, the "surplus" of sources of some 600-thousand m^3 amounts to 0.2% of total wood uses. The importance of the wood pulp industry in the forest-based industry is striking. This industry is the largest material user of wood, followed by sawmilling, while the wood-based panel industry is rather small in comparison (Figure 6).

Wood-based manufacturing in all account for almost two thirds of total wood uses. Wood-based manufacturing in the region is mainly based on primary wood sources, estimated at some 167 million m^3, or 83%, while secondary wood sources account for around 17% (Figure 7). This circumstance is a reflection of the region being rich in forest resources and sparsely populated. Coniferous species dominate, accounting for 83% of the IRW used. Secondary woody biomass ("indirect wood") is the largest reported source of wood-based bioenergy, accounting for 69%, or 80 million m^3 (Figure 8), of which black liquor account for more than half (Table 3). Wood of unknown origin account for six percent of energy wood uses. Energy uses account for only 15% of total primary wood use.

Table 3. Wood resource balances for region North for year 2019, 1 000 m^3 solid wood equivalents (sources: own calculations).

	Sources	1 000 m^3	1 000 m^3	Uses	
PRIMARY	Industrial roundwood removals (conifer)	135 147	76 261	Sawmill industry (conifer)	MATERIAL
	Industrial roundwood removals (non-conifer)	24 444	2 627	Sawmill industry (non-conifer)	
	Fuel wood removals (conifer)	9 237	658	Veneer sheets industry	
	Fuel wood removals (non-conifer)	14 303	4 062	Plywood industry	
	Net-import industrial roundwood (conifer)	343	4 267	Particle board industry	
	Net-import industrial roundwood (non-conifer)	3 275	599	Fiberboard industry	
	Net-import fuel wood	-521	15 776	Mechanical pulp industry	
	Bark	25 582	73 535	Chemical pulp industry	
SECONDARY	Sawmill residues	39 517	2 628	Semi-chemical pulp industry	
	Other industrial residues	3 003	6 133	Dissoving pulp industry	
	Wood pellets	15 288	15 288	Wood pellets industry	
	Black liquor	43 060	28 465	Direct wood	H&P
	Net-import wood chips and particles	4 662	80 131	Indirect wood	
	Net-import other wood residues	749	7 415	Unknown wood	
	Net-import wood pellets	-6 923			
	Post-consumer wood	7 279			
	Total sources	**318 446**	**317 846**	**Total uses**	
		601 **Unreported uses**			

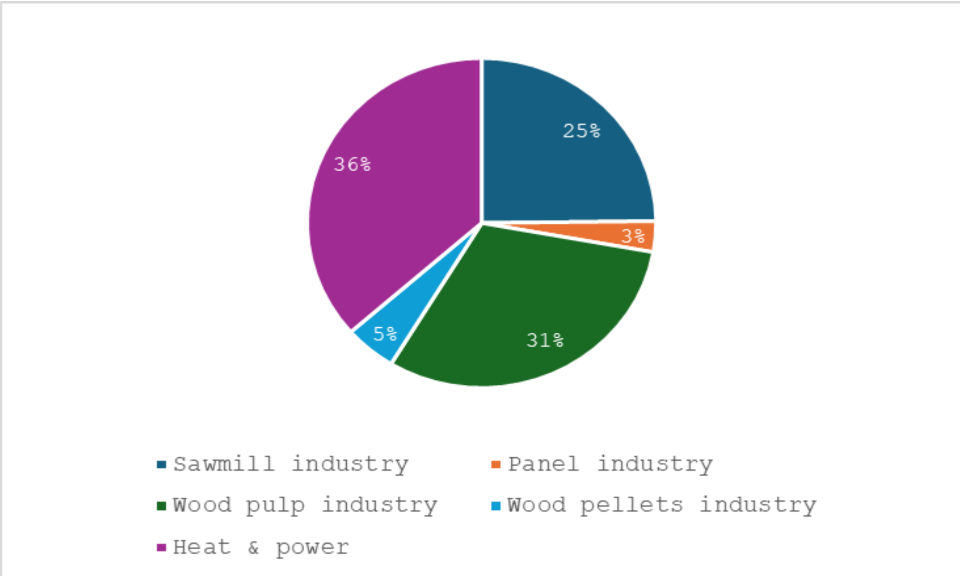

Figure 6. Wood uses by sector in year 2019 in region North, % (sources: European Commission, 2021 and own calculations).

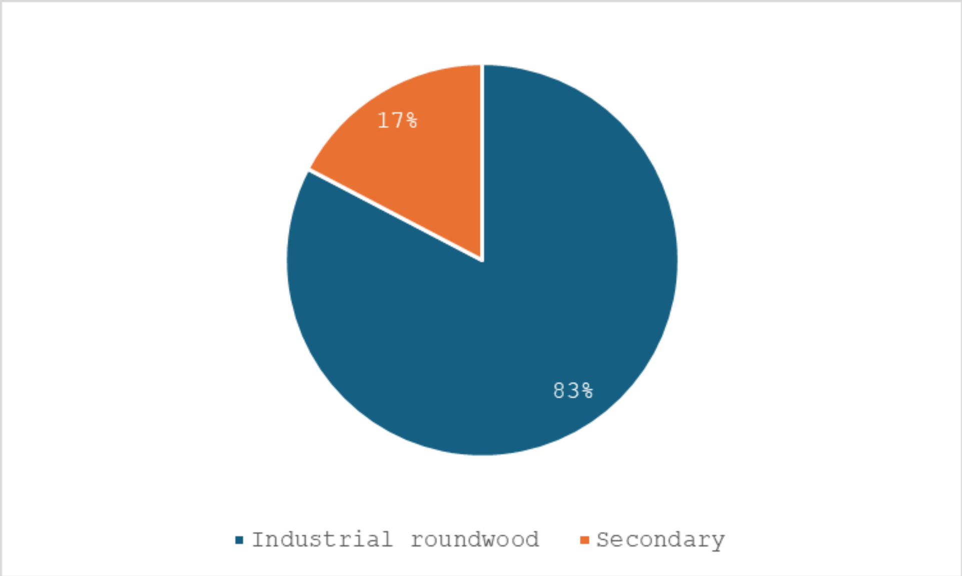

Figure 7. Type of biomass used for material in year 2019 in region North, % (sources: European Commission, 2021 and own calculations).

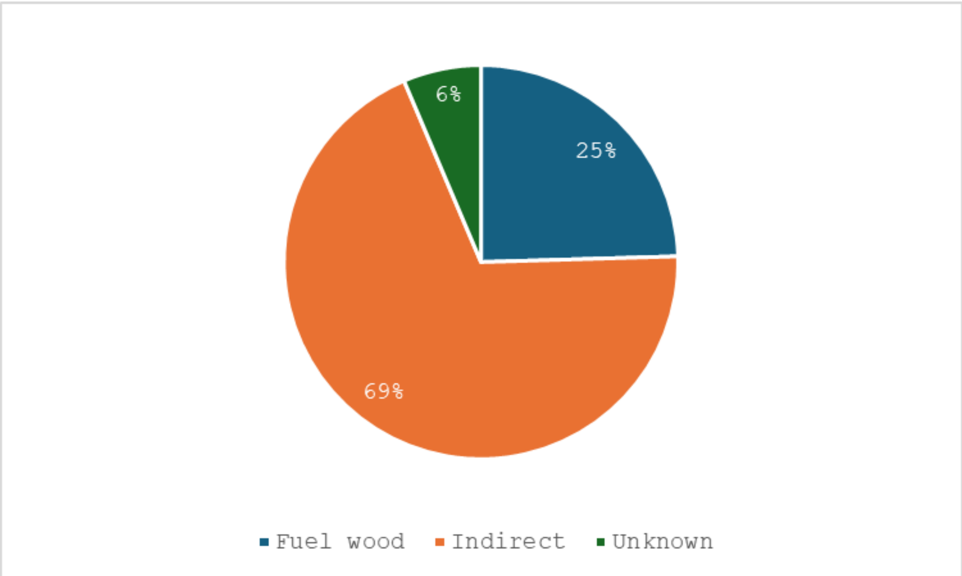

Figure 8. Type of biomass used for energy in year 2019 in region North, % (sources: European Commission, 2021 and own calculations).

Table 4 depicts the WRB for region West - comprising Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, Switzerland and the UK – for year 2019. This is a populous, densely populated region, less endowed with forests in terms of forest area per capita than region North (see, e.g., Forest Europe, 2020). This region is the largest user of woody biomass of the four analyzed here. The solid wood products industry is dominating forest-based industry use of wood, with sawmilling being the largest material user of wood, followed by the wood-based panel industry, using half the amount of wood as compared to the sawmill industry (Figure 9). In all, energy uses account for some 54% of total uses of wood (Ibid.), and 39% of primary wood use. Wood-based manufacturing in the region uses a larger proportion of secondary wood sources than region North, 26% as compared to 17% (Figure 10), including a substantial amount of recovered post-consumer wood, 8.6million m^3 (Table 4), a reflection of the region being more densely populated and relatively less endowed with forests, making re-use of woody biomass both more economically feasible and more of a necessity. Again, coniferous species dominate IRW use, accounting for 84% of the IRW used. Secondary woody biomass ("indirect wood") is again the largest reported source of wood-based bioenergy, accounting for 59%, of the wood used for energy (Figure 11).

Noteworthy is the circumstance that region West used almost twice the amount of wood for energy compared to region North, but a smaller amount of wood in forest-based industries (Tables 3 and 4). Turning to the sources side of the WRB, the region is a net importer of industrial roundwood and forest industry by-products, and a major net importer of wood pellets. The UK accounted for 74% of these wood pellets net imports in 2019. Again, trade in fuelwood is insignificant. Notable is the circumstance that, unlike region North, in region West total sources fall significantly short of total uses, by some 36 million m^3. This is mostly due to under-reported roundwood. Hence, the estimated amount of primary wood required for material and energy uses, 215 million m^3, exceed recorded supply (removals + net-imports) of roundwood (IRW and FW) with 29 million m3, of which 71%, 21 million m^3, accrue to energy uses. As several studies have indicated a strong tendency toward underestimation of removals and fellings in official statistics, see e.g., Pilli et al. (2015) and Jochem et al. (2015), it is reasonable to allocate the 29 million m^3 to roundwood removals. Corrected removals would then amount to 207 million m^3.

