EcoReFibre



CIRCULAR VALORISATION OF WOOD WASTE



GUIDEBOOK

GUIDEBOOK ON CIRCULAR VALORISATION OF WOOD WASTE

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WOOD-BASED PANELS

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GLOSSARY

TERM/ACRONYM	DEFINITION
ANCI	Associazione Nazionale Comuni Italiani (National Association of Italian Municipalities)
BAT	Best Available Techniques
CDW	Construction and demolition waste.
CEN	European Committee for Standardization
CONAI	Consorzio Nazionale Imballaggi (Italian National Packaging Consortium)
CPR	Construction Products Regulation, Regulation (EU) 2024/3110
Defibration, extraction	Processing solid wood or fibreboard into fibres (from sources such as virgin wood, wood waste, or industrial by-products).
EOS	European Organisation of the Sawmill Industry
EPF	European Panel Federation – EcoReFibre partner
EPR	Extended Producer Responsibility
ERF	EcoReFibre
ESB	École Supérieure du Bois (France) – EcoReFibre partner
FB	Fibreboard
FCBA	Institut Technologique Forêt Cellulose Bois-construction Ameublement (France) – EcoReFibre partner
FEFPEB	European Federation of Wooden Pallet and Packaging Manufacturers
Fibres	Wood particles with elongated shape and an average length of about 2 mm
Fines	Wood particles with round shape and a max. dimension of about 0,3 mm or less
Hardboard	Wet process fibreboard in accordance with EN 622-2 (> 800 kg/m³)
HDF	High density fibreboard: Dry process fibreboard in accordance with EN 622-5 (> 800 kg/m³)
IHD	Institut für Holztechnologie Dresden (Dresden Institute for Wood Technology, Germany) – EcoReFibre partner
Industrial by-products	Not considered as waste, cf. Waste Framework Directive [16]. For example chips, off-cuts and sawdust resulting from the primary production process in the sawmill industry are by-products because their further use is certain, they can be used directly without any further processing other than normal industrial practice and further use is lawful.
IPPC	International Plant Protection Convention
IVL	IVL Swedish Environmental Research Institute (Sweden) – EcoReFibre partner

TERM/ACRONYM	DEFINITION
JRC	Joint Research Centre of the European Commission
LCSA	Life Cycle Sustainability Assessment
LDF	Low density fibreboard: Dry process fibreboard in accordance with EN 622-5 (< 650 kg/m³).
MDF	Medium density fibreboard: Dry process fibreboard in accordance with EN 622-5 (650 kg/m³ - 800 kg/m³).
(m)TMP process	(Moisture modifying) Thermo-Mechanical-Pulp process, a type of defibration.
NIBIO	Norwegian Institute of Bioeconomy Research (Norway) – EcoReFibre partner
OSB	Oriented strand board
OVAM	Openbare Vlaamse Afvalstoffenmaatschappij (Public Waste Agency of Flanders)
PB	Particleboard
Post-consumer wood (waste)	Reclaimed wood waste such as pallets, private household wood waste, used wood arising from construction or demolition of buildings or from engineering works, whether contaminated or not.
PW	Plywood
Recovered wood	Recovered wood is waste material that was collected/separated from a waste stream due to its potential for recycling; included are e.g. damaged stock and materials or products that were rejected by a manufacturer, and reclaimed post-consumer wood (such as pallets or other wood packaging material, demolition waste, used furniture). Industrial by-products are excluded.
RED III	Renewable Energy Directive, Directive (EU) 2023/2413
Secondary raw material	Material that has been reprocessed from recovered (reclaimed) material by means of a manufacturing process and made into a final product or into a component for incorporation into a product. Obtained from waste by recycling, can replace some or all virgin material in manufacturing processes. In practice, it often encompasses industrial by-products (legally non-waste) and recovered wood (legally waste, unless national End-of-Waste criteria apply).
SLU	Swedish University of Agricultural Sciences (Sweden) – EcoReFibre project coordinator
TRL	Technology Readiness Level
WBP	Wood-based panels, general term
WFD	Waste Framework Directive, Directive 2008/98/EC
(Wood) waste	(Wood) products and materials which the holder discards or intends to discard or is required to discard, examples are discarded furniture or beams from demolition sites. This term encompasses recovered wood, post-consumer-wood (waste), and wood that is not reutilised (e.g. sent to landfill). It excludes industrial by-products such as sawmilling residues and wood to which national End-of-Waste criteria apply.

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1 EXECUTIVE SUMMARY



Europe's wood-based panel industry already shows that circularity works. Recovered wood makes up 50% of the raw wood used for European particleboard, and up to 90% in some countries, making particleboard an established example of multi-stage cascading use. Fibreboard, and MDF in particular, lags far behind: recovered wood accounted for just 2% of the MDF industry's raw wood demand in 2025. So far, MDF and other fibreboards have mainly been recycled into particleboard, with most post-consumer fibreboard still being burnt or landfilled.

EcoReFibre has shown that fibreboard can be recycled back into high-value products (other than particleboard). Across five pilot projects, the consortium worked on several steps of the value chain to close the loop between production and disposal:

- Sorting: An AI-supported sorting line processed more than 100 tonnes of wood waste, recovering solid wood at 95% purity and fibreboard at 97% purity (chapter 4).
- Fibres and fines recovery: Three complementary technologies (a wet steam-explosion process, a dry process and the mTMP process) produced recycled fibres and fines of quality comparable to virgin fibres from post-consumer fibreboard and solid wood waste. These technologies reached TRL 6 and can be integrated into existing panel lines (chapter 4).
- Incorporation of recycled fibres and fines into products: The recovered fibres, fines and dust were then incorporated into new, second-life products: fibreboards (MDF, HDF), insulation products, particleboard and bioblocks, a bio-based construction material. The share of recycled content varied by product and application (chapter 5).

The life cycle sustainability assessment (chapter 6) shows what is at stake. Scaled up across Europe, an EcoReFibre system could save up to 4.4 million tonnes of virgin wood a year, about half of current virgin wood demand for MDF. Compared with today's situation, it would cut climate impacts by 18–44%, avoiding around 7 million tonnes of CO_2-equivalent each year, and save an estimated €720 million to €1.2 billion a year through cheaper raw materials and lower waste-management costs. As these results are based on pilot- and lab-scale data, they are likely to be conservative.

Technology alone will not deliver this potential: a reliable supply of clean, well-sorted feedstock remains the main barrier. Chapter 7 therefore sets out policy recommendations for collecting more wood waste and improving the quality of collected streams, in line with the cascading principle of RED III. These recommendations build on the EcoReFibre Strategic Roadmap [8] and were refined with more than 70 stakeholders at the EcoReFibre Policy Conference in Brussels in March 2026 [10].

Finally, chapters 8 and 9 provide practical product guides and application overviews for the main wood-based panel types. They cover standards, properties and circularity aspects.

This guidebook brings together the main results and conclusions of the EcoReFibre project. Because wood fibre recycling is a broad topic, it is designed to help readers quickly identify the key technologies, products and supporting documents. To best align with the reader's needs, each topic offers the possibility of contacting the project partners.

2 INTRODUCTION



2.1 - PROJECT SUMMARY

EcoReFibre – upscaling circular use of wood waste and fibre recycling in the European wood-based panel industry

The EcoReFibre project (grant no. 101057473) ran from May 2022 to October 2026. Funded with €12 million under Horizon Europe and coordinated by the Swedish University of Agricultural Sciences (SLU), it brought together 20 partners from 7 countries. Its core mission was to develop smart technologies for recycling post-consumer fibreboard and other wood waste back into fibreboards and other products.

Fibreboard is a growing challenge for wood waste management. In Europe, it is mainly used in furniture (49%), laminate flooring (19%) and construction, including doors (13%), with smaller shares going into packaging (7%), mouldings (5%) and other applications (7%) [13]. Once these products reach the end of their life, the fibreboard is still mostly incinerated or landfilled. It is difficult to reprocess, and only limited amounts can be used in particleboard, the main recycling route for wood waste today.

To address this, five industrial pilots demonstrated how circular approaches, combined with innovative and digitally supported technologies, can secure a supply of secondary raw materials. The pilots covered the sorting of wood waste, the recovery of wood fibres and fines, and their conversion into fibreboards, insulation products, particleboard and bioblocks. The project set out to study the viability of replacing up to 25% of the virgin fibres used in the European fibreboard industry, as a way of increasing the wood resources available in Europe, and to explore how circular technologies can be scaled up.

2.2 - GUIDEBOOK CONTEXT AND OBJECTIVES

This guidebook is a EcoReFibre reference document for putting the project's results into practice. It brings together, in one place, the validated technological solutions developed within the project for recycling post-consumer and industrial fibreboard waste. It places them in the wider context of the wood-based panel (WBP) industry and the circular bioeconomy.

The guidebook focuses on wood-based panels, and on fibreboard in particular. Particleboard already shows how recovered wood can be kept in material use through multi-stage cascading. Fibreboard, by contrast, has so far remained largely outside this loop. Closing that gap matters beyond waste management: the call under which EcoReFibre was funded aims to strengthen the resilience of Europe's forest-based sector. By recovering fibres from waste panels, EcoReFibre's solutions broaden the raw material base for fibreboard production.

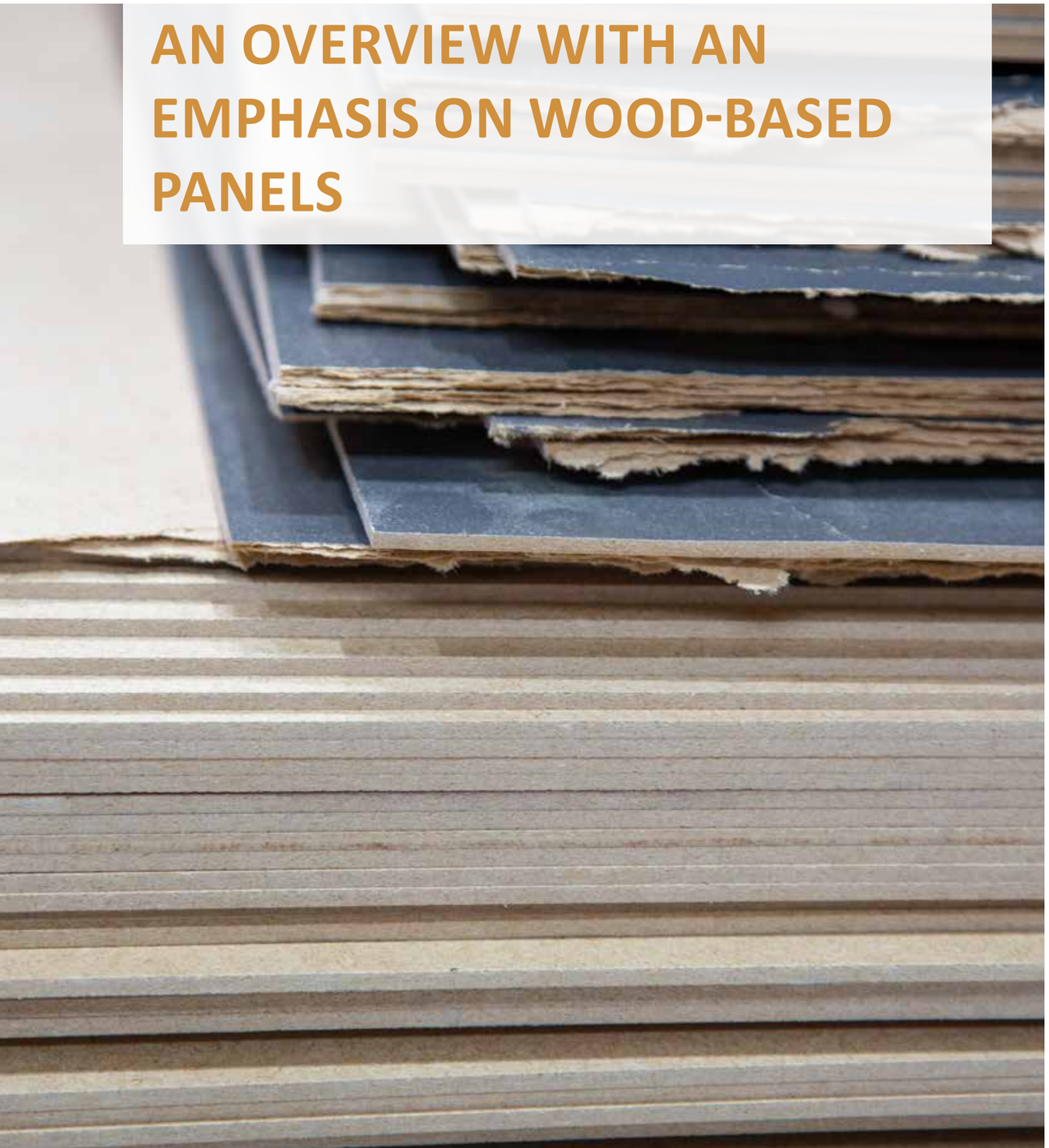
The guidebook has three objectives:

- Inform: give an accessible overview of the market context, the state of wood recycling in Europe and the technologies demonstrated in EcoReFibre, from sorting and fibre recovery to new products with recycled content.
- Support decisions: present the environmental and economic performance of these solutions and the policy conditions needed to scale them up. Present best-practice examples of wood waste collection systems in the EU.
- Guide practice: provide product guides and application overviews for the main wood-based panel types, including standards, properties and circularity aspects.