Table 4. Wood resource balances for region West for year 2019, 1 000 m^3 solid wood equivalents (sources: own calculations).

	Sources	1 000 m^3	1 000 m^3	Uses	
PRIMARY	Industrial roundwood removals (conifer)	96 677	80 276	Sawmill industry (conifer)	MATERIAL
PRIMARY	Industrial roundwood removals (non-conifer)	18 013	5 807	Sawmill industry (non-conifer)	MATERIAL
PRIMARY	Fuel wood removals (conifer)	20 426	846	Veneer sheets industry	MATERIAL
PRIMARY	Fuel wood removals (non-conifer)	42 890	1 367	Plywood industry	MATERIAL
PRIMARY	Net-import industrial roundwood (conifer)	8 759	26 208	Particle board industry	MATERIAL
PRIMARY	Net-import industrial roundwood (non-conifer)	-871	15 824	Fiberboard industry	MATERIAL
PRIMARY	Net-import fuel wood	390	3 839	Mechanical pulp industry	MATERIAL
PRIMARY	Bark	25 963	21 493	Chemical pulp industry	MATERIAL
SECONDARY	Sawmill residues	35 446	0	Semi-chemical pulp industry	MATERIAL
SECONDARY	Other industrial residues	3 331	3 117	Dissoving pulp industry	MATERIAL
SECONDARY	Wood pellets	17 949	17 949	Wood pellets industry	MATERIAL
SECONDARY	Black liquor	13 130	84 463	Direct wood	H&P
SECONDARY	Net-import wood chips and particles	783	125 304	Indirect wood	H&P
SECONDARY	Net-import other wood residues	3 053	905	Unknown wood	H&P
SECONDARY	Net-import wood pellets	27 931			
SECONDARY	Post-consumer wood	37 187			
	Total sources	**351 056**	**387 398**	**Total uses**	
		-36 342			
		Unreported sources			

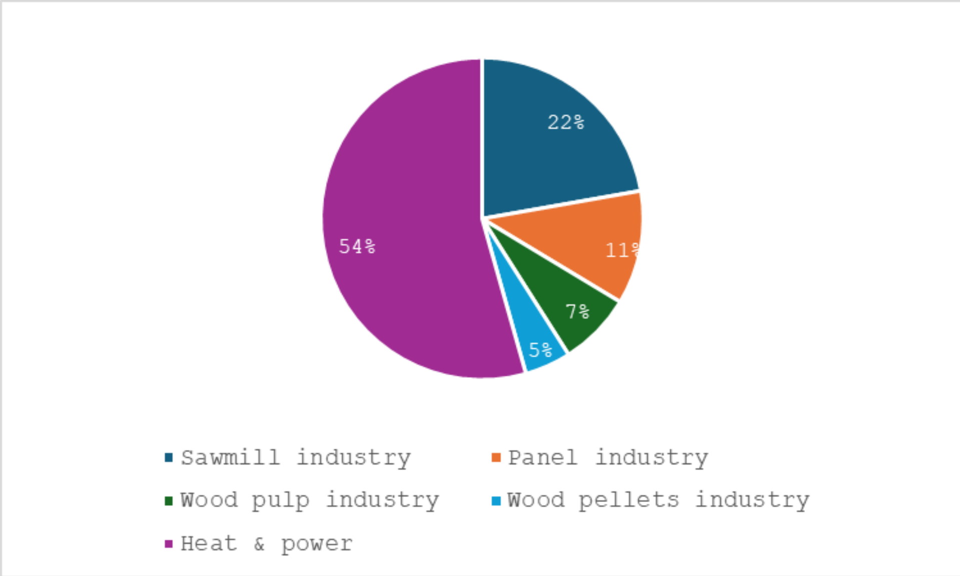

Figure 9. Wood uses by sector in year 2019 in region West, % (sources: European Commission, 2021 and own calculations).

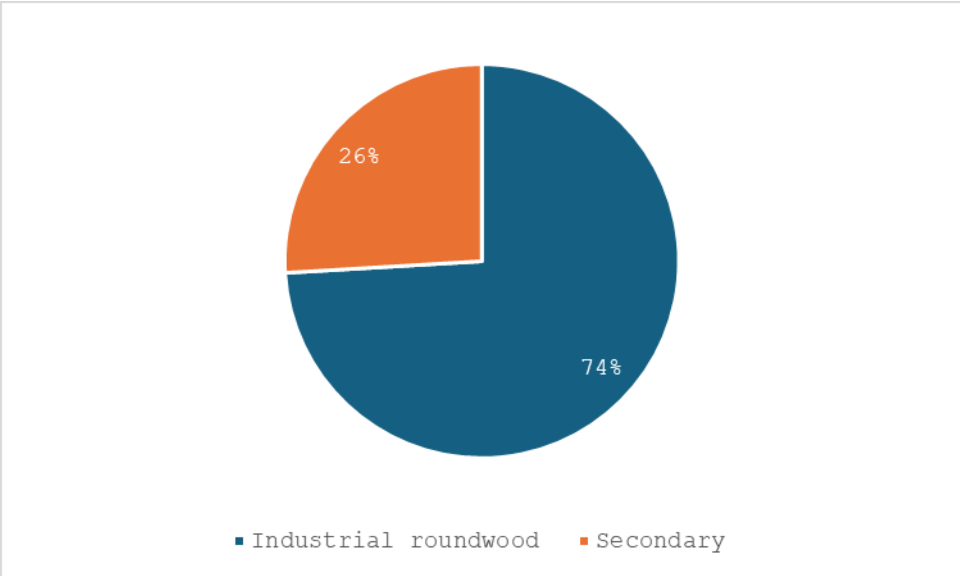

Figure 10. Type of biomass used for material in year 2019 in region West, % (sources: European Commission, 2021 and own calculations).

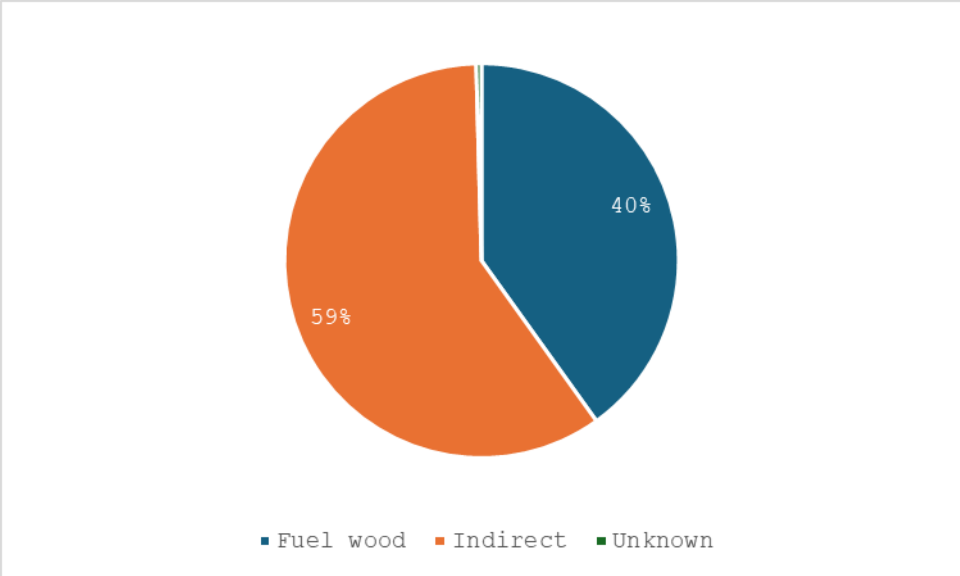

Figure 11. Type of biomass used for energy in year 2019 in region West, % (sources: European Commission, 2021 and own calculations).

Table 5 presents the WRB for region East – Bulgaria, Croatia, Czechia, Hungary, Poland, Romania, Slovakia and Slovenia – for year 2019. This is a region less populous, more endowed with forests in terms of forest area per capita than region West, though less so than Region North (see, e.g., Forest Europe, 2020). Region East registered notable net exports of industrial roundwood and wood pellets in 2019, while it was a net importer of forest industry by-products. Again, the same as is the case in region West, total sources fall short of total uses to a significant degree, some 33 million m^3. Again, as in region West, the solid wood products industry is dominating industry use of wood, sawmilling being the largest material user of wood, closely followed by the wood-based panel industry (Figure 12). Coniferous species dominate in the IRW use, though not to the same extent as is the case in regions North and West, accounting for a share of 74%. Wood-based manufacturing in the region is based on secondary wood sources to the same degree, in relative terms, as region West, 26% (Figure 13), or 25 million m^3.

Unlike region North and region West, primary woody biomass ("direct wood") is the largest reported source of wood-based bioenergy, 53% (Figure 14). A peculiarity is the high proportion, 30%, of wood of unknown/unspecified origin in the recorded energy use of wood (Ibid.). Energy uses account for some 50% of total uses of wood (Figure 12), and 42% of primary wood use. The estimated amount of primary wood required for material and energy uses, about 120 million m^3, exceed recorded supply (removals + net-imports of IRW and FW) with some 15 million m^3, which is completely due to energy uses. As a matter of fact, the recorded IRW supply exceeds estimated material roundwood needs by some 9.7 million m^3, implying that this amount of IRW was actually used for energy. Allocating the 15 million m^3 to roundwood removals results in corrected removals of 137 million m^3.

Table 5. Wood resource balances for region East for year 2019, 1 000 m^3 solid wood equivalents (sources: own calculations).