Each chapter can be read on its own. Readers interested in a specific solution will find contact details for the responsible project partners in the relevant section.

The guidebook is available both as this downloadable report and as an interactive web version on the **EcoReFibre website**. The web version presents the same content in a format that is easier to navigate. It lets readers go directly to the topics, technologies and product guides most relevant to them, with links to the underlying project deliverables and publications.

3 WOOD RECYCLING AN OVERVIEW WITH AN EMPHASIS ON WOOD-BASED PANELS



Europe's wood-based panel (WBP) industry is, first and foremost, a major user of wood resources. In 2025, EPF-member producers (around 90% of European WBP producers) processed 43.1 million dry tonnes of raw wood to manufacture nearly 59.6 million m³ of panels [13, Tables II.1 and II.4]. Making efficient use of this resource requires more than optimising its first application. It also means keeping wood in productive material use for as long as technically and environmentally appropriate, including through reuse and recycling, before its eventual recovery for energy. This is the principle of cascading use.

The composition of this raw-material supply, and particularly the proportion of wood that has already completed a previous use, varies considerably between panel types. This is particularly relevant to particleboard, which today is the main outlet for recycled wood in Europe – not only within the wood-based panel industry, but across the wood sector as a whole. The particleboard sector has relied on secondary material feedstock for decades and has already worked through many of the practical challenges that come with it. In this sense, particleboard production is genuinely instructive for EcoReFibre's ambition to feed recovered fibreboard back into the production of new fibreboard.

3.1 - CASCADING USE: THE PRINCIPLE BEHIND WOOD RECYCLING

Cascading use seeks to make the most efficient use of wood resources by retaining them in productive use over successive stages. In practical terms, wood should first be used in material applications and the service life of wood products should be extended wherever possible. At the end of one product life, suitable wood should be reused or recycled into new products, with energy recovery providing a final outlet for material that can no longer be reused or recycled safely or effectively.

Wood recycling is therefore not separate from cascading use, but an integral part. When recovered wood from packaging, furniture, construction products or previous wood-based panels is processed into a new panel, the material enters another productive cycle rather than leaving the material economy after its first use.

This continued material use extends the useful life of the wood resource, reduces the immediate need for primary wood and postpones its final conversion into energy – a benefit reinforced when recycled wood displaces primary raw material in the manufacture of new products. Importantly, it also extends the period during which biogenic carbon remains stored in wood products [1].

Cascading use does not imply that every wood stream can or should be recycled indefinitely. The appropriate next use depends on factors including material quality, contamination, technical suitability, environmental performance and economic viability. Energy recovery continues to perform an important role for end-of-life wood that is no longer suitable for further material use. The objective is to avoid sending recyclable wood prematurely to energy recovery when it can still provide value in a further material application.

Wood-based panels occupy a particularly important position in this cascade, as their manufacturing processes can convert not only industrial by-products but also post-consumer wood into new products, providing an additional material life for those resources.

3.2 - THE PARTICLEBOARD SUCCESS STORY

Before turning to the progress that EcoReFibre is making towards greater circularity in fibreboard production, it is useful to consider what has already been achieved at industrial scale with another product of the wood-based panel industry: particleboard.

The scale of the achievement

Particleboard production in EPF countries reached 31.8 million m³ in 2025, representing 53% of the total production of all wood-based panel types and making it by far the largest panel sector in Europe [13, Chapter II]. As a consequence, particleboard production consumed nearly 20.7 million dry tonnes of wood, equivalent to 48% of the entire wood-based panel industry's wood demand [13, Table II.4].

What distinguishes particleboard is not only the scale of its production but also the unique composition of its raw material supply. In 2025, recovered wood accounted for 50% of the wood consumed by the European particleboard industry, comprising both pre-consumer residues from manufacturing processes and post-consumer materials such as pallets, packaging, and end-of-life furniture. This represents a significant increase from 29% in 2012 and marks the first time in the EPF data series that recovered wood has supplied half of the sector's total wood demand [13, Table II.26].

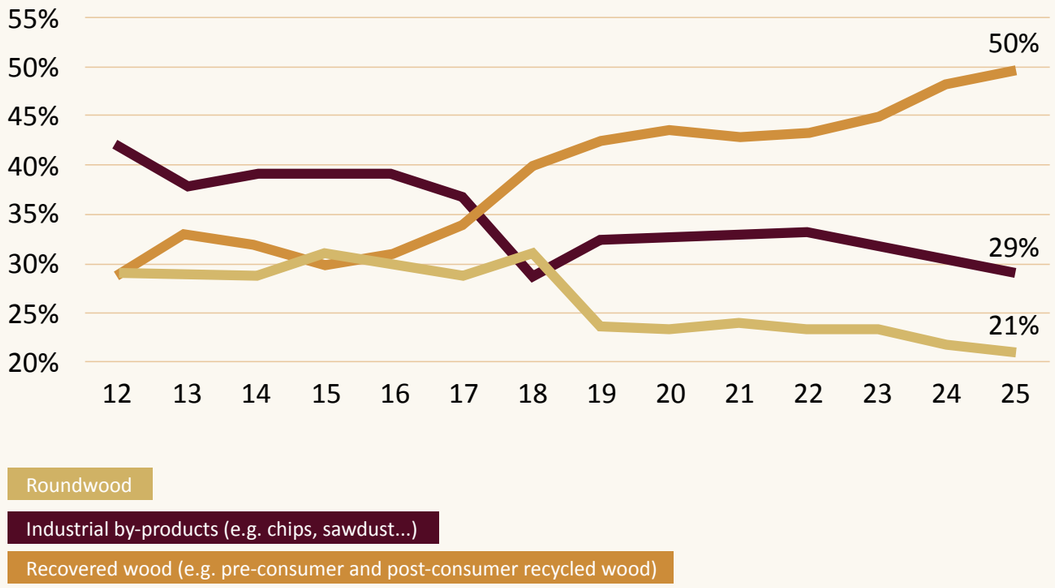


Figure 1 - Wood composition of the European Particleboard industry, 2012-2025 [13]

Particleboard consequently leads the wood-based panel industry in the use of recovered wood, drawing on substantial volumes alongside roundwood and industrial by-products. By returning pre- and post-consumer wood to productive material use, particleboard provides an established industrial example of multi-stage cascading. In practical terms, it is estimated to have avoided the use of nearly 10.3 million dry tonnes of primary wood in 2025 alone [13, Section 2.7].

Recovered wood is also beginning to be used in MDF and OSB production, albeit currently in smaller quantities. More broadly, MDF and OSB producers, and to a lesser extent plywood producers, make use of cascading streams of industrial by-products.

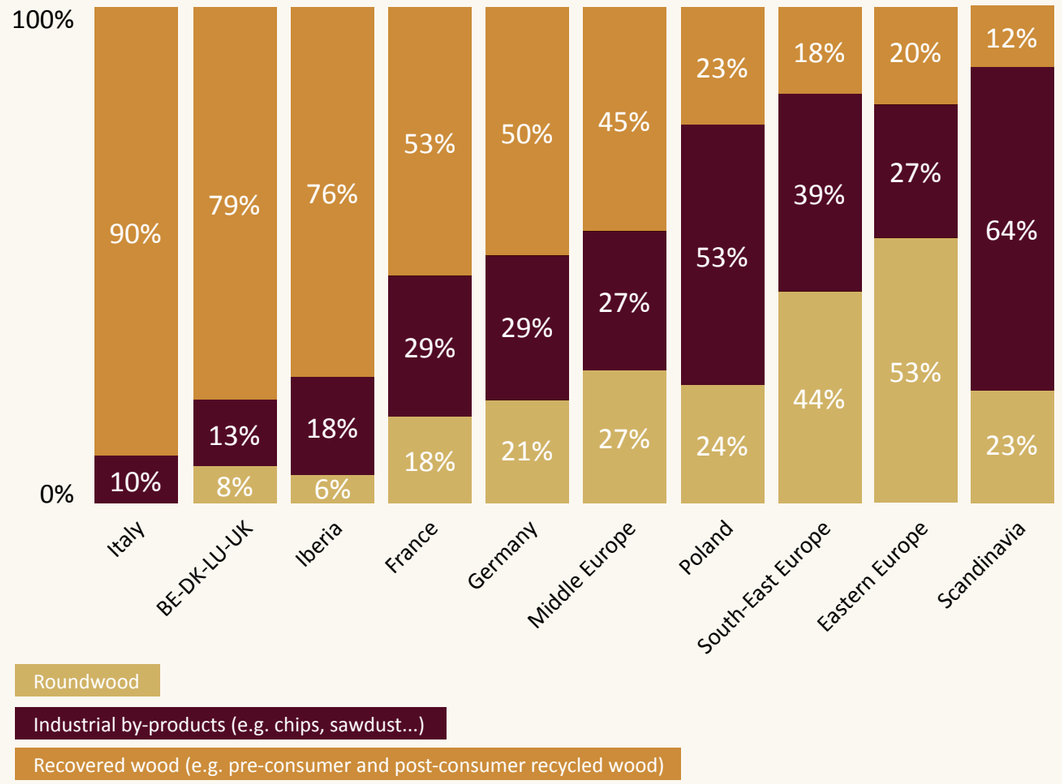


Figure 2 - Regional composition of the raw wood consumption mixes in the European particleboard industry, 2025 [13]

Sources: European Panel Federation - Members data (2025)
Regional definition:
BE-DK-LU-UK: Belgium, Denmark, Luxembourg and the UK,
Eastern Europe: Estonia, Latvia, Lithuania and Slovakia,
Iberia: Portugal and Spain,
Middle Europe: Austria, Czech Republic and Switzerland,
Scandinavia: Finland, Norway and Sweden,
South-East Europe: Bulgaria, Greece, Hungary and Romania

The cascading use of recovered wood and industrial by-products is therefore not merely an ambition, but an established industrial practice. Its uptake nevertheless varies considerably across Europe, reflecting differences in local resource availability, market conditions and collection infrastructure. Recovered wood accounts for 90% of particleboard wood procurement in Italy and 79% in the Belgium–Denmark–Luxembourg–UK group, where access to roundwood and industrial by-products is more constrained. By contrast, regions with more abundant forest resources, such as Scandinavia and Eastern Europe, continue to rely predominantly on roundwood and industrial by-products [13, Table II.27].

These regional differences show that the uptake of recovered wood depends not only on the technical capacity to process it, but also on the availability of suitable material and the infrastructure required to collect, sort and prepare it. Fibreboard recycling is therefore likely to follow different development pathways across Europe, shaped by the resources, infrastructure and market conditions of each region.

Why particleboard led the way

The capacity of particleboard production to use recovered wood at scale is closely linked to the way the panel is manufactured: wood particles are arranged in distinct layers rather than refined into fibres and formed into a homogeneous mat. Two aspects of this process are particularly important. First, particle-based production can accommodate a broader range of input material, including variations in particle geometry and a greater presence of residual non-wood material, than fibre-based production typically allows. Knife-ring flakers and hammer mills are generally more tolerant of mineral grit, metal fragments and cured resins, whereas these materials can accelerate wear on the narrow-gap plates of an MDF defibrator and cannot themselves be reduced to usable wood fibres. Second, particleboard typically comprises a coarser core enclosed by finer surface layers. This structure allows more variable furnish to be directed to the core while finer, cleaner particles are reserved for the faces. MDF has no equivalent layered structure: its homogeneous mat and consistently smooth, machinable surface depend on a more uniform and carefully prepared fibre furnish. These differences are inherent to the respective production technologies rather than findings specific to EcoReFibre, and they help explain why particleboard became, once again, the principal outlet for recovered wood.

The timing of these developments was as important as the technological differences. Commercial particleboard production began in Europe in the 1940s, originally as a means of converting wood residues and waste wood – including post-consumer wood – into a strong panel capable of replacing plywood in many applications. After the Second World War, as roundwood became more readily available, producers increasingly turned to fresh wood, and the sector expanded rapidly during the 1950s and 1960s, whereas MDF did not achieve significant production capacity in Europe until the late 1980s. By the time fibreboard had become a substantial industry, the particleboard sector had already accumulated four decades of installed capacity, established supplier relationships and experience in handling variable furnish. When recovered wood came back into use from the 1980s onwards, the sector was therefore well placed to absorb it – in effect, returning to its origins.

This head start also influenced the development of the surrounding supply chain. Capacity for collecting, sorting, cleaning and chipping post-consumer wood grew largely in response to demand from particleboard manufacturers and was designed around the requirements of their production processes. Fibreboard producers seeking to use the same material today must therefore work with a recovered-wood supply chain that was not originally developed to meet the more exacting requirements of fibre production – one reason why cleaning and fraction sorting are so central to EcoReFibre's work.

Alongside growing environmental awareness and industry-led initiative, regulatory developments created further momentum for the use of recovered wood in panel production. From the late 1990s onwards, the EU Landfill Directive [3] and subsequent waste-framework measures encouraged the diversion of wood waste from landfill. At that time, particleboard was the wood-based panel sector best positioned to use the resulting volumes – a ready and productive outlet for wood that might otherwise have been landfilled.

Growing competition for virgin wood provided an additional catalyst, particularly as demand for woody biomass for energy generation increased. Greater pressure on the availability and cost of primary wood resources encouraged panel manufacturers to diversify their raw-material supply and increase their use of recovered wood. In doing so, the sector has put cascading use into practice by extending the useful material life of wood through recycling before its eventual energy recovery.

The contrast with fibreboard, and signs the gap is closing

Fibreboard, and MDF in particular, still sits in a very different position, though the picture is now more encouraging than it was before the EcoReFibre project. Recovered wood accounted for just 2% of the European MDF industry's raw wood demand in 2025 – up from 1% in 2024, but still marginal against a sector overwhelmingly dependent on roundwood (65%) and industrial by-products (33%) [13, Table II.28]. The following sections investigate whether fibreboard wood waste is at a comparable stage to where particleboard wood waste was a generation ago. To do so, they examine the scale and characteristics of the fibreboard waste stream and evaluate evidence from collection systems elsewhere to determine how far this transition could realistically progress.

3.3 - WASTE GENERATION TRENDS

The scale of the resource

Viewed beyond the panel industry, the use of recovered wood forms part of a much larger story about Europe's waste streams. Eurostat's most recent comprehensive data show that economic activities and households across the EU generated 2,233 million tonnes of waste in 2022. Wood accounted for a relatively modest 2.1% of this total, equivalent to just under 47 million tonnes. This share has declined over time: in 2004, wood waste amounted to 65.8 million tonnes, or 3% of a smaller overall waste stream [12]. However, these figures likely understate the true volume of wood no longer in productive use, for two distinct reasons. First, differences in collection, classification and the separation of wood from mixed waste across Member States mean reporting is inconsistent. Second, and more fundamentally, waste statistics can only capture material that has formally acquired waste status: wood that is reused, or kept in circulation without ever entering the legal waste stream, falls outside these figures entirely, and the scale of that material is hard to estimate.

Table 1: Total wood waste sources in the European Union, 1,000 tonnes (hazardous and non-hazardous) [12]

Sources of wood waste	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	%share in total in 2022
A. Agriculture, forestry and fishing	1,930	2,150	2,760	2,920	3,340	140	160	140	240	260	1%
B. Mining and quarrying	40	30	50	40	50	50	50	100	80	40	0%
C. Manufacturing of which :	44,880	40,220	39,750	31,180	26,910	22,540	23,700	21,390	18,720	17,500	37%
• Manufacture of wood and of products of wood and cork, including wood-based panels	32,110	25,220	25,340	20,990	18,250	13,860	14,760	13,400	11,980	10,210	22%
• Manufacture of furniture, repair and installation of machinery and equipe-ment	2,330	1,910	2,290	2,080	1,950	2,380	2,170	2,100	1,790	2,090	4%
D. Electricity, gas, steam and air conditionning sup	60	1,430	250	130	290	530	410	440	320	280	1%
E. Water supply; sewerage, waste management and remation activities	6,100	6,100	6,100	6,100	6,900	7,670	8,630	8,990	10,4801	10,880	23%
F. Construction	6,570	7,570	8,520	8,550	7,750	8,010	8,210	8,700	8,590	8,000	17%
• Services (except wholesale of waste and scrap)	4,060	3,560	3,600	3,500	3,130	2,640	3,100	3,730	4,290	4,540	10%
• wholesale of waste and scrap	30	130	200	510	240	310	380	470	430	430	1%
• Households	2,100	2,470	2,730	3,280	3,530	3,780	4,330	4,870	5,110	4,860	10%
Total of waste wood generated	**65,770**	**63,660**	**63,960**	**56,210**	**52,140**	**45,670**	**48,970**	**48,830**	**48,260**	**46,790**	**100%**

According to the latest figures from 2022, most wood waste originates from three sectors. Manufacturing accounts for the largest share, at 37% of the EU total (see Table x). Within this category, the wood products industry alone generates 22% of all wood waste, making it the largest individual source. Waste management and water supply account for a further 23%, followed by construction at 17%. Furniture manufacturing, despite using substantial volumes of wood-based panels, generates a comparatively small share (4%, or approximately 2.1 million tonnes), while EU households directly contribute close to 10% or 5 million tonnes [12].

Developments within manufacturing also reinforce the particleboard success story described in Section 3.2. Wood waste from the manufacture of wood products fell by more than half between 2004 and 2022, from nearly 45 million tonnes to less than 20 million tonnes. This decline reflects the increased diversion of manufacturing off-cuts from the waste stream for their use as bioenergy, as well as higher recycling rates and more efficient use of this material, particularly within the particleboard industry [10]. In other words, particleboard producers have not only created a material outlet for recovered wood from other sources, they have also improved the internal use of their own industrial by-products.

Wood-waste generation is geographically concentrated, as are the routes through which the material is subsequently recovered. Germany, France, Italy, Belgium, Finland, the Netherlands and Romania together account for 81.5% of all wood waste generated in the EU. Nordic and Baltic countries produce particularly high volumes relative to their populations, reflecting the importance of their domestic wood industries [23].

Once collected, the great majority of this material is recovered rather than discarded. Eurostat data for 2020 indicate that 99% of EU wood waste underwent some form of recovery: 53% was used for energy and 46% was directed to material recycling. Only 0.6% was landfilled or incinerated without energy recovery [23].

This distribution indicates a somewhat higher share of material recycling than an earlier estimate based on JRC data published in 2026 and referring to 2021. The earlier analysis placed material recycling of wood wastes (predominantly into particleboard) at approximately 36%, compared with around 64% for energy recovery [26]. Because the estimates cover different years and use different methodologies, they should not be compared directly. Nevertheless, both lead to the same broad conclusion: energy recovery continues to receive the larger share of recovered wood, despite its lower position in the waste hierarchy. The established use of recovered wood in particleboard demonstrates that material recycling can provide a viable alternative at industrial scale, while further development of recycling pathways could allow an even greater proportion of the resource to remain in productive use.

Non-hazardous, but not necessarily process-ready

According to Eurostat [12], 95–98% of the wood waste generated in the EU is classified as non-hazardous. At face value, that suggests the great majority of the EU's wood waste stream is a genuine materials opportunity, safe to handle and recycle, rather than a contamination problem.

That classification, though, describes a regulatory category, not a guarantee that material arriving at a recycling centre is ready to feed straight into a production line. A 2019 peer-reviewed study sampling three Danish recycling centres found that, once physical impurities – misplaced items, interfering materials such as glass, metal or plastic, and low-quality wood – were excluded, only 41–87% of the wood collected for recycling (by weight) met the strict definition of clean, recyclable wood waste; the remainder needed further sorting even though none of it was hazardous [20]. Preservative-treated wood requiring disposal through incineration, rather than recycling, made up a comparatively small share of the same samples, 2–6%, which sits close to the 2–5% hazardous share implied by the EU-wide Eurostat figure above, showing that even though the Danish study covers only three sites, its findings are broadly consistent with the wider European picture.

Taken together, these findings point to a broader practical conclusion: sorting quality, rather than chemical hazard, is usually what stands between a tonne of collected wood waste and a tonne of usable secondary raw material – precisely the bottleneck that EcoReFibre's sorting demonstrations, covered in the following chapter, were designed to address.

Fibreboard: a sub-sector primed to follow

Set against this wider context, the trajectory of fibreboard begins to look familiar. European apparent consumption of MDF, increased from approximately 2.5 million m³ in 1995 to 11 million m³ in 2025 [13, Table II.17].

Evidence from EcoReFibre, together with more than 20 years of recycling experience among particleboard producers, confirms that fibreboard is already present in the recovered-wood stream. Between 2022 and 2025, the project analysed 205 post-consumer wood waste samples from 29 recycling sites across France. Fibreboard represented an average of 4.5% of the general recovered-wood stream and 8.4% of furniture-specific waste – almost twice the proportion found in the general stream [5]. The same analysis found that more than 90% of the sampled general recovered-wood stream was suitable for high-quality particleboard production.

EcoReFibre developed a model[1] to predict the annual volumes of waste fibreboard generated in Europe and these estimates at European level reinforce this picture. Under the conservative EU27 scenario available in the model, with no adjustment for imports, apparent MDF consumption reached a peak of 12.2 million m³ in 2021. Annual waste generation is nevertheless expected to continue increasing as material already in use progressively reaches the end of its service life, reaching a projected maximum of 10.1 million m³ in 2053 [4].

Fibreboard therefore already represents a growing secondary resource, yet recovered wood supplied only 2% of the European MDF industry's raw wood demand in 2025. The next challenge is not primarily the availability of the material, but the capacity to identify, separate and direct it towards suitable recycling processes. Developing dedicated collection, sorting and processing pathways would allow the fibreboard industry to make greater use of this resource, much as the availability of recovered wood helped establish the supply chain that now serves the particleboard sector.

Turning consumption into waste volumes

Fibreboard consumption only becomes waste after a delay that varies considerably by application and intended service life, ranging from packaging designed for efficient, shorter-use cycles to furniture, shop interiors, mouldings, doors, insulation boards and other construction products that may remain in service for decades.

Drawing on a survey of 208 respondents and European end-use market shares, an EcoReFibre assessment calculated 12 years to be the representative average lifespan of a typical product containing European MDF [4]. This lifespan estimate was combined with historical production and consumption data to model the volume of MDF entering the waste stream. The model assumes that 15% of each year's production becomes waste within one year through processing losses (due to transport, storage, cutting, shaping, etc.). The remainder enters the waste stream progressively along a four-parameter symmetric sigmoidal curve based on the 12-year average lifespan, with 99% assumed to have become waste within 45 years.

The model also accounts for fibreboard entering Europe in the form of imported products. On this basis, approximately 9 million m³ of waste MDF was projected to arise across Europe in 2025 from apparent consumption alone. The estimate increases to around 11 million m³ when consumption is adjusted upwards by 20% to account for these imported products [4].

The wave has not yet peaked

The model is published as an open-access interactive tool embedded on the **EcoReFibre website**. Users can select a geographical scope - World, EU27, France, Germany or Sweden - adjust the assumed contribution of imported products from 0% to 200%, vary the average lifespan between 6 and 15 years, and compare optimistic, conservative and pessimistic demand trajectories. Together, these variables provide 270 scenarios for each geographical area [4].

[1] The model is freely available here: https://ecorefibre.eu/model/

The projections show that the decline in apparent consumption following its 2021 peak will not immediately translate into lower waste generation. Instead, annual waste volumes are expected to continue increasing as fibreboard already in use progressively reaches the end of its service life. For planning purposes, the analysis indicates that the assumed product lifespan primarily affects when the waste peak occurs, rather than its overall magnitude. Estimates of regional waste volumes are particularly sensitive to assumptions about fibreboard entering the market through imported products [4].