	Sources	1 000 m^3		1 000 m^3	Uses	
PRIMARY	Industrial roundwood removals (conifer)	72 626		29 254	Sawmill industry (conifer)	MATERIAL
	Industrial roundwood removals (non-conifer)	23 822		8 233	Sawmill industry (non-conifer)	
	Fuel wood removals (conifer)	10 197		743	Veneer sheets industry	
	Fuel wood removals (non-conifer)	15 750		3 751	Plywood industry	
	Net-import industrial roundwood (conifer)	-16 531		19 608	Particle board industry	
	Net-import industrial roundwood (non-conifer)	-180		10 803	Fiberboard industry	
	Net-import fuel wood	-932		1 209	Mechanical pulp industry	
	Bark	14 490		10 589	Chemical pulp industry	
SECONDARY	Sawmill residues	16 708		823	Semi-chemical pulp industry	
	Other industrial residues	3 968		1 956	Dissoving pulp industry	
	Wood pellets	7 761		7 761	Wood pellets industry	
	Black liquor	6 749		49 752	Direct wood	H&P
	Net-import wood chips and particles	1 753		15 663	Indirect wood	
	Net-import other wood residues	-565		27 672	Unknown wood	
	Net-import wood pellets	-2 872				
	Post-consumer wood	2 273				
	Total sources	**155 017**		**187 817**	**Total uses**	
			-32 800 **Unreported sources**			

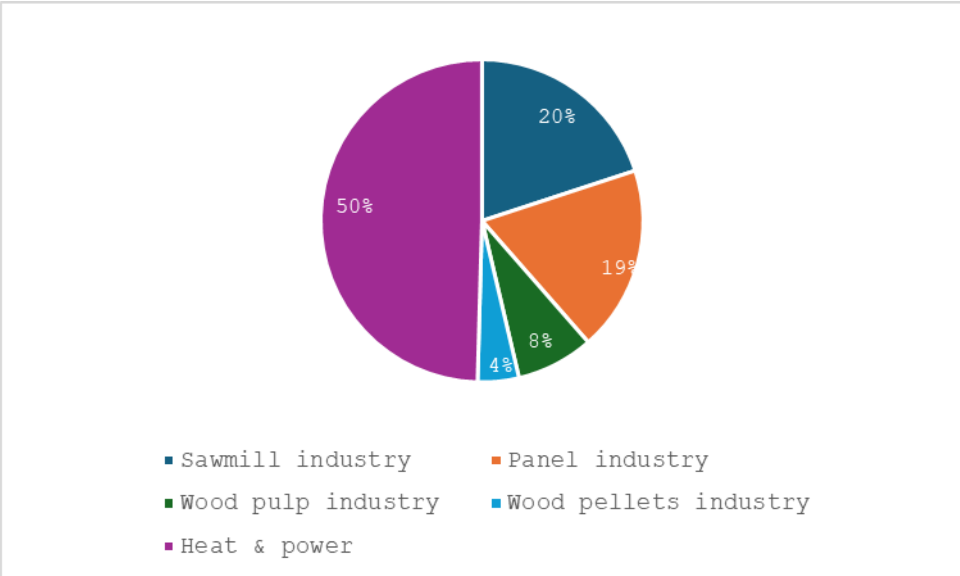

Figure 12. Wood uses by sector in year 2019 in region East, % (sources: European Commission, 2021 and own calculations).

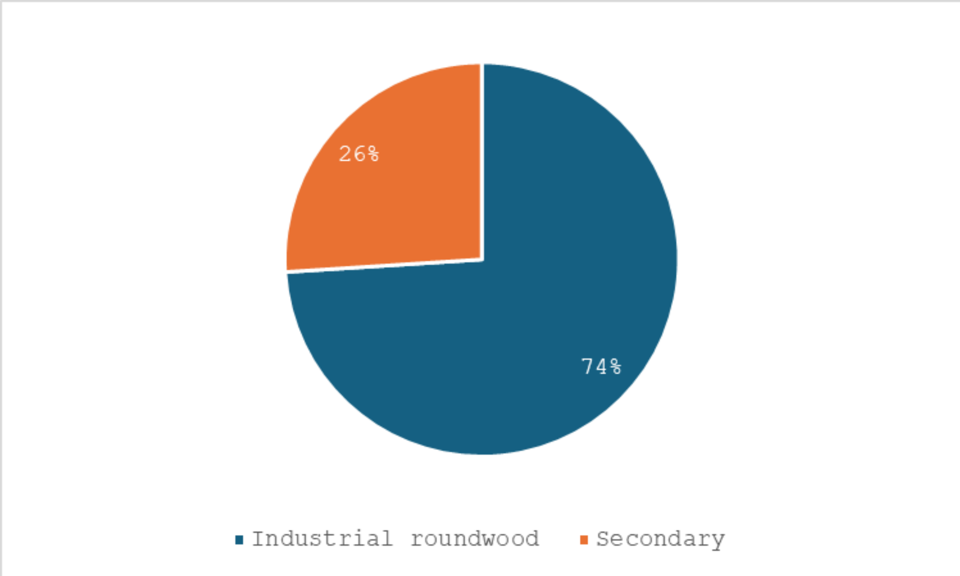

Figure 13. Type of biomass used for material in year 2019 in region East, % (sources: European Commission, 2021 and own calculations).

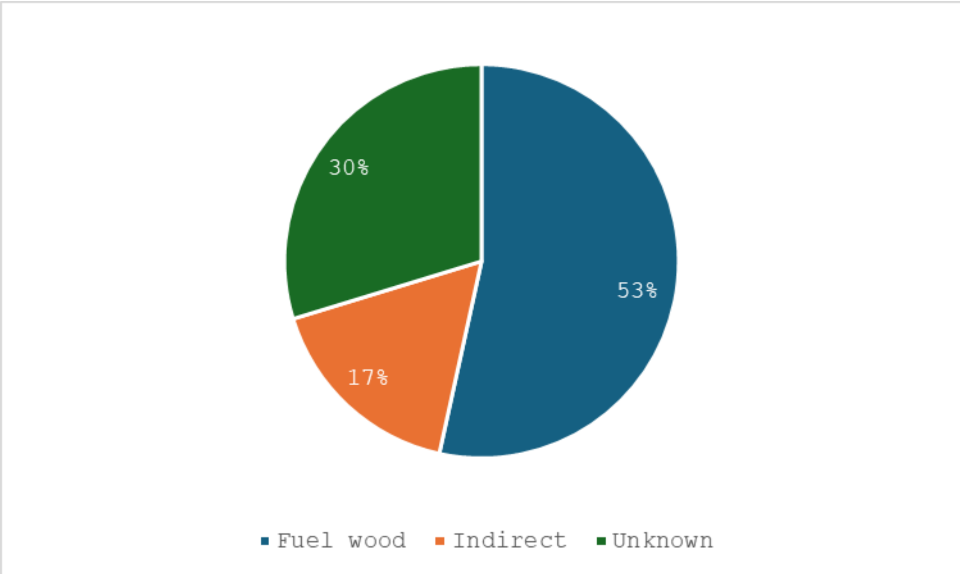

Figure 14. Type of biomass used for energy in year 2019 in region East, % (sources: European Commission, 2021 and own calculations).

Table 6 presents the WRB for region South – Cyprus, Greece, Italy, Malta, Portugal and Spain – for year 2019. This region, quite heterogeneous in terms of forest endowment and the use of wood, uses the smallest amount of wood overall. The region is a net importer of all types of wood assortments. Again, the same as is the case in regions West and East, total sources fall short of total uses to a significant degree, about 32 million m^3, the largest gap in relative terms. The wood pulp industry is the largest industrial user of wood, followed by the panel industry (Figure 15). Interestingly, sawmilling is the smallest in terms of wood use. Energy uses account for some 60% of total uses of wood (Ibid.). Wood-based manufacturing in the region is to a considerable degree based on secondary wood sources, 32% or some 16 million m^3 (Figure 16). IRW use in this region is more evenly distributed in tree species sense, non-coniferous species accounting for 43%.

The same as region East, primary woody biomass is the largest reported source of wood-based bioenergy, 53% (Figure 17). The estimated amount of primary wood required for material and energy uses, about 75 million m^3, exceed recorded supply with some 21 million m^3, a gap entirely due to energy uses as recorded IRW supply actually exceeds estimated material roundwood needs by some 3.8 million m^3. Region South is the only region where energy uses of primary wood dominate, accounting for 54%. Corrected removals of roundwood are about 71 million m^3.

Table 6. Wood resource balances for region South for year 2019, 1 000 m^3 solid wood equivalents (sources: own calculations).