The comparison with particleboard introduced in Section 3.2 is therefore increasingly supported by the available evidence. Particleboard's recovered-wood supply chain developed both in response to constraints on roundwood availability, as significant volumes were being diverted to energy use, and because substantial volumes became available in the waste stream needed a productive outlet, providing a source of recovered wood for production. Fibreboard is now approaching a similar opportunity: sampling in France confirms its presence in the general recovered-wood stream, while EcoReFibre's modelling indicates that annual MDF waste generation in the EU27 will continue increasing for several decades. These volumes are geographically dispersed, including across countries that consume MDF but do not manufacture it. The central challenge is therefore not primarily the availability of feedstock or, as the sorting evidence indicates, its overall quality. It is the development of effective sorting, cleaning and processing routes capable of returning recovered fibres to panel production - the gap that EcoReFibre has helped to close.

3.4 - BEST PRACTICES IN WOOD WASTE COLLECTION

If one of the major constraints is the infrastructure that collects, sorts and prepares wood waste rather than the resource itself, then the systems already operating at national level deserve close attention. Collection design determines both how much wood waste is captured and, critically for panel production, how homogeneous and how clean it is when it arrives. Two European examples illustrate complementary approaches: Italy, where a state/producer-financed consortium has built a nationwide collection and pre-processing network closely coupled to panel manufacturing, and Flanders, where binding regulation, dense civic-amenity infrastructure and pricing signals combine to keep clean wood streams separate at source. Neither is directly transferable in full, but both show which design choices tend to generate the quality of feedstock that material recycling requires – and are therefore instructive for any region seeking to build a recovered-wood supply chain for fibreboard.

The Italian case

In Italy, Rilegno – the national consortium for the collection, recovery and recycling of wood packaging – coordinates a nationwide system through which more than 1.7 million tonnes of wood waste, approximately half of which is wood packaging, are sent for recycling each year through around 100,000 shipments. More than 90% of the material collected is directed to panel plants. Together, the Rilegno system and the particleboard industry enable approximately 2.6 million tonnes of domestically generated wood waste to be recycled annually, supported by panel production capacity of around 3.8 million m^3. Italy's recycling rate for wood packaging is approximately 64%, exceeding the EU target for 2030.

Rilegno operates within the National Packaging Consortium (CONAI) extended producer responsibility framework and is financed primarily through an environmental contribution applied to wood packaging placed on the Italian market. The contribution will rise to 12 euros per tonne from January 2027. Additional funding is provided by industries using post-consumer wood, in proportion to the quantities collected, and through contributions from consortium members. This funding supports two complementary collection routes:

- municipal separate collection under the National Association of Italian Municipalities (ANCI)-CONAI framework agreement, which compensates for the additional cost of separate collection and differentiates payments according to the quality of the collected material; and
- a nationwide network of almost 380 affiliated private platforms, through which businesses may deliver the wood-packaging fraction free of charge.

The platforms carry out an initial reduction in volume through pressing, crushing, shredding or chipping, thereby improving transport efficiency and reducing downstream logistics costs. To ensure national coverage despite the concentration of recycling capacity in northern Italy, Rilegno also subsidises the transport of material collected in central and southern regions. In 2022, this support covered approximately 780,000 tonnes of wood waste transported over around 40,000 trips.

The system captures heterogeneous wood-waste streams at scale and directs them primarily to integrated panel-production facilities, where impurities and unwanted materials are progressively removed during processing. The resulting panels meet the relevant performance requirements established by European harmonised standards, EPF Industry Standards and the Italian industry standard UNI/PdR 115:2021 on the management of recycled wood for wood-based panel production. Italian companies have developed the technological capacity to process a wide range of wood-waste fractions that might otherwise be difficult to recover.

The Italian system also combines recycling with upstream reuse. By 2022, more than 903,000 tonnes of pallets, corresponding to approximately 70 million units, had been repaired or regenerated and returned to their original function. This demonstrates how reuse and recycling can operate alongside one another within a coordinated system.

Collectively, stable EPR (Extended Producer Responsibility) funding, complementary public and private collection channels, quality-related compensation, nationwide platform coverage, logistics equalisation and strong demand from panel manufacturers help explain Italy's high wood-packaging recycling rate and provide a potentially replicable model for other countries.

The Flemish case

Flanders' system is anchored by the Materials Decree and VLAREMA (Flemish Regulation on the Sustainable Management of Material Cycles and Waste), and implemented by OVAM, the Flemish Public Waste Agency. Flanders deliberately prioritises separate collection at source, delivered through a dense, user-friendly network of recycling parks (civic amenity sites): 90% of the population lives within 5 km of an accessible site, or there is at least one site per municipality above 10,000 inhabitants. These parks accept over 30 waste fractions with clear signage and operational controls, yielding homogeneous streams that enable high-quality recycling.

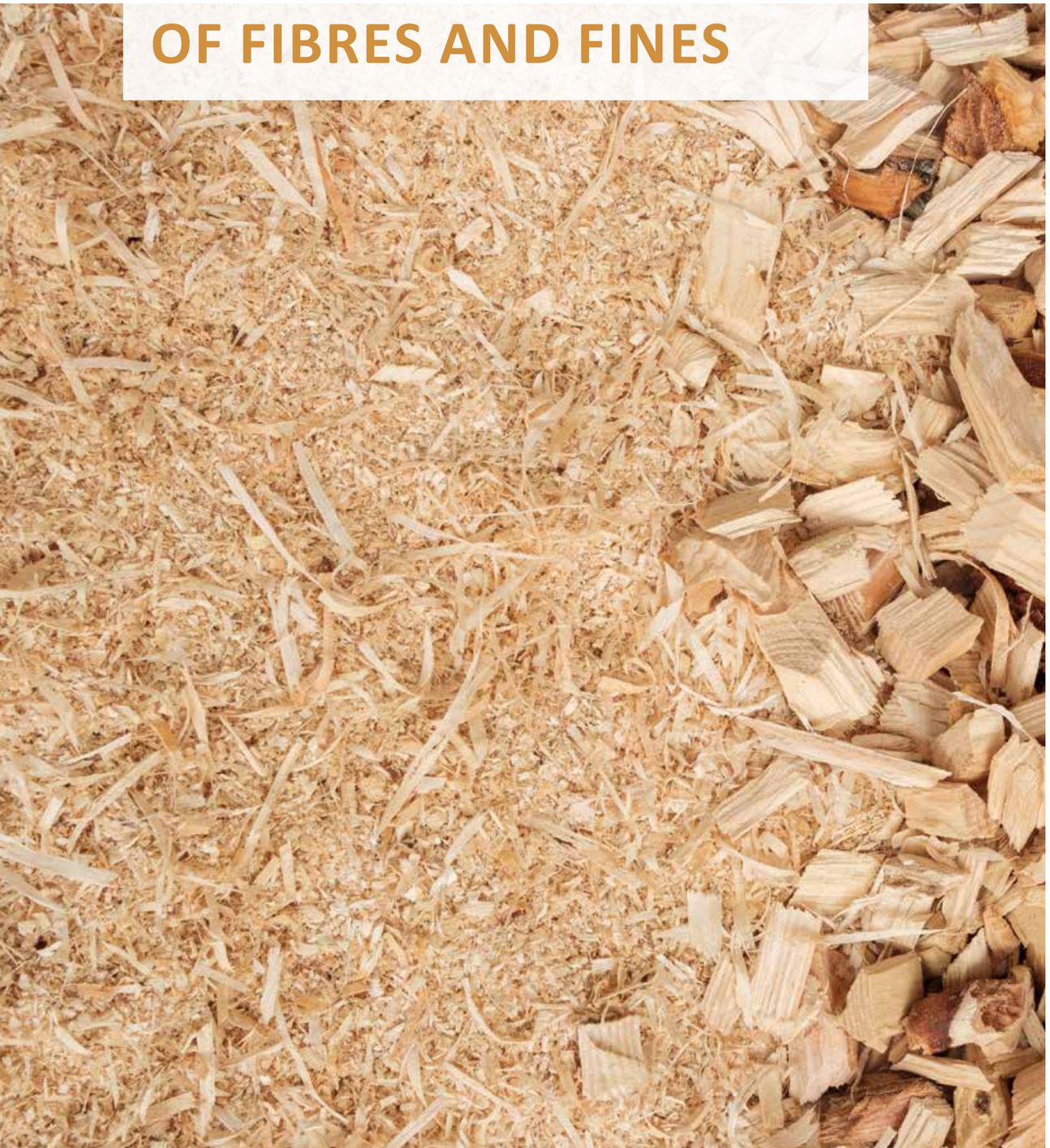
Economic instruments reinforce behaviour: pay-as-you-throw for mixed household waste (with standardised minimum and maximum tariffs to ensure incentives and fairness), and landfill/incineration bans and taxes to steer waste towards prevention, reuse and recycling. Flanders also embeds EPR, both through duty of acceptance and take-back obligations, leveraging retail and municipal infrastructure for collection. Additionally, reuse is integrated structurally via accredited reuse centres and initiatives such as the De Kringwinkel network and recycling platform, supported by municipal cooperation agreements and subsidies, ensuring that reusable furniture and other items are captured, while non-reusable components are subsequently channelled to recycling.

This balanced policy mix – source separation, access convenience, pricing signals, regulatory restrictions on disposal, EPR, and formalised reuse partnerships – has produced one of Europe's highest diversion and recycling performances, with OVAM emphasising that the approach is designed to generate homogeneous streams for high-quality recycling while ensuring transparent governance and seamless enforcement.

Flanders' Materials Decree and VLAREMA translate the waste hierarchy into binding, enforceable rules that make high-quality material use the default for wood. Through separate collection obligations, acceptance controls, EPR, and market-enabling end-of-waste pathways – reinforced by landfill and incineration restrictions – clean wood flows are preserved for panel manufacturing and other circular applications, with energy recovery reserved for non-recyclable residues.

Building on chapter 3, which presents the overall approach to wood waste recovery, this chapter focuses on the two connected stages demonstrated by EcoReFibre. Section 4.1 describes the sorting line used to separate mixed wood waste into usable fractions. Sections 4.2 and 4.3 present two different fibre recovery approaches: Dieffenbacher's wet and dry process and a mTMP process proposed by Institut fuer Holztechnologie Dresden GmbH (IHD).

4 SORTING AND RECOVERY OF FIBRES AND FINES



4.1 - A SORTING LINE FOR SEPARATING WOOD WASTE INTO USABLE FRACTIONS FOR NEW WOOD-BASED PANELS (DEMO A)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

EcoReFibre demonstrated a multistage sorting line that recovers three output streams: solid wood, fibreboard and a remaining mixed fraction.

Technology, achievements and next steps

Pre-shredded wood waste with mixed chip dimensions is first screened to create a consistent fraction based on thickness. Adjustable roller gaps and roller speeds separate the stream into chips, fines, and oversized material. This screening step is essential to remove material that is too fine or too coarse. The screened fraction then enters a cleaning unit that removes impurities (incl. metals, stones, plastics, etc.) in order to improve material quality before optical sorting. Optical sorting uses camera-based detection and AI classification to achieve high purity, separating the mixed waste wood stream by wood types.

The system analyses items on the conveyor in fractions of a second relying on Machine Learning. Classification relies on optical features, including shape and break edge which helps distinguish fibreboard pieces from wood particles even when coatings are present. At the end of the conveyor, items are diverted into separate streams through precisely timed pulses of compressed air.

A first optical sorting step recovers a solid wood fraction. A second step produces a fibreboard enriched fraction and a remaining mixed stream. A third step can be applied to further concentrate fibreboard chips as the final output.

The EcoReFibre sorting demonstration confirmed that high-purity fractions can be recovered from wood waste. Solid wood was separated in a single sorting stage, reaching 95% purity. Fibreboard was recovered through a two-stage sorting approach, achieving 97% purity. In total, more than 100 tonnes of material were processed, supporting the industrial relevance of the technology. The sorted material was further used in downstream trials to demonstrate new recycling pathways. Both recycled fibreboard and solid wood were broken down into fibres, and the resulting recycled fibres were then used to manufacture different fibreboard products.

With feedstock sorted to 97% purity, small residual impurities remain and must be removed so they do not become visible on the panel surface, where they impair the finish and may cause micro holes during sanding or coating. On the one hand, this can be improved through better and early upstream material classification. On the other hand, ongoing work optimises the Machine Learning focusing on the optical sensors to strengthen contaminant detection and removal.

4.2 - EXTRACTION OF WOOD FIBRES AND FINES FROM POST-CONSUMER FIBREBOARD (DEMO B)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

Following the sorting stage described in section 4.1, this section presents two routes developed by Dieffenbacher to recover fibres and fines from the separated fibreboard fraction. The wet and dry processes provide different pathways to generate secondary raw materials for wood-based panel production and other uses.

The wet process is a batch process and can be integrated into existing fibreboard production lines. The dry process is a continuous process that can be integrated into particleboard plants. EcoReFibre has demonstrated both processes using post-consumer fibreboard to produce high-quality secondary raw materials for wood-based panels. Both technologies reached Technology Readiness Level (TRL) 6.

Wet process: technology, achievements and next steps (DEMO B-wet process)

In the wet process, saturated steam softens the chips under pressure, breaking down water soluble binders. A rapid pressure drop then releases the fibres and dries them, reducing moisture to below 15%. The fibres are then cleaned in a sifter to remove impurities such as metals, plastics and all kind of surface coatings. These fibres are ready to be used in the production of new fibreboards. The wet process can handle production residues from medium- and high- density fibreboards (MDF, HDF), laminate flooring and insulation boards.

The wet process treated several tonnes of post-consumer fibreboard chips and produced clean fibres with quality comparable to virgin fibres. The process tolerates contaminants (e.g. screws, plastic, coatings) to be removed afterward to meet required quality standards. It also showed economic advantages through lower thermal and electrical energy demand than fibreboard production from virgin wood. The technology is scalable, with industrial units available at 1.5 tonnes per hour and 4 tonnes per hour.

In the wet process, future work includes testing a wider range of input materials, aiming the process to reliably handle pre- and post-consumer fibreboard (MDF, HDF), laminate flooring and insulation products. In parallel, further optimisation should focus on operating settings and plant layout to maximise fibre quality, impurity removal and integration into existing industrial lines.

Dry process: technology, achievements and next steps (DEMO B-dry process)

In the dry process, fibreboard chips are milled in a continuous process into fine particles with a defined particle size using a horizontally rotating tool. Because post-consumer fibreboard often has surface coatings, the chamber is designed to remove them during processing. Air currents lift coatings away from the milling zone, and an internal flap opens periodically to extract them pneumatically. The remaining material is then screened into three fractions, each collected as separate output streams: oversize, fines and dust. Oversize is recirculated for further milling. Fines are the coarser fine-particle fraction, while dust is the finer, powder-like fraction.

The dry process processed more than 22 tonnes of post-consumer fibreboard chips. It produces fines with the required particle size distribution for particleboard surface layer, while separating coatings into a dedicated stream. The remaining dust can be used for bioblocks, modular construction units developed in another part of the project.

For this process, next steps include refining key settings such as rotation speed and screen mesh size to maximise output quality and quantity for downstream production.

4.3 - DEFIBRATION OF SOLID WOOD WASTE AND POST-CONSUMER FIBREBOARDS: THE MTMP PROCESS (DEMO C)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

Following the wet and dry routes presented in Section 4.2, this section introduces IHD's mTMP process as another approach to fibre recovery. It describes the technology, its optimisation and its progression toward continuous operation and industrial upscaling.

Technology, achievements and next steps

The moisture modifying thermo-mechanical pulping (mTMP) process addresses one of the main technical limitations of recovering fibres from wood waste: that is the low moisture content of the input material. With only minor adjustments to existing industrial plants, the technology enables the production of fibres for medium- and high-density fibreboard (MDF, HDF) and insulation material from various waste wood streams, including dry solid wood and post-consumer fibreboards. Recycled wood chips are first moistened using a specially designed evacuation device, then heated and softened in the digester. Mechanical treatment in the refiner finally transforms the chips into fibres with a size distribution comparable to those obtained from virgin wood.

The mTMP process advanced from TRL 5 to TRL 6, producing high-quality fibres for fibreboard production with infeed including up to 25% recycled post-consumer fibreboard or up to 100 % solid wood waste. In addition, it provides valuable data for industrial upscaling.

During the first phase of development, the mTMP process reached TRL 5 through the optimisation of process parameters in a batch-based defibration system. The optimised process successfully produced high-quality fibres from post-consumer fibreboards and solid wood waste. Fibre size and type distribution were comparable to those of virgin wood, demonstrating the potential of the technology for industrial application. Dust levels, an indicator of effective humidification of dry waste wood, were significantly reduced compared to a non-modified TMP process, thus improving fibre yield and handling. In the second phase, a continuous process was developed (TRL6), marking progress towards industrial upscaling. Trials with different defibration parameters, including variations in steam pressure, retention time and grinding gap, ensured consistent fibre quality. The trials showed that prioritising uncoated boards for recycling is required to maintain fibre quality. The generated process data, close industry collaboration, and preparatory design work, now underpin the industrial upscaling and integration of the mTMP process.

Future R&D activities could focus on further optimising the defibration process to ensure high fibre quality across different waste wood sources. This includes developing technologies optimising fibre saturation through enhanced steam penetration into wood chips to maintain fibre properties regardless of their initial moisture content. In parallel, further research could build on IHD's work on chemical properties, such as formaldehyde content and pH, which differ from those of virgin wood fibres. This research would help to better understand how these properties affect emissions, bonding performance and identify ways to optimise them for fibreboard production.

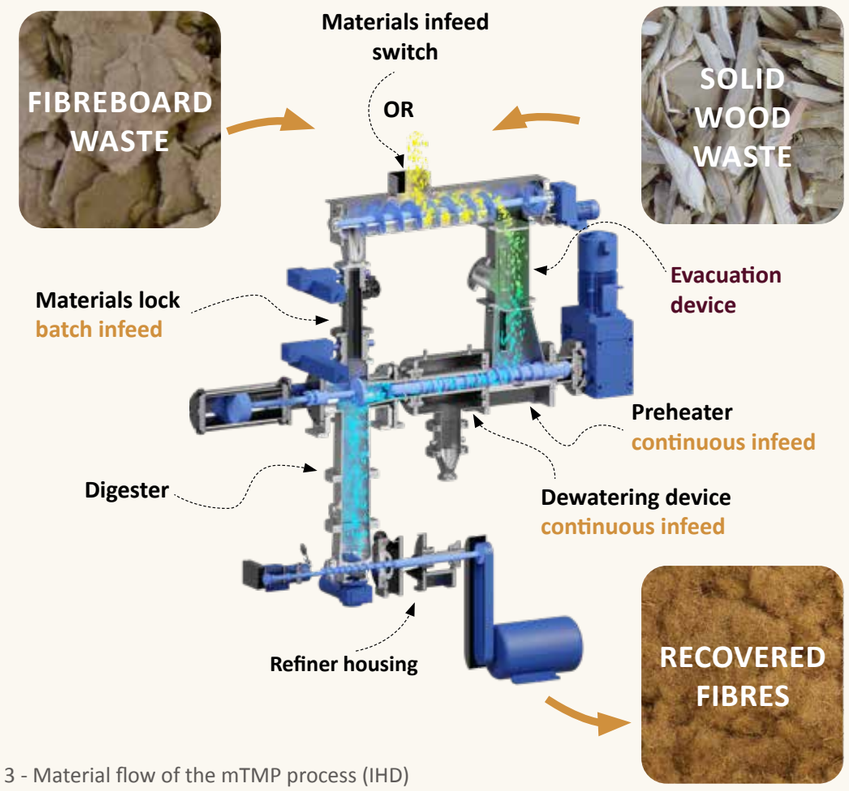


Figure 3 - Material flow of the mTMP process (IHD)

5 NEW PRODUCTS WITH RECYCLED CONTENT AND BY-PRODUCT VALORISATION



5.1 - RECYCLING POST-CONSUMER FIBRES FROM WOOD WASTE INTO NEW FIBREBOARDS (DEMO F)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

Building on the fibre recovery processes presented in chapter 4, this section examines how post-consumer fibres were incorporated into new MDF and HDF panels. It presents the recycled content achieved and the performance of the resulting products. Further information on the characteristics and applications of MDF and HDF is provided in chapters 8 and 9.

Achievements and next steps

EcoReFibre demonstrations showed that MDF and HDF containing recycled fibres achieved performance comparable to reference panels, confirming technical feasibility. At laboratory scale, the incorporation of 15% and 25% of fibres obtained from post-consumer fibreboards into new panels was successfully demonstrated. Two extraction technologies provided the fibres: the mTMP developed by IHD and the wet process by Dieffenbacher. These fibres were then used to produce panels in a conventional lab press. The resulting physical and mechanical properties aligned with reference panels in most aspects (e.g. bending strength, thickness swelling, stiffness). However, internal bond, panel density and surface quality required some optimisation. Overall, incorporating 15% recycled fibres yielded better performance than 25%.

Following the lab results, industrial trials were conducted. A trial using fibres produced by Dieffenbacher's wet process replaced virgin fibres at 5%, 10% and 15% in HDF production. They had to be blended unglued with the virgin fibres that were slightly overglued to achieve a standard overall gluing ratio. The trial confirmed that up to 15% recycled fibres can be incorporated into thin HDF without reducing or affecting line productivity, surface quality and paintability. Swelling and modulus of elasticity showed no significant changes, while both bending strength and internal bond decreased. Due to the absence of adhesive on the post-consumer fibres, the latter results were expected and could not be balanced with a 10% glue increase. Workability tests found little or no change in permeability; cutting and milling quality remained good and no critical issues from the recycled fibres were found. In addition to post-consumer fibreboards, two more trials were carried out using post-consumer solid wood as input: one for MDF and one for thin HDF. The solid wood was processed in a conventional thermo-mechanical pulping process to obtain fibres. For both, results showed that if the material is well sorted and cleaned, it can be integrated into production. Post-consumer solid wood was crushed and blended with virgin wood chips. Panels containing up to 25% recycled fibres met all physical, mechanical and internal requirements (EN 622-5), with properties comparable to reference boards, and without reducing line productivity or degrading mechanical and swelling properties. In the MDF trial, all samples surfaced with melamine resin-impregnated decorative paper showed no visual defects or processing issues, confirming suitability for decorative paper surfacing. Migration of harmful substances testing proved all quantified elements were below EN 71-3 thresholds, confirming toy safety compliance and no performance impact from recycled wood incorporation. In thin HDF, a slight improvement in some properties was even observed. However, as these boards are produced in a single layer and are particularly sensitive to impurities, any loss of material quality can affect the final product, also risking damage to the press. Visual inspection occasionally revealed surface imperfections from tiny plastic fragments, including removable pieces that left micro holes and local uplifted areas. These defects can affect subsequent finishing such as painting or foiling.

Complete feedstock purity was identified as the main challenge for increasing recycled content. Even the 95% purity level reached was not enough, indicating the need for perfectly sorted and cleaned material. In addition, optimised logistics and expanded collection networks are needed to ensure a stable supply of high-quality material. At plant level, adaptations are required to integrate recovered wood into existing production lines while maintaining compliance with quality and performance standards. These concern sifter capacity, sorting, cleaning and blending.

5.2 - RECYCLING POST-CONSUMER FIBRES FROM WOOD WASTE INTO NEW INSULATION PRODUCTS (DEMO G)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

After recovering fibres through the processes described in chapter 4, EcoReFibre assessed their use in rigid, flexible and loose-fill insulation products. This section presents the recycled content achieved, the performance of the different products and the next steps toward industrial application. Further information on the characterises of wood fibre insulation products is provided in chapters 8 and 9.

Achievements and next steps

The incorporation of recycled fibres from post-consumer fibreboard and solid wood waste into insulation products was successfully demonstrated at pilot scale (bridging lab and industrial scale). Fibres from two different EcoReFibre technologies have been used: the moisture modified thermo-mechanical pulping (mTMP) developed by IHD and the wet process developed by Dieffenbacher.

- Rigid insulation boards showed differences by product density and fibre source. In all cases, high-density boards (200 kg/m3) did not reach the required mechanical performance when recycled fibres were incorporated. In contrast, lower-density boards (115 kg/m3) met the specifications with up to 25% fibres from post-consumer fibreboard or with well sorted and cleaned fibres from post-consumer solid wood at 25%, 50% and 100% substitution.
- Flexible insulation boards with up to 50% fibres from post-consumer fibreboard had properties comparable to conventional reference panels, with even a slightly improved thermal performance. While recycled fibres increase dust content in the board, the addition of a facing on one side could help limit dust release. Flexible insulation boards with up to 100% well sorted and cleaned fibres from post-consumer solid wood met all specifications.
- Loose-fill insulation was assessed using 25% fibres from post-consumer fibreboard while fibres from post-consumer solid wood were tested up to 100% incorporation. For attic insulation, none of the formulations met specifications at the incorporation rates tested. For wall cavities, results were more promising with several products meeting the density and thermal conductivity specifications thresholds.