	Sources	1 000 m^3	1 000 m^3	Uses	
PRIMARY	Industrial roundwood removals (conifer)	19 113	6 915	Sawmill industry (conifer)	MATERIAL
PRIMARY	Industrial roundwood removals (non-conifer)	16 490	2 262	Sawmill industry (non-conifer)	MATERIAL
PRIMARY	Fuel wood removals (conifer)	2 085	535	Veneer sheets industry	MATERIAL
PRIMARY	Fuel wood removals (non-conifer)	12 567	2 185	Plywood industry	MATERIAL
PRIMARY	Net-import industrial roundwood (conifer)	284	9 061	Particle board industry	MATERIAL
PRIMARY	Net-import industrial roundwood (non-conifer)	2 605	5 094	Fiberboard industry	MATERIAL
PRIMARY	Net-import fuel wood	1 152	1 220	Mechanical pulp industry	MATERIAL
PRIMARY	Bark	7 568	17 361	Chemical pulp industry	MATERIAL
SECONDARY	Sawmill residues	4 027	211	Semi-chemical pulp industry	MATERIAL
SECONDARY	Other industrial residues	2 189	910	Dissoving pulp industry	MATERIAL
SECONDARY	Wood pellets	5 012	5 012	Wood pellets industry	MATERIAL
SECONDARY	Black liquor	9 997	40 185	Direct wood	H&P
SECONDARY	Net-import wood chips and particles	2 468	35 637	Indirect wood	H&P
SECONDARY	Net-import other wood residues	370	0	Unknown wood	H&P
SECONDARY	Net-import wood pellets	4 317			
SECONDARY	Post-consumer wood	4 122			
	Total sources	94 367	126 591	Total uses	
		32 225 Unreported sources			

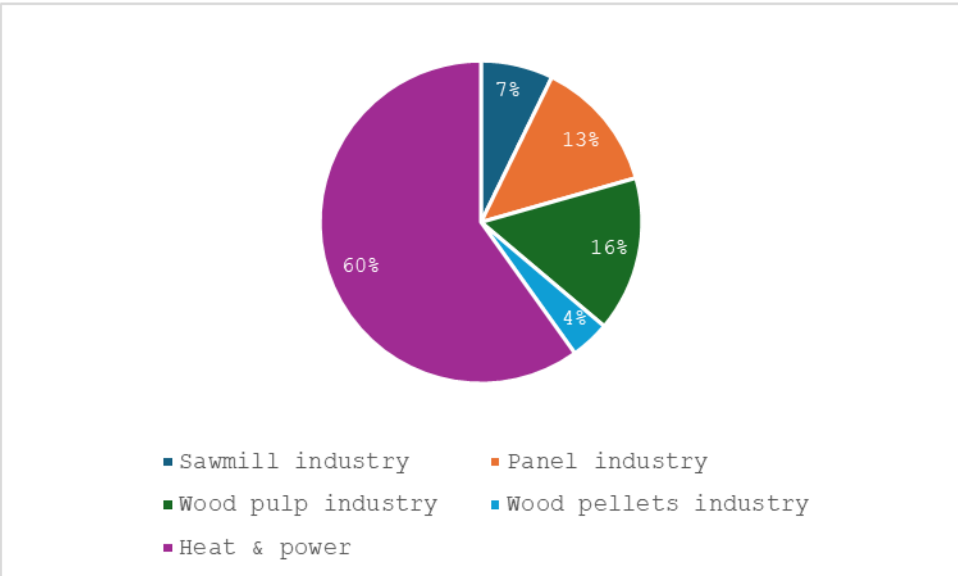

Figure 15. Wood uses by sector in year 2019 in region South, % (sources: European Commission, 2021 and own calculations).

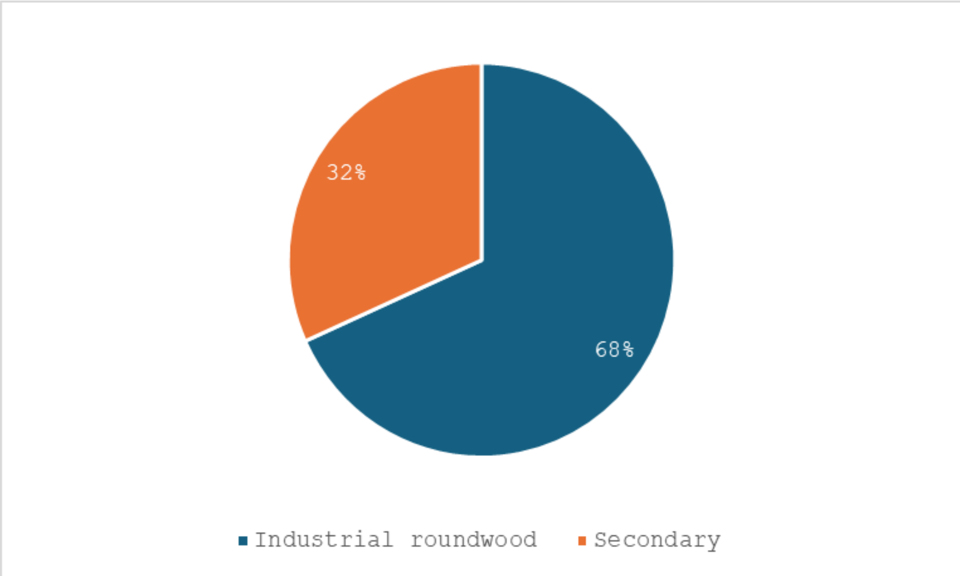

Figure 16. Type of biomass used for material in year 2019 in region South, % (sources: European Commission, 2021 and own calculations).

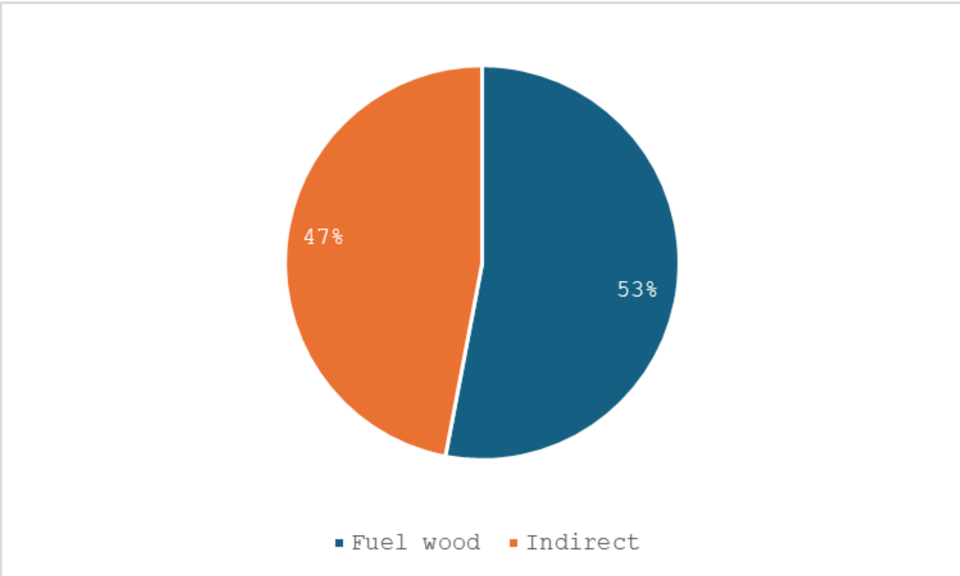

Figure 17. Type of biomass used for energy in year 2019 in region South, % (sources: European Commission, 2021 and own calculations).

Table 7 summarizes fellings[5] and increment data for the four regions under study and provides estimates of the fellings to increment ratio for year 2019. Seemingly, all regions fulfilled the basic sustainability requirement of F/I ratios smaller than one, implying increasing growing stocks. However, the margins are small, in particular region West have little room for increasing fellings. No apparent trend in NAI over the period is discernible in any of the regions (Figure 18).

[5] Removals + bark + logging residues

Table 7. Net annual increment and fellings, million m³ over bark, fellings to increment ratios (sources: fellings are calculated from removals using Pilli et al, 2024 and a conversion factor of ub to ob volume of 0.88. NAI data are from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

	North	West	East	South
NAI	317	281	219	105
Fellings	258	267	184	89
F/I ratio	0.81	0.95	0.84	0.85

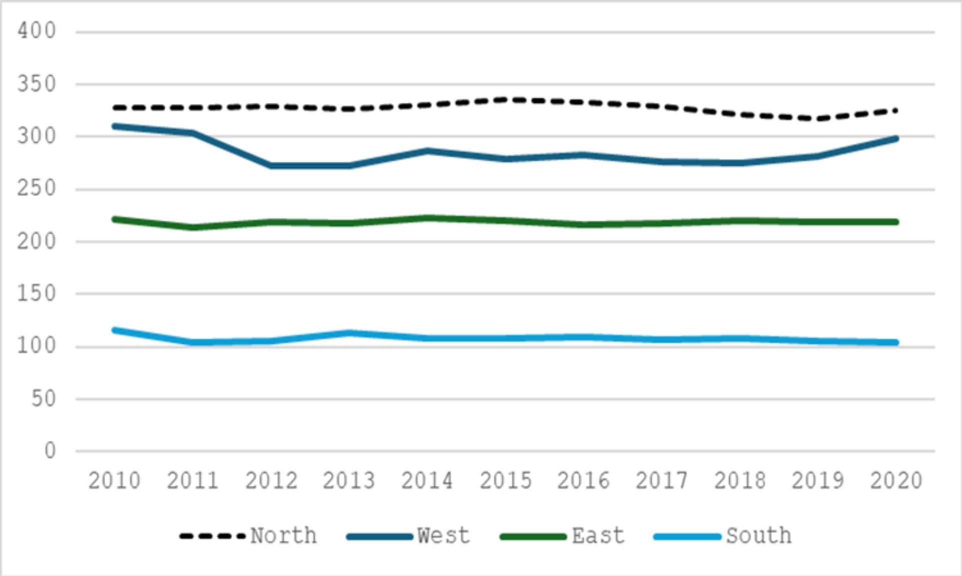

Figure 18. Net annual increment, million m³ (source: Eurostat European forest accounts, https://ec.europa.eu/eurostat/web/forestry)

5. Drivers of change

To assess potential future developments in the use and supply of wood, an understanding of how the factors driving change are likely to evolve. Factors frequently cited include socio-economic developments, policy instruments, in particular those linked to climate change, and geopolitical developments (Jonsson et al., 2011). These drivers partly work over different time scales, as policy instruments, economic growth and geopolitical developments have rather immediate implications, while demographic developments have more of medium and longer-term impacts.

5.1 Policy

Policies aimed at mitigating climate change affect both the use and supply of wood. As regards the former, the most pertinent policy driver is certainly the renewable energy directive (RED), aiming at reducing emissions through fossil fuel substitution. The mandatory requirements and the zero carbon-rating of biomass combustion − meaning there are strong incentives to use biomass − have already significantly increased the use of wood for energy, as earlier discussed. First introduced in 2009, the RED established a target of a 20% share of renewables in EU energy consumption by 2020. The year 2018 revision set a target of 32% renewables in EU energy consumption by 2030. The 2023 revision, *Renewable Energy Directive EU/2023/2413*, raises the EU's binding renewable target for 2030 to a minimum of 42.5%, almost doubling the existing year 2022 share of renewable energy in the EU, 23% (European Commission, 2023a).

Conversely, the Land-use, land-use change and forestry (LULUCF) regulation aim to mitigate climate change by boosting green house (GHG) removals in the EU, which means increasing natural carbon sinks. The LULUCF Regulation was revised in 2023 for the period up to 2030. For the first time, the revised LULUCF regulation has a separate land-based net carbon removals target of 310 million tonnes of CO_2 equivalent by 2030 (see Figure 19). This EU-wide target is to be implemented through ambitious, binding, net removal national targets for the LULUCF sector (European Commission, 2023b). As is apparent from figure 19, the overall LULUCF sector is actually moving away from the 2030 target, the result of a decreasing forest sink[6]. In addition to the LULUCF regulation, the EU

[6] Net sink is shown below the X axis, as it is conventionally denoted with a negative number in Green House Gas inventories (GHGI), while net source is denoted with a positive number

biodiversity strategy (European Commission, 2020) could also lead to reduced fellings in Europe, as projected by Schier et al. (2022).

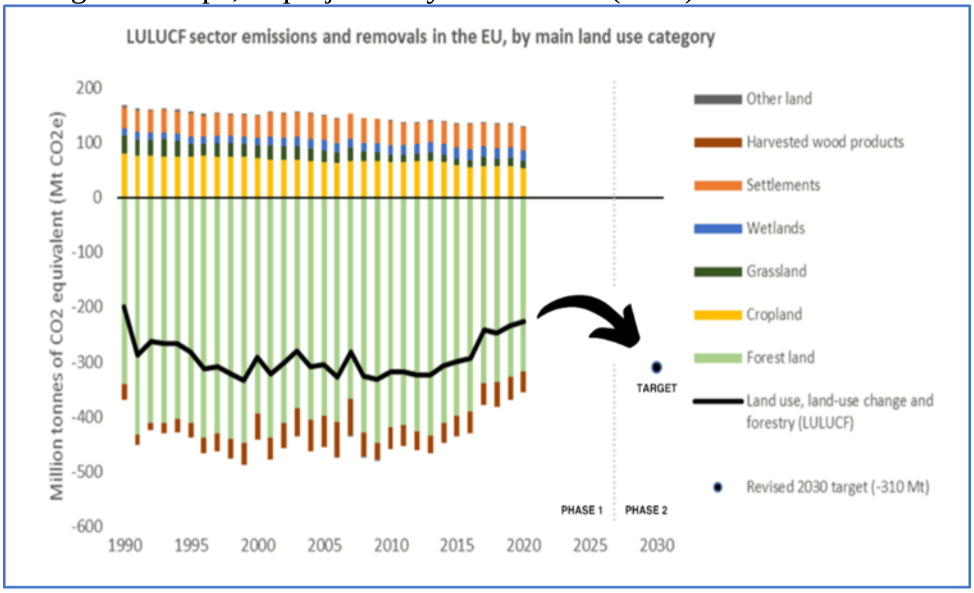

Figure 19. LULUCF sector emissions and removals in the EU by main land-use category, million tonnes of CO_2 equivalent (source: European Commission, 2023b)

5.2 Socio-economic drivers

Economic growth is associated with growing demand for products and services, including wood-based ditto. According to neoclassical growth theory, economic growth is driven by growth in population (labor), by capital and technological change (Solow, 1956). Developed economies (G7 countries – Canada, France, Germany, Italy, Japan, United Kingdom- and United States) accounted for most of global GDP until 2000. However, more rapid growth in developing economies is tipping the balance, with BRICS (Brazil, Russian Federation, India, China, South Africa) recently overtaking the G7 (Figure 20). Hence, the global demand for forest products is expected to continue to mainly grow in Brazil, China, India and other developing or transitioning countries. The current rate of economic growth in Europe is much lower than in developing countries, partly as a consequence of stagnating population growth, and it is predicted to slow further in the future (Egger et al., 2024).

In the immediate and shorter term, economic development at global and EU level is very much affected by events related to the crises triggered by the Ukraine war. Sanctions and other disruptions to trade have exacerbated inflation – mainly through exorbitant energy and food prices – and adversely affected economic growth (Egger et al., 2024). GDP projections by the Energy Security Scenarios of the Shell corporation (https://www.shell.com/news-and-insights/scenarios/the-energy-security-scenarios.html) attempt to factor in the effects of the Ukraine war, with European growth rates in the period 2019 to 2040 being rather modest, ranging from 0.9% to 2.0%.

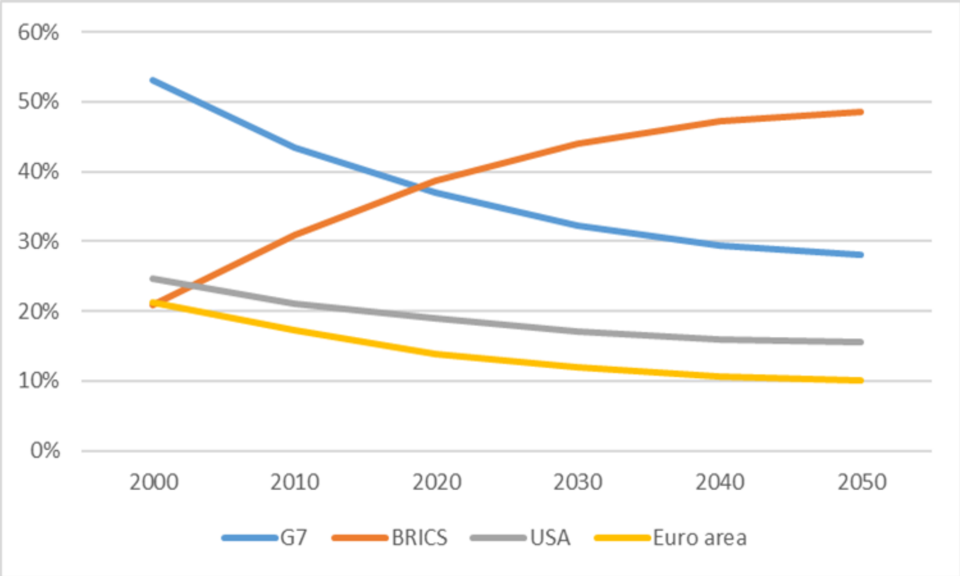

Figure 20. Share of global gross domestic product (GDP), percentages (source: OECD, 2022)

Demographics affect forest product markets in several ways. First of all (as already mentioned), population increase can result in economic growth and increased demand, and vice versa. A sizeable population also provides a large domestic market. Europe's total population peaked at 746 million in 2020, and is projected to decrease to 703 million by 2050 (Figure 21). This projected fall in population − most pronounced in Southern and Eastern Europe – is one crucial factor behind the expected slow economic growth in Europe. To make things worse, there is a pronounced trend of ageing of the European population, with the old age dependency ratio projected to increase significantly (Figure 22). Stagnating population growth, ageing and a pronounced urbanization entail a decreasing − in particular rural − labor force, affecting forest management as well as wood processing, thus posing serious challenges for the provision of wood-based products in Europe. Further, a growing proportion of non-traditional, urban, passive or absentee private forest owners in Europe − mirroring the general demographic trends in terms of ageing and urbanization of the population − pose a further challenge for wood supply (Egger et al., 2024).

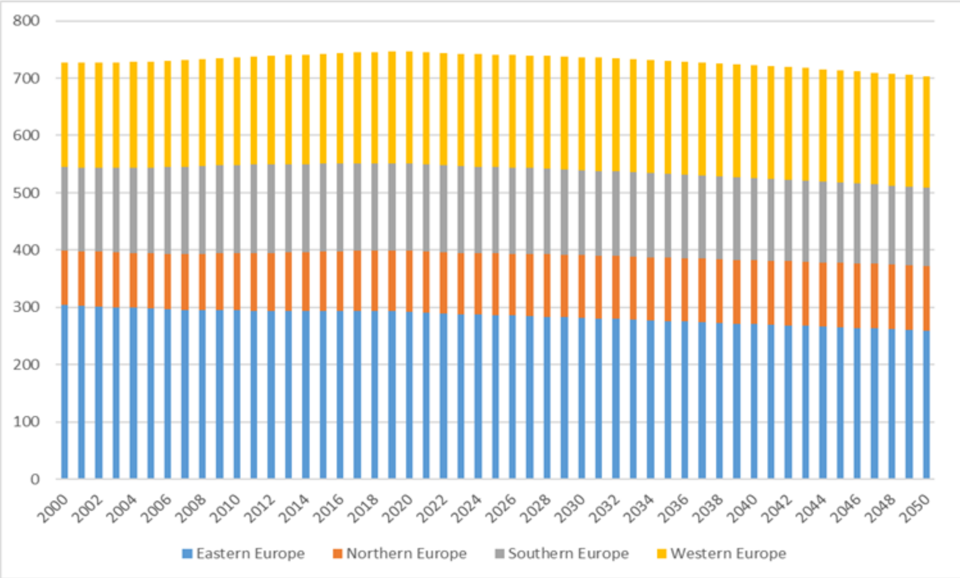

Figure 21. Total population, million individuals (source: United Nations, 2023)