Key next steps include maintaining consistent input quality and tighter process control, especially when using fibres from post-consumer fibreboard to reduce dust and maintain mechanical performance. Lastly, these improvements will need to be confirmed at industrial scale to support process scale-up.

5.3 - INTEGRATING RECYCLED FIBREBOARD FINES IN THE SURFACE LAYER OF PARTICLEBOARD (DEMO D)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

Following the dry process described in Section 4.2, EcoReFibre assessed how recovered fibreboard fines can be used in the surface layer of particleboard (PB). This section presents the lab and industrial demonstration results and evaluates the potential to replace part of the conventional wood mix. Further information on the characteristics and application of particleboard is provided in chapters 8 and 9.

Achievements and future challenges

Fines can be obtained from wood processing and from recycling fibreboards (FB). Indeed, when recycling FB, the panels are disintegrated into a mixture of fibres and fines, with their relative proportion depending on the process used. In the EcoReFibre project demonstration, these fines were integrated at 10%, 20% and 30% into the surface layer of PB to test if they can substitute the standard wood mix. The fines were produced with the dry process developed by Dieffenbacher – a water and chemical-free mechanical process. At lab scale, substitution of up to 30% with FB fines showed promising results. However, to ensure product performance and process stability, the industrial trial focused on 20% substitution with FB fines integrated into the conventional production line. The resulting particleboards achieved performance comparable to the reference panels.

Visual surface quality proved sensitive to material variability with occasional defects at higher substitution levels caused by local fines agglomeration. Analysis showed that these agglomerates were linked to storage in big bags and mechanical conveying methods that did not sufficiently disperse fines clusters. Future work should therefore focus on improving feedstock preparation and handling to achieve a more homogeneous surface layer and fully exploit the potential of recycled fines under industrial conditions.

5.4 - BIOBLOCKS: CONSTRUCTION MATERIAL MADE FROM WOOD FIBREBOARD DUST (DEMO E)

ACCESS THE RESULTS IN BRIEF AND CONTACT INFORMATION.

Product design and potential applications

Bioblocks are modular construction units made from fibreboard dust, a by-product from sanding and routering fibreboards before their use in interior fittings. The dust is combined with a fully bio-based adhesive (citric acid and sorbitol). Hence, bioblocks valorise secondary raw material that would otherwise be burnt for energy recovery and offer a circular building material for the construction sector. The current second-generation “bioblock II” design integrates axial voids that reduce weight and allow for reinforcement or service conduits. Male-female interlocking alignment keys enable precise mortar-free assembly, simplifying installation and supporting industrial scalability. Originally designed for non-load-bearing interior partitions, bioblocks are undergoing testing and optimisation that indicate potential for structural applications. Their strength, modular design, relatively low weight (450 kg/m3), and easy handling make them a promising and cost-effective option for lightweight extension solutions. This includes the possible addition of one or two storeys of existing residential or small commercial buildings.

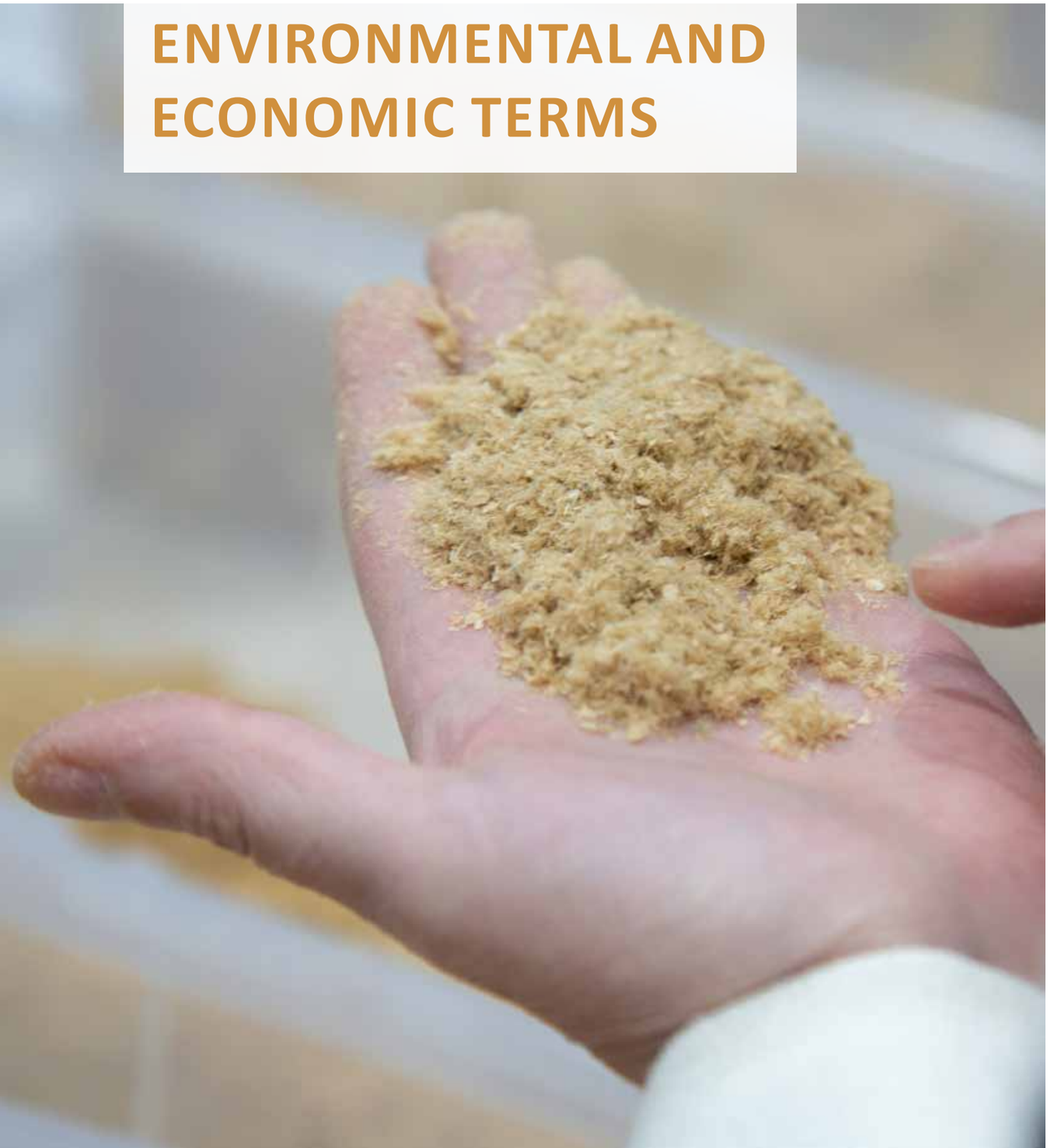
Achievements and R&D

Bioblocks proved ready for pilot and industrial trials as biobased, recyclable, high-performance building material. The bioblock concept has advanced from small lab prototypes to full-scale building blocks. The production process was optimised using a design of experiments approach (DoE). At pilot scale, bioblocks were produced using blends of post-consumer fibreboard fine particles and dust processed by Dieffenbacher and Smartpanel production residues, with post-consumer content of 0%, 25%, 50%, 75%, 100%. Performance tests achieved strong compressive strength, moisture-resistance (minimal swelling after water exposure), and promising thermal and acoustic performance. In addition, the material can be reused or recycled into new blocks multiple times, supporting circular use.

Studies indicate that bioblocks could help improve the environmental performance of fibreboard waste and replace more harmful construction materials. However, the influence of residual synthetic resins from medium-density fibreboard (MDF) on the production process and final performance still requires further assessment. On the way towards industrial-scale production, Smartpanel has developed a bulk processing curing method in a large container dryer.

Smartpanel and NIBIO are optimising the product and curing system to complete the demo phase and prepare for pilot-scale production. Interlocking connection strength is being investigated, with vertical reinforcement poles across the voids and other reversible bonding systems. Further testing was conducted to assess fire resistance, thermal and acoustic performance, and volatile organic compounds (VOC) emissions. Scale up was expected to improve cost-efficiency. Developing wall prototypes, assessing the adhesive system and carrying out long term-monitoring were also identified as next steps to optimise the product and support large-scale testing.

6 LCSA RESULTS IN ENVIRONMENTAL AND ECONOMIC TERMS



This chapter provides an overview of the main findings of the Life Cycle Sustainability Assessment (LCSA) carried out within the EcoReFibre project. The detailed results are reported in Deliverable D4.1 – Sustainability: applications and recycling value chains [6].

The LCSA first assessed each EcoReFibre value chain individually – from waste wood sorting, through recycled fibres and fines extraction, to final product manufacture – against reference products based on virgin wood resource. The environmental assessment followed ISO 14040/14044 (SimaPro software, EcoInvent database) and allowed the calculation of eight impact indicators, chosen from those recommended by EN 15804 + A2. The economic assessment applied a life cycle costing framework, with all costs normalised to 2023 European price levels. This section of the Guidebook focuses solely on the environmental and economic findings. Additionally, D4.1 also includes a full social life cycle assessment of these value chains, covering supplier and workforce-related risk categories, which are not covered here. For an in-depth view of the full report, the reader can refer to EcoReFibre Deliverable 4.1 – Sustainability: applications and recycling value chains [6].

Concerning recycling of fibres into MDF, HDF panels and flexible and rigid insulation panels, the environmental results show equivalent to slightly positive performance of the products containing recycled fibre in comparison to reference products. On the economic side, net cost savings ranging from 3 to 9% are identified.

One methodological point is worth keeping in mind throughout: reference product data come from mature, full-scale industrial processes, while EcoReFibre data come from pilot- or lab-scale experiments. Because recycling processes typically become more efficient once implemented at industrial scale, the sustainability benefits of EcoReFibre solutions could well improve further once these pathways move beyond the pilot stage.

Across almost every product studied, the same handful of factors determine whether a given recycling pathway brings advantages or disadvantages relative to its reference product: the amount and type of glue and additives used, process energy costs, and the recycled-content incorporation rate itself. For a European-scale recycling system, variations in transport distance for waste wood (whether before sorting or between processing stages) made no significant difference to the environmental or economic conclusions in any application tested.

Ultimately, the purpose of this work was to compare the environmental impacts and cost trade-offs of implementing these recycling pathways at European scale against the present situation – one in which the management of post-consumer fibreboard waste does not include material recycling at all.

Therefore, beyond individual products, the study modelled four scenarios for a combined «EcoReFibre system» – sorting and recycling fibreboard waste at European scale, feeding it into MDF, HDF and insulation production – against a reference scenario representing today's situation (virgin-fibre production plus fibreboard waste disposal split evenly between incineration and landfilling).

Virgin Wood Saved

Depending on the scenario, recycling fibreboards could save up to 4.4 million tonnes of virgin wood annually, against the roughly 8.6 million tonnes of virgin wood (56% roundwood, 44% sawmill by-products) currently used for MDF production across the EU. At the upper end, this represents around half of current virgin wood demand for MDF.

Environmental results

Compared with the reference scenario, all EcoReFibre scenarios perform significantly better on climate change (-18–40% less CO2), human toxicity (15–25% lower) and non-hazardous waste disposed (15–25% lower), while using more secondary material (23–24% more, a positive indicator here). Acidification, and water use show no meaningful difference. For Eutrophication and fossil resource use, the results are sometimes equivalent and sometimes degraded (up to respectively 21% and 26%) The one exception is ecotoxicity (freshwater), which is higher under every EcoReFibre scenario (10–22%).

In absolute terms, this amounts to around 7 million tonnes of CO2-equivalent emissions avoided per year. Looking ahead to 2050, using EcoReFibre's own fibreboard waste projection model, the picture holds up: assuming a prudent 3% rise in MDF production and stable recycled-content shares, the same scenarios would deliver climate benefits of 36–51%, with 5–7% additional improvement in CO2 terms between 2023 and 2050.

Economic results

All EcoReFibre scenarios generate substantial cost savings, in the range of roughly 720 million to 1.2 billion euros per year at European scale, with a 25%-recycled-content scenarios. These savings are, in effect, a twofold gain: recycled fibre is cheaper to use in production, and avoiding incineration and landfill disposal of fibreboard waste saves on waste management costs.