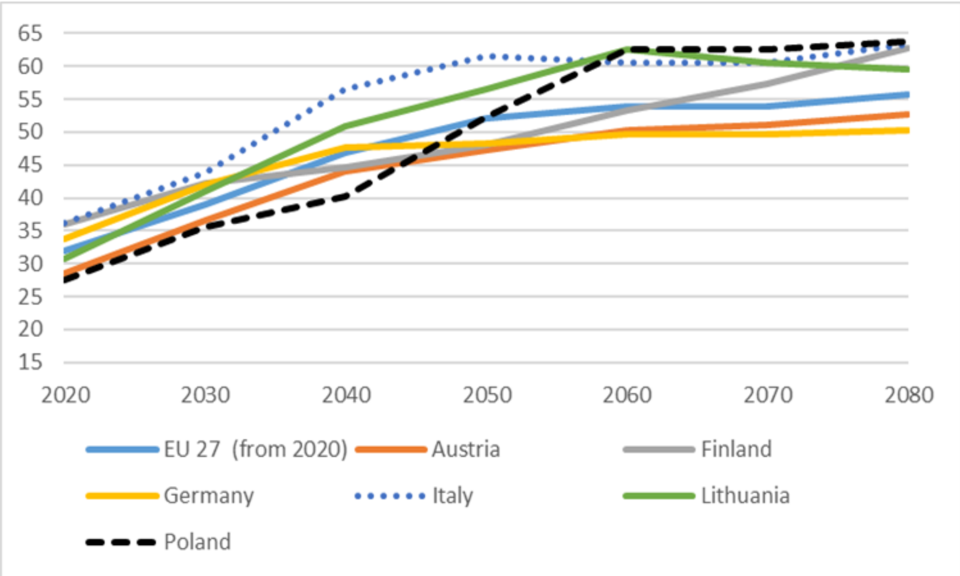

Figure 22. Old-age dependency ratio, population 65 years or over to population 15 to 64 years, expressed as percentages (source: Eurostat, 2023)

5.3 Geopolitical developments

In response to the Russian invasion of Ukraine, the European Council banned the import of wood commodities covered by the EU Timber Regulation from Russia and Belarus (CEU, 2022). This has already negatively impacted EU wood supply. These EU trade sanctions on wood imports from Russia and Belarus further reduce the possibility of bridging the growing wood supply gap in Europe. This supply shortfall is likely to be further exacerbated by a reduced future supply of coniferous roundwood after bark beetle infestation-induced salvage loggings have run their course (Egger et al., 2024). Even a hypothetical lifting of sanctions is unlikely to return the Russian supply of wood products to Europe, as Russia has reoriented its wood exports from Europe to China (GWMI, 2022). It will also prove hard to find alternative sources for roundwood imports, as, notably, the EU Timber Regulation has re-directed trade flows to countries with less stringent legislations, notably China (Jonsson et al., 2015).

Further, already elevated electricity prices within Europe – stemming from a rebound in economic activity after the COVID-19 pandemic as well as the increasing reliance on intermittent, weather-dependent energy sources (Kuik et al., 2022) – have been reinforced by sanctions on Russian hydrocarbons and the sabotage of the Nord Stream natural-gas pipelines. This situation is leading to a serious loss of competitiveness in energy-intensive industries relative to corresponding industries in regions with lower energy prices, not the least China and the USA (Birol, 2023). European wood-based industries are impacted to varying degrees. Pure paper mills, mechanical pulp producers and reconstituted wood-based panel manufacturers are among the most adversely affected. These industries suffer not only from high energy prices, but also from increased competition for wood-based raw materials from energy uses while having manufacturing processes that do not result in any sizeable amounts of residues usable for process energy (Egger et al., 2024). At the same time, European forest industry enterprises benefit from the removal of Russian and Belarusian competition in markets for semi-finished wood products, notably chemical wood pulp manufacturers who can sell electricity (see, e.g., Kallio, 2024).

6. Outlook: scenarios to 2040

6.1 Higher availability (HA)

In this scenario, drawing on the Shell Corporation scenario *Archipelagos* (https://www.shell.com/news-and-insights/scenarios/the-energy-security-scenarios.html), political impetus shifts away from managing emissions towards energy security, with a strong emphasis on energy efficiency. The drive for energy security still includes the greater use of low-carbon technologies. Bio-energy use follows the path of the EU Reference Scenario 2020. Europe has either managed to find replacements for imports of roundwood from the Russian Federation and the Belarus or revoked sanctions in this respect (and convinced the Russian Federation and Belarus to resume exports of wood-based commodities to Europe).

Figure 23 shows the evolution of fellings in region North and, for comparison, the average NAI for the period 2010 to 2020. Given the absence of a trend in the NAI, this can be seen a plausible approximation of the future NAI. Fellings would be lower than NAI over the whole outlook period, resulting in increasing forest carbon stocks. However, the forest carbon sink would be decreasing, as NAI increases at a slower rate than fellings (see, e.g., Korosuo et al., 2023). Total use of wood in region North is projected to increase by some 8% in this scenario from 2019 to 2040. This increase is due to material uses, increasing by some 18% in all, while energy uses are actually projected to decline by 7% over the whole outlook period, after an initial increase from 2019 to 2030 by 6.5%.

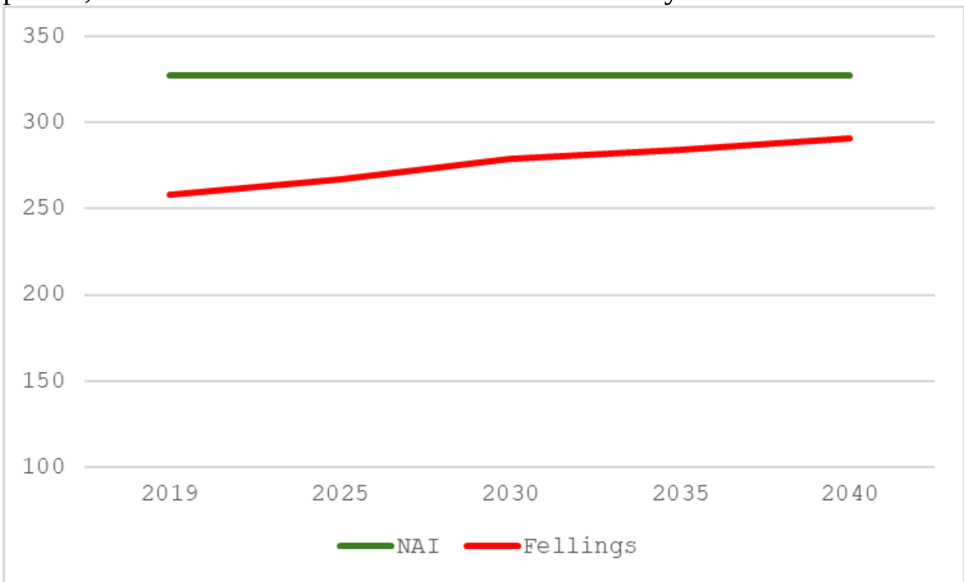

Figure 23. Fellings and the historical average NAI for region North, million m^3 (source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

Figure 24 depicts projected fellings for the period 2019 to 2040 and the average NAI for the period 2010 to 2020 in region West. Again, in the absence of a clear trend in the NAI, the average can be seen as a plausible approximation of the future NAI. Here, year 2027 would be the inflection point, after which fellings would be greater than NAI, resulting in decreasing growing and carbon stocks and the forest turning from a sink to a source of carbon. Total use of wood in region West is projected to increases by around 10% in this scenario from 2019 to 2040. Material uses are foreseen to increase by some 15% in all, while energy uses are projected to increase by 7.6% over the whole outlook period.

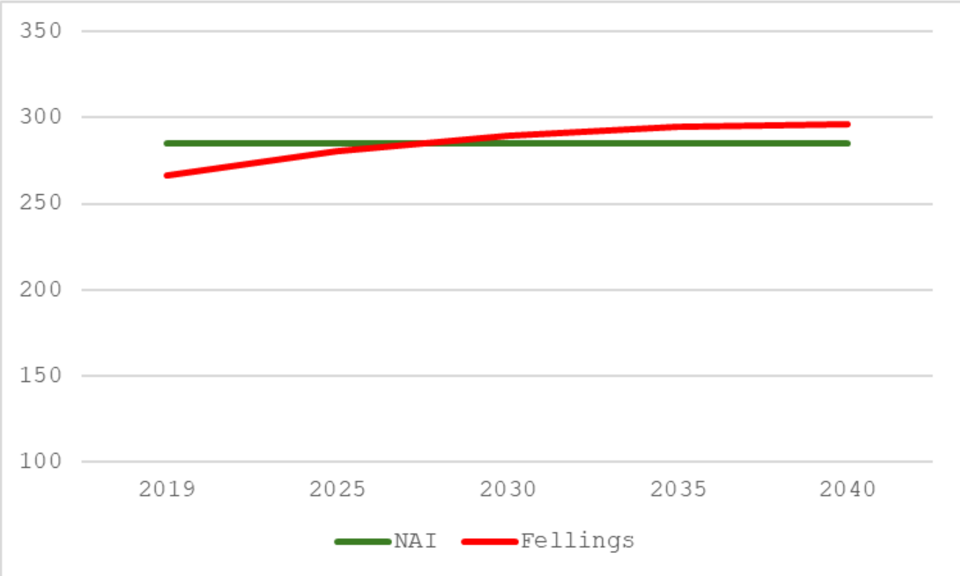

Figure 24. Fellings and the historical average NAI for region West, million m^3 (source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

Figure 25 depicts projected fellings and the average NAI for the period 2010 to 2020 in region East. Yet again, in the absence of a clear trend in the NAI, the historic average can be seen as a plausible approximation of the future NAI. Here, year 2035 would be the inflection point, after which fellings would be greater than NAI, resulting in decreasing growing and carbon stocks and the forest turning from a sink to a source of carbon. Total use of wood in region East is projected to increases by around 27% in this scenario from 2019 to 2040. Energy uses are projected to outgrow material ones, increasing by some 38% as compared to 17% for material uses. As a consequence, the overall share of energy in total uses of wood increases from 52% to 56%.