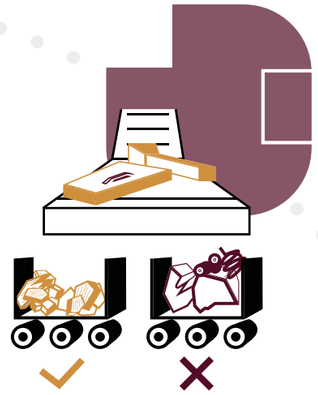
As stated earlier, because reference products reflect mature industrial-scale processes while EcoReFibre data come from pilot- and lab-scale trials, today's results are likely a conservative baseline: moving these pathways to full industrial scale should be expected to improve, rather than worsen, the comparisons between reference products and EcoReFibre demos presented here.

7 POLICY RECOMMENDATIONS

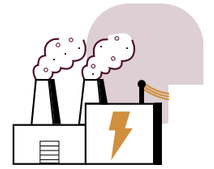




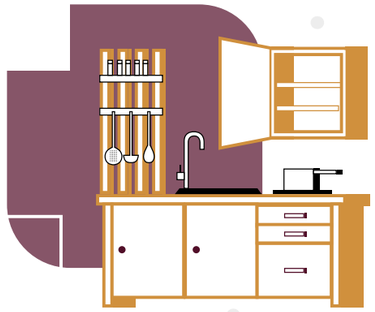
1 USED PRODUCTS, MATERIALS AND WASTE COLLECTION



2 SORTING



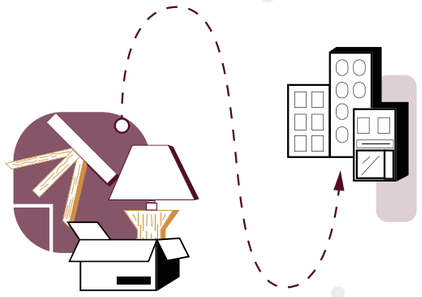
ENERGY RECOVERY FROM RESIDUAL MATERIALS



8 FURNITURE AND PRODUCTS USE

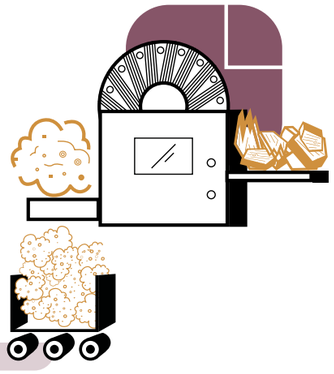


3 VIRGIN AND RECOVERED MATERIALS PROVISION

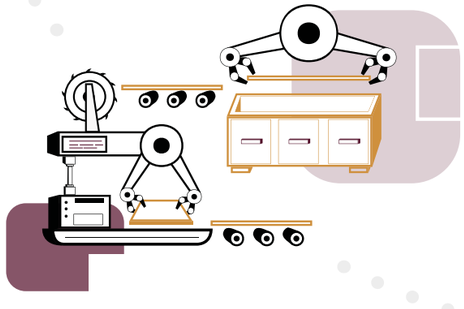


DISTRIBUTION 7

4 FIBRE PRODUCTION



6 FURNITURE AND PRODUCTS MANUFACTURING



5 PANEL PRODUCTION

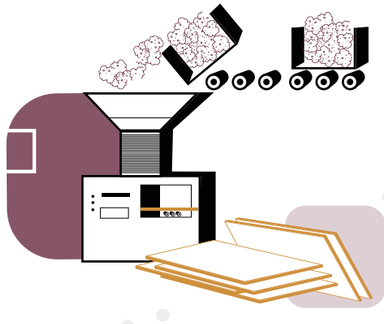


Figure 4 - General overview of the wood material cycle for fibre recycling. EcoReFibre technologies focus on 2. sorting and 4. fibre production from recovered wood.

The previous chapters have shown how, from a macroeconomic, environmental, and societal perspective, keeping wood in material loops delivers the greatest overall added value: it preserves embedded carbon in new products, strengthens the EU's circular bioeconomy, and reduces pressure on virgin resources. In line with the Waste Framework Directive's (WFD) hierarchy [16] and Renewable Energy Directive III's (RED III) [18] emphasis on material use before energy recovery, EcoReFibre focuses on scaling highquality recycling of wood and fibreboard waste so that these secondary raw materials can flow back into manufacturing while preserving their highest value.

Figure 4 summarises the wood material cycle, from the collection and sorting of end-of-life products to fibre recovery, panel production, manufacturing, distribution and use. It shows how the technological solutions presented in chapters 4 and 5 support a more circular use of wood by improving the recovery of fibres and fines, reintegrating them into new products and directing residual materials to energy recovery.

However, establishing this circular model at scale requires more than technological solutions. Three mutually reinforcing conditions must be met:

Design for circularity

Products and components are designed for reuse and high-value recycling, supported by available, proven recycling technologies and process routes.

Efficient secondary materials markets

Clear specifications and standards, predictable demand from end-users (e.g. panel manufacturers), and fair market conditions enable long-term investment in collection, sorting, and recycling capacity across the EU.

Secure high-quality supply at volume

Ensure that the maximum practicable share of recovered wood reaches material recycling streams as clean, well-characterised fractions, rather than being lost to disposal or low-value recovery.

Across Europe, secondary raw material markets and infrastructures are only partly designed for a circular bioeconomy. The fulfilment of the above-mentioned conditions 2 and 3 requires substantial adjustments and setup of decentralised multi-stakeholder networks for higher value creation that optimise the use of secondary raw materials and close material loops early.

A sustained dialogue across the value network is then essential, linking waste holders, collectors, sorters, logistics providers, recyclers, panel manufacturers, brands, municipalities and regulators, as to enable a common understanding of the conditions required to keep secondary raw materials flowing to their highest-value use.

Ultimately, improved wood waste management enables an expansion of the overall material supply and benefits the entire forestbased sector. The following sections outline targeted policy recommendations that operationalise these goals. These recommendations are set out in greater detail in EcoReFibre Deliverable 5.3, the Strategic Roadmap [8], which explores how to unlock the circularity and market potential from wood waste. The reader can access the Strategic Roadmap for further detail. The **STRATEGIC ROADMAP** was presented at a Policy Conference held on 25th March 2026 in Brussels, hosted by the EPF and the InnovaWood network together with the EcoReFibre consortium, where more than 70 experts from policy, industry, research and civil society took part in workshops to discuss and jointly refine its recommendations. The results of these workshops have been compiled in the report Results and recommendations from the Policy Conference «Unlocking Circularity and Market Potential from Wood Waste» [10]. The conference presentations are available in [9].

While D5.3 focuses on policy recommendations, EcoReFibre Deliverable 4.2, Sustainability: general and technology recommendations for optimised implementation, takes a technology and implementation perspective: it places the results of the life cycle sustainability assessment in a broader system context and recommends how recycled fibres can be integrated into wood-based products in ways that improve overall sustainability [7].

7.1 INCREASING THE QUANTITY OF WOOD WASTE COLLECTED

Mobilising wood waste collection and recycling

Challenge

A significant increase in wood waste collection is the essential first step to unlock the full potential of recycling and circularity. Only with a significantly higher volume of collected wood waste can the efficient sorting, logistics, and recycling schemes be developed and optimised. To achieve these foundational steps, a balanced mix of measures that works with local realities is required. An integrated approach would expand volumes across all streams, lower transport and carbon, and keep economic value and jobs within the EU.

Recommendations for policy measures:

- Increase wood waste collection as a top priority to expand the volume available for material recycling across all streams. Encourage Member States to design and adopt flexible collection and sourcing approaches that reflect local market structures. Where feasible, set ambitious yet realistic recycling targets to drive sustained capture growth, monitoring outcomes to assess whether a later, proportionate harmonisation of collection systems would add value.
- Incentivise producer take-back and reverse logistics so that furniture and construction product manufacturers arrange the return of post-consumer wood to panel producers/recyclers, enabling direct material recycling and closing the loop between product and raw material supply, e.g. under EPR schemes.
- Provide incentives or support mechanisms for local authorities, waste operators, and businesses to invest in infrastructure and logistics for increased wood waste collection.

Prioritising material use of wood over energy recovery

Challenge

To maximise the circular use of wood resources, it is essential to ensure that high-quality wood fractions are prioritised for material recycling before energy recovery. This aligns with cascading principle of the RED III Directive [18], which prioritises wood-based products, reuse, and recycling ahead of bioenergy, reserving energy recovery for cases where no economically viable or environmentally appropriate material use exists. In parallel, accelerating alternative renewables relieves pressure and competition on suitable fractions of woody biomass for higher-value material uses. Mandating the separation and diversion of suitable wood for material use allows for increased recycling rates and resource use optimisation.

Recommendations for policy measures:

- Recalibrate public support to avoid distorting competition with the material sectors.
- Implement the cascading use principle of the RED III Directive: "prioritise material uses with a view to ensuring that woody biomass is used according to its highest economic and environmental added value in the following order of priorities: (a) wood-based products; (b) extending the service life of wood-based products; (c) reuse; (d) recycling; (e) bioenergy; and (f) disposal" [18].
- Adjust the deployment of alternative renewable energy sources, such as solar, wind, geothermal and non-woody biomass to reduce heat and electricity demand from woody biomass, to align with the EU's energy transition goals.

Optimising storage for consistent wood supply

Challenge

Adequate and flexible storage capacity at recycling and collection sites is essential for the efficient management of wood waste and to buffer substantial seasonal fluctuations in supply and demand. Regulatory frameworks should be adapted to local market conditions, fire safety requirements, and stakeholder needs.

Recommendations for policy measures:

Increase allowable storage limits for operators with the technical capability to assess quality, avoid fire risk and channel high-quality fractions to material recycling. Additionally, allow for temporary or flexible storage solutions (such as modular storage or covered outdoor areas). This enables the management of seasonal peaks in the generation of wood waste, thereby preventing significant quantities from being excluded from value creation.

7.2 UPGRADING THE QUALITY OF COLLECTED STREAMS

Modernising collection and sorting technologies

Challenge

To maximise the quality and value of wood waste fractions, it is essential to modernise collection systems and integrate advanced sorting technologies at the earliest stages of the process. The goal is to reduce material mixing, improve sorting efficiency, and lower operational costs, thereby enabling a robust and economically viable recycling value.

Recommendations for policy measures:

- Maximise the recovery of recyclable wood waste through targeted pre-processing and dismantling (furniture) and selective demolition (construction/renovation), paired with mandatory or incentivised separate collection at municipal and commercial levels. Implement dedicated streams with advanced containers and clear labelling, high-control methods at civic amenity sites, and embed these requirements in public procurement, building codes, and demolition permits to ensure early differentiation and minimise mixing.
- Mandate that EPR funds are reinvested in the continuous improvement of collection systems, prioritising the recovery of recyclable wood waste at or near the source to improve resource efficiency and support the development of secondary material markets.
- Support the deployment and scaling-up of AI-supported and sensor-based sorting technologies through targeted funding, public-private partnerships, or regulatory requirements.

Efficient delivery of recyclable wood to material reusers

Challenge

Separately collected wood waste often loses value when first handled by operators without the technical capability to assess quality and channel high-quality fractions to material recycling. To safeguard quality and maximise circular value, public guidance for municipalities and large waste holders should set a preferrable follow-up destination – qualified material producers, such as panel manufacturers, who are the main downstream user of recovered wood. Positioning technically capable operators at the front of the chain improves consistency for civic amenities and reduces leakage to lower-value uses.

Recommendations for policy measures:

- Recognise all qualified facilities for material use of wood waste, such as wood-based panel manufacturers, as “wood waste competence centres” and set them as the preferred destination for separately collected recyclable wood waste. These competences include:

  (a) to assess, clean, and grade the incoming streams against agreed quality criteria;

  (b) to prioritise allocation of recyclable fractions to material recycling routes.