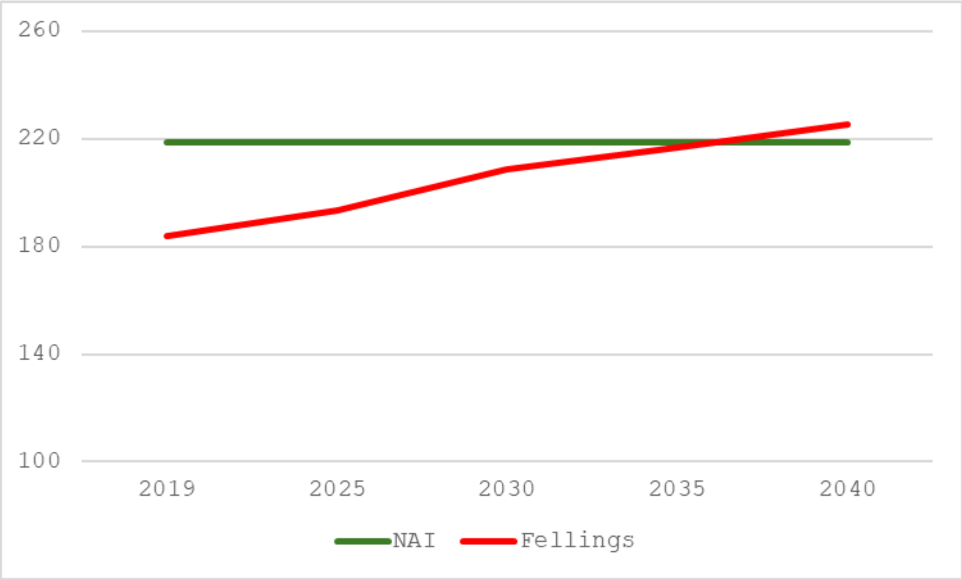

Figure 25. Fellings and the historical average NAI for region East, million m^3 *(source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)*

Figure 26 depicts fellings and the average NAI for the period 2010 to 2020 in region South. Yet again, in the absence of a clear trend in the NAI, the historic average can be seen as a plausible approximation of the future NAI. As for region East, year 2035 would be the inflection point, after which fellings would be greater than NAI, resulting in the forest turning from a sink to a source of carbon. Total use of wood in region South is projected to increases by some in 22% from 2019 to 2040 in this scenario, with energy and material uses projected to roughly grow at the same pace.

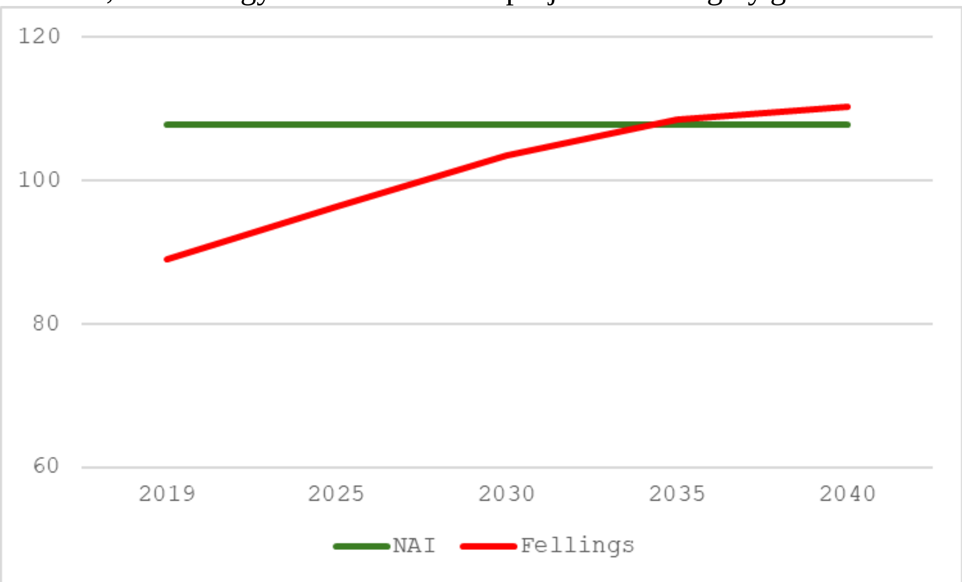

Figure 26. Fellings and the historical average NAI for region South, million m^3 *(source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)*

6.2 Lower availability (LA)

In this scenario, drawing on the scenario Sky 2050 of the Shell Corporation (https://www.shell.com/news-and-insights/scenarios/the-energy-security-scenarios.html), long-term climate security is the main focus, with specific targets to reach net zero GHG emissions by 2050. For EU MS, this means the implementation of the 2023 revision of RED, Renewable Energy Directive EU/2023/2413. Europe has not been able to find replacements for imports of roundwood from the Russian Federation, which means reduced imports compared to HA, and mainly so in region North.

Figure 27 shows the evolution of fellings in region North in the LA and, for comparison, the average NAI for the period 2010 to 2020. Fellings increase strongly over the outlook, the rate of increase, 15%, is highest from 2019 to 2030, reflecting the targets of the revised RED. The rate of growth between 2030 and 2040 is only 4%. Fellings are lower than NAI over the whole outlook period, though the difference is, obviously, notably smaller than in the HA. Hence, the forest carbon sink would be on a more marked decreasing path than in the HA. Total use of wood in region North is projected to increase by some 21% in this scenario from 2019 to 2040, as material uses increase by 18% while energy uses increase by 27%. As a consequence, the share of energy uses increases from 38% to 40%.

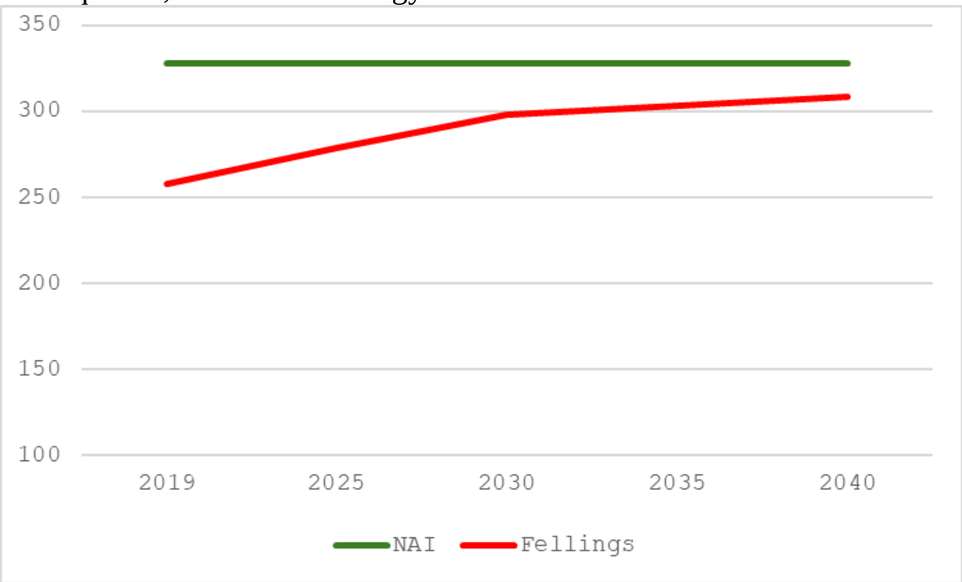

Figure 27. Fellings and the historical average NAI for region North, million m^3 (source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

Figure 28 depicts fellings in the LA and the average NAI for the period 2010 to 2020 in region West. Fellings increase markedly, the rate of increase, 17%, is highest from 2019 to 2030, reflecting the targets of the revised RED. The rate of growth between 2030 and 2040 is a mere 2%. Year 2025 would be the inflection point, after which fellings would be greater than NAI, resulting in decreasing growing and carbon stocks and the forest turning from a sink to a source of carbon. Total use of wood in region West is projected to increases by some 32% from 2019 to 2040 in this scenario. Material uses would increase by some 15% in all, while energy uses are projected to increase by 48%. As a consequence, the share of energy uses increases from 56% to 63%.

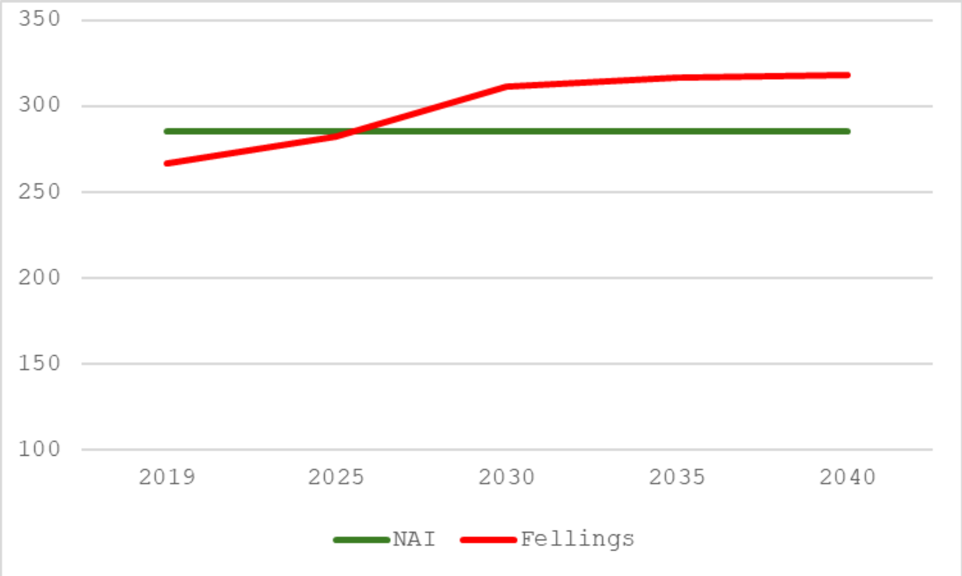

Figure 28. Fellings and the historical average NAI for region West, million m³ (source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

Figure 29 depicts fellings in the LA and the average NAI for the period 2010 to 2020 in region East. There is a substantial increase in fellings, again the rate of increase, 31%, is highest from 2019 to 2030. The rate of growth between 2030 and 2040 is only 9%. Also here year 2025 would be the inflection point, after which fellings would be greater than NAI, resulting in decreasing growing and carbon stocks and the forest turning from a sink to a source of carbon. Total use of wood in region East is projected to increases by some 53% from 2019 to 2040 in this scenario. Energy uses, projected to grow by a staggering 91%, would mainly be responsible for this, while material uses would increase by 17% over the whole outlook. As a consequence, the share of energy uses increases from 56% to 64%.

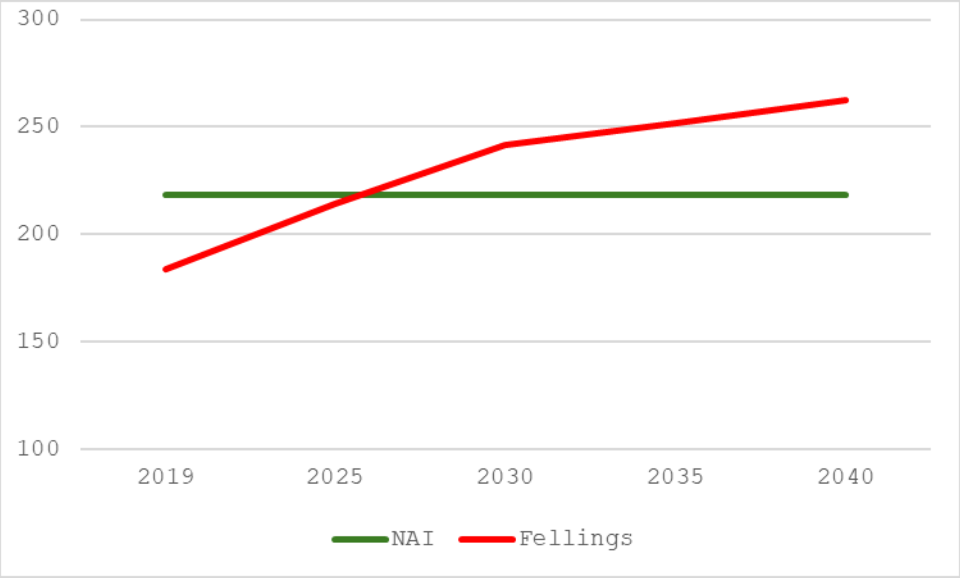

Figure 29. Fellings and the historical average NAI for region East, million m^3 (source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

Figure 30 depicts fellings in the LA and the average NAI for the period 2010 to 2020 in region South. The rate of increase in fellings, 41%, is highest from 2019 to 2030, between 2030 and 2040 it is a mere 6%. Year 2025 would be the inflection point, after which fellings would be greater than NAI. Total use of wood in region South is projected to increases by some 49% from 2019 to 2040. Energy uses, projected to grow by 68%, would mainly be responsible for this, material uses increase by 25%. The share of energy uses increases from 62% to 69%.

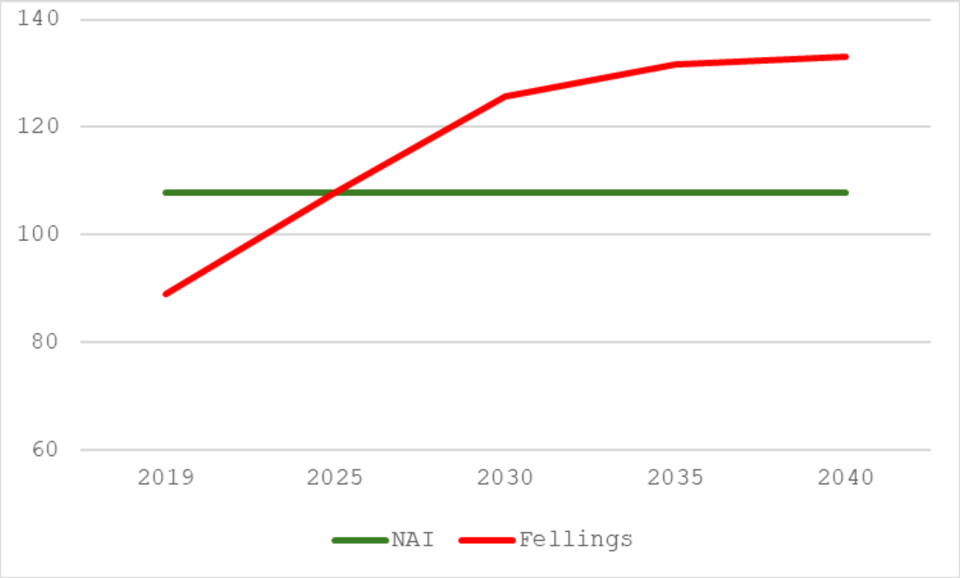

Figure 30. Fellings and the historical average NAI for region South, million m^3 (source: own calculations, average NAI derived from Eurostat European forest accounts https://ec.europa.eu/eurostat/web/forestry)

7. Discussion and conclusions

Removals as well as consumption of fuelwood in the EU28 (current EU27 + the UK) outgrew removals and consumption of industrial roundwood in the period 2007 to 2019, with a particularly marked increase from year 2009. The overall use of woody biomass for energy increased by 48%, or 159 million m^3, between 2009 and 2019. The overall use of woody biomass for material purposes increased by a mere 20%, or 76 million m^3, during the same period. It is hard to make any other interpretation than that this was largely the effect of policies, notably the renewable energy directive introduced in year 2009.

The four European regions under study – North, West, East and South – are quite heterogeneous in terms of population density, forest endowment, and the composition of wood use. Hence, the forest rich, sparsely populated region North uses the largest share of primary wood in wood-based manufacturing, 83%. This region, with a sizable forest-based industry, is also the one with the lowest overall share of wood used for energy (heat and power), 38%, and the lowest share of primary wood in energy uses, 25%. In contrast, in region South, energy dominate wood use, accounting for some 63% of total wood use, and wood-based manufacturing is to a considerable degree based on secondary wood sources, 32%, while primary woody biomass is the largest reported source of wood-based bioenergy, 53%.

In addition to forest endowment and, obviously, the relative size of wood-use, the composition of wood use is determinant for how the regions fare in terms of the most basic form of sustainability, i.e., the development of the forest growing stock. Energy use of wood obviously precludes any further use. In contrast, wood-based manufacturing results in a main product which can be used once more for energy purposes – in a single stage cascade – or – in a multi-stage cascade – at least once more in material form before disposal or recovery for energy purposes. In addition, wood-based manufacturing normally results in by-products which themselves can be used in the manufacturing of wood-based products or for energy generation. In light of this, irrespective of which of the two futures envisioned, region North is the only region that would see increasing growing stocks over the whole outlook period. This region has the highest NAI, and is also the region with the lowest overall share of energy in total wood use, and, most importantly, by far the lowest share of energy in primary wood use. Still, even for region North, the forest carbon sink would decrease over the outlook period, making it all but impossible to meet the year 2030 LULUCF target.

There are a number of potential options, and combinations thereof, to remedy the situation. Net annual increment could be increased, by increasing gross annual increment and/or reduce natural losses. This would prove difficult, however, at least in the short to medium term, particularly given climate change induced calamities such as the bark beetle infestation. Secondly, efforts could be made to increase imports of wood raw materials. However, it is difficult to see how imports could be substantially increased, given the geopolitical situation and policy instruments in place, notably the EU Timber Regulation. And, from a climate change mitigation perspective, this would in any case be a dubious approach, as it would imply increasing fellings or crowding out of wood uses elsewhere, which could negate any climate benefits achieved in Europe. Perhaps, along with increased efficiency in manufacturing and energy generation, the most promising avenue is to enhance the cascading wood use. In this respect, the high share of primary woody biomass in wood used for heat and power in all European regions but region North – precluding any cascading – is problematic.

8. Glossary

By-product: An incidental product deriving from a manufacturing process or chemical reaction, and not the primary product or service being produced.

Cascading wood use: In a single stage cascade, wood is processed into a product and this product is used once more for energy purposes. In a multi-stage cascade, wood is processed into a product and this product is used at least once more in material form before disposal or recovery for energy purposes.

Direct wood: Any wood fibre entering energy production without any further treatment or conversion.

Fellings: Roundwood removals + bark + logging residues

Fuel wood: Roundwood that will be used as fuel for purposes such as cooking, heating or power production. It includes wood harvested from main stems, branches and other parts of trees (where these are harvested for fuel), round or split, and wood that will be used for the production of charcoal (e.g., in pit kilns and portable ovens), wood pellets and other agglomerates. It also includes wood chips to be used for fuel that are made directly (i.e., in the forest) from roundwood. It excludes wood charcoal, pellets and other agglomerates.

Gross annual increment: Annual volume of increment of all trees. Includes the increment of trees which have been felled or have died during the reference period.

H&P / Energy uses (H&P): Woody biomass used for heat and power production.

Indirect wood: Processed and unprocessed by-products (residues) from the wood processing, solid (sawdust, chips, slabs, etc.) or liquid from the pulp industry (black liquor or tall oil). Processed wood fuels with improved energy content per bulk volume (compressed), such as wood pellets, briquettes but also wood charcoal are also mainly included under indirect supply. Moreover, it includes post-consumer wood.

Industrial roundwood: All roundwood except fuel wood.

Material uses: Woody biomass used by wood-processing industry.

Net annual increment: Gross annual increment minus natural losses.

Post-consumer wood: Any waste wood fibre after at least one life cycle. It comprises wood from construction, renovation and demolition, but also packaging as well as old furniture.

Primary sources: It is an aggregate of all roundwood, including bark.

Removals: The volume of all trees, living or dead, which are felled and removed from the forest, other wooded land or other felling sites in the country in question. It includes natural losses that are recovered (i.e., harvested), removals during the year of wood felled during an earlier period removals of non-stem wood such as stumps and branches (where these are harvested) and removal of trees killed or damaged by natural causes (i.e., natural losses), e.g., fire, windblow, insects and diseases. It excludes bark and other non-woody biomass and any wood that is not removed, e.g., stumps, branches and treetops (where these are not harvested) and felling residues (harvesting waste).

Solid Wood Equivalent: Amount of solid wood fibre contained in the product. It is the roundwood equivalent volume (green volume prior to any shrinkage) needed to produce the product when there are no losses or wood residues [5].

Unknown wood: Woody biomass used for energy production from unknown sources.

Unreported sources/uses: Amount of woody biomass required to reach a perfect balance between sources and uses.

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