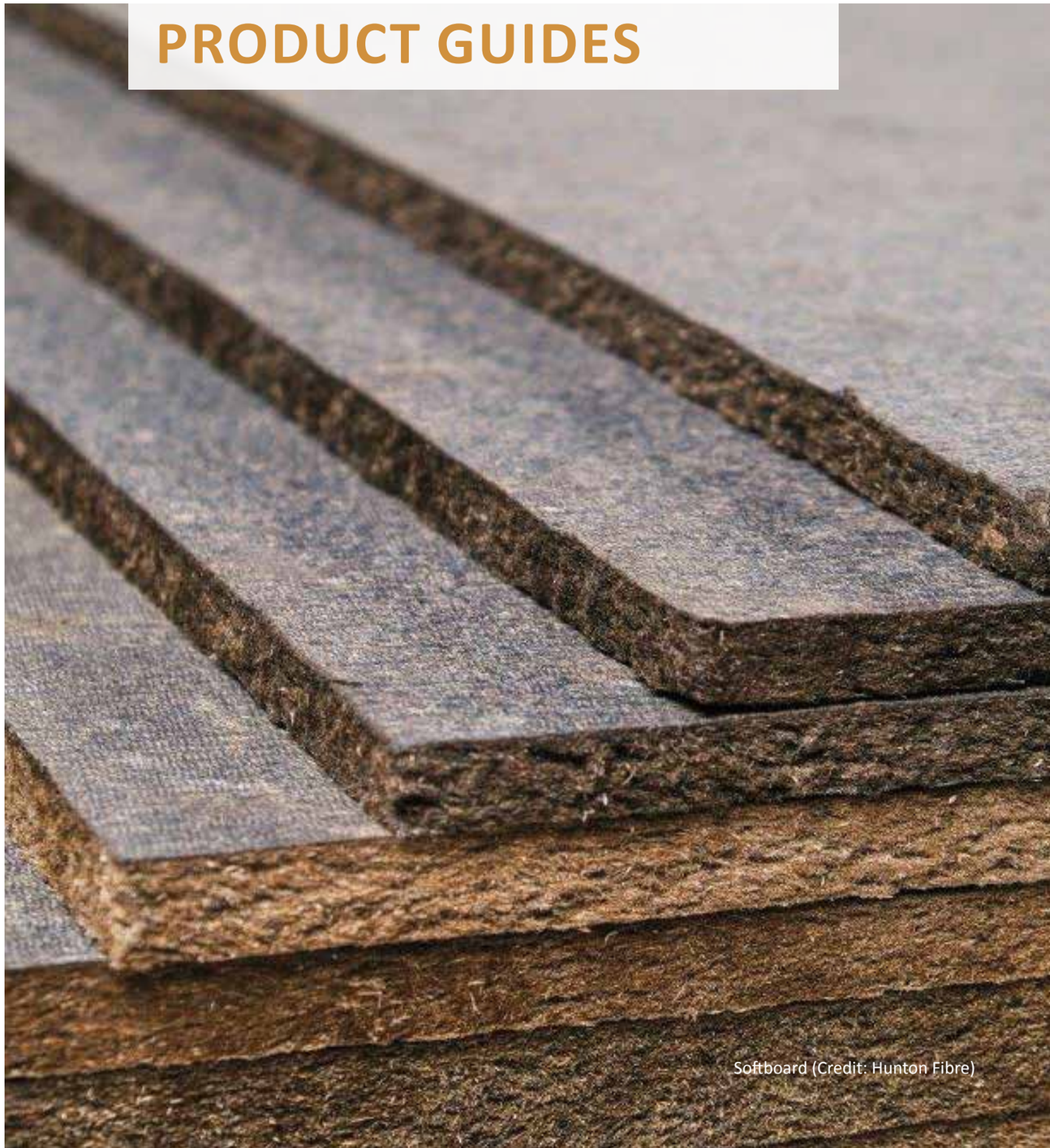






Results and recommendations from the Policy Conference «Unlocking Circularity and Market Potential from Wood Waste»

8 WOOD-BASED PANELS PRODUCT GUIDES



Softboard (Credit: Hunton Fibre)


Particleboard (Credit: Sonae Arauco)

Particleboard (credit: Unilin)

8.1 - PARTICLEBOARD

Definition

Particleboard (PB), also known as chipboard, is a wood-based panel manufactured by bonding wood particles (e.g., chips, flakes, shavings, sawdust) – and, where applicable, other lignocellulosic particles (such as flax shives, hemp shives or bagasse fragments) – with a polymeric adhesive, then consolidating the formed mat under heat and pressure [27].

Manufacture / Composition

Particleboard is made primarily from wood particles sourced from a broad range of feedstocks, including roundwood as well as sawdust, shavings, production rejects (from panel manufacture or furniture production) and recovered wood supplied through waste wood streams. These particles are commonly prepared by mechanical chipping of coniferous softwoods, especially spruce, although pine, fir and hardwoods such as birch may also be used. Depending on the grade, a significant proportion of recycled wood can be incorporated. The particles are typically blended with synthetic resin systems (and additives as required), formed into a mat (usually as a multi-layer structure with finer particles in the surface layers and coarser particles in the core) and then hot-pressed between heated platens under pressure to compress and cure the panel. The finished boards are subsequently sanded and cut to size, produced with either square or tongued-and-grooved (T&G) edges, and manufactured across a wide range of densities and thicknesses to suit different applications [27].

Density, mass and size

Affected by the timber species and the process used in manufacture, panel density will vary depending on the product. Typical densities are 600 kg/m3 to 680kg/m3. Panel sizes commonly available are:

- 1830mm × 1200mm
- 2440mm × 1220mm
- 2750mm × 1220mm
- 3050mm × 1220mm
- 3660mm × 1220mm

in thicknesses of: 2.5mm, 3.2mm, 6mm, 9mm, 12mm, 15mm, 18mm, 19mm, 22mm, 25mm, 30mm and 38mm. Dimensions other than the standard formats listed above are also available and can be produced to order.

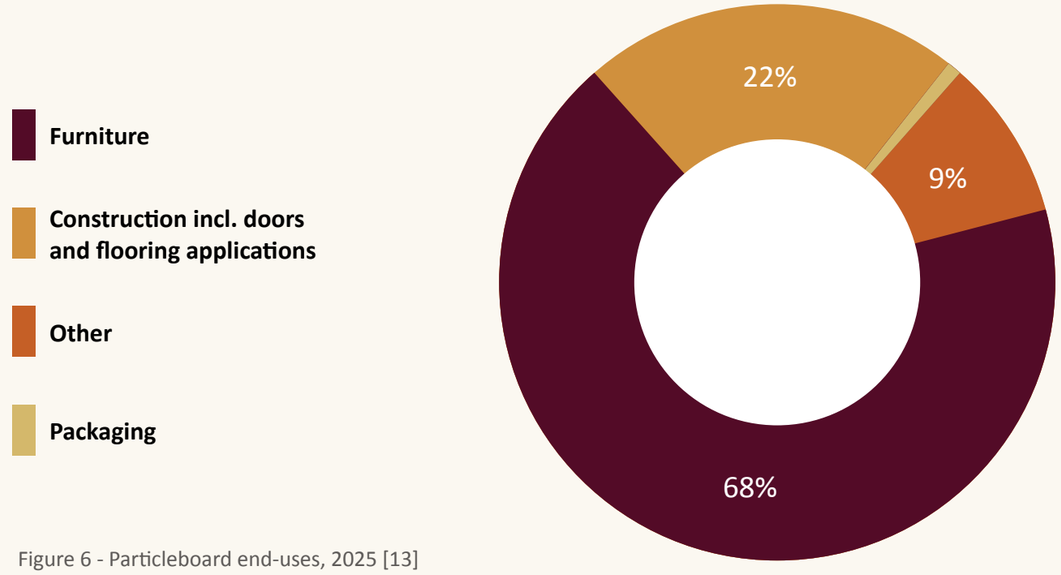


Figure 6 - Particleboard end-uses, 2025 [13]

Applications

Particleboard is used extensively in furniture and interior fit-out, particularly for kitchen units and worktops, and for dining-room and bedroom furniture, typically with veneered or laminated surfaces. It is also widely used in ready-to-assemble furniture and in cabinetry and shelving, where a smooth, flat substrate is required for surface finishes.

In construction, particleboard is used as floor decking on timber joists and in floating floor systems, including platform and raised access floors. Grades are available for different environmental conditions and loading requirements, from domestic to industrial use, with higher grades being also used in industrial storage systems. Particleboard is additionally used in doors and in non-structural applications such as wall panelling and internal partitions.

The suitability of particleboard for use in construction and non-construction applications is further explored in chapter 9.

Standards / Specifications

In Europe, particleboard is normally manufactured to meet the requirements of EN 312 (particleboard – specifications). Where particleboard is placed on the market for construction uses, it must meet the requirements of the Construction Products Regulation (CPR) [19] via the harmonised standard EN 13986 [2] (Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking), which references EN 312 for particleboard performance classes and requirements.

EN 312 defines particleboard into ‘technical classes’ or ‘grade’ for different service conditions (dry or humid) and structural demand (non-load-bearing, load-bearing, heavy-duty load-bearing), distinguished as follows:

- P1: General purpose boards for use in dry conditions
- P2: Boards for interior fitments (including furniture) for use in dry conditions
- P3: Non load-bearing boards for use in humid conditions
- P4: Load-bearing boards for use in dry conditions
- P5: Load-bearing boards for use in humid conditions
- P6: Heavy duty load-bearing boards for use in dry conditions
- P7: Heavy duty load-bearing boards for use in humid conditions

Selection of the appropriate grade depends on the expected service environment, notably moisture exposure, and the design loading for the intended application, which can be construction (structural or non-structural) or non-construction e.g. furniture.

Panels intended for “humid conditions” are designed to tolerate elevated relative humidity and occasional, short-term wetting. However, they are not intended to be waterproof, and sustained or direct wetting should be prevented through appropriate detailing and protection. Under long periods of moisture exposure, particleboard may become susceptible to biological deterioration (e.g., fungal decay), though not associated with attack by wood-boring insects.

The basic mechanical performance requirements for particleboard are set out in EN 312. For structural applications using load-bearing grades, the characteristic values used for design to EN 1995-1-1 (Eurocode 5) are provided in EN 12369-1 (Wood-based panels – Characteristic values for structural design – OSB, particleboards and fibreboards) or by the manufacturer testing.

Circularity

Particleboard is a product that is entirely recyclable. In 2025, the particleboard industry in EPF member countries consumed more than 20 million dry tonnes under bark, as wood raw material. Last year, the share of processed roundwood and industrial by-products decreased slightly to 21% (-1%) and 29% (-1%) respectively. At the same time, the share of recovered wood (including pre-consumer wood waste from manufacturing processes and post-consumer wood waste such as pallets, used furniture, wood packaging) increased from 39% in 2012 to 50% in 2025. The usage of recovered wood in the particleboard production contributed to save nearly 10.3 million dry tonnes of primary wood.

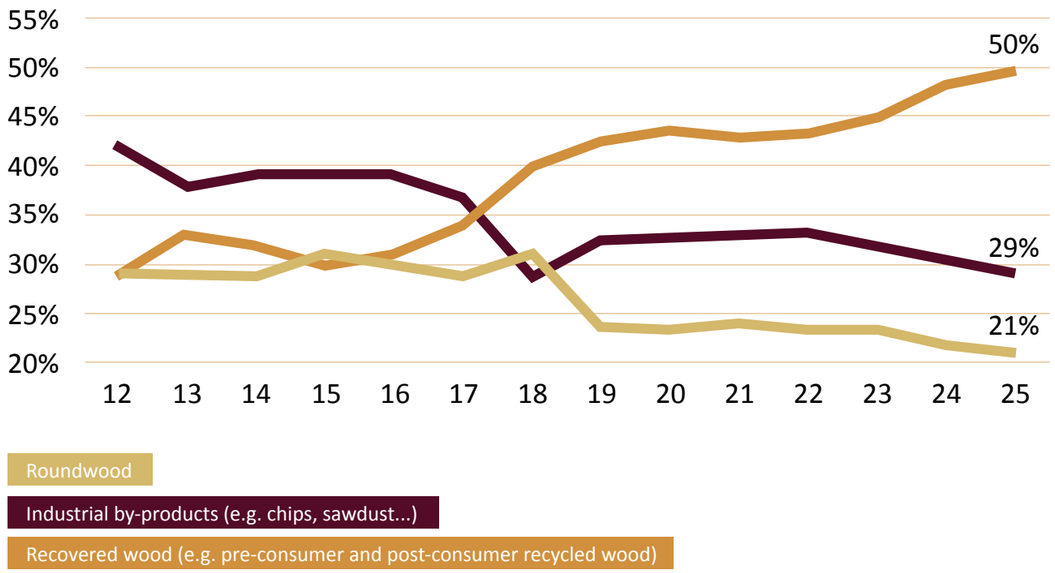


Figure 7 – Wood composition of the European Particleboard industry, 2012-2025 [13]

The manufacture of particleboard is the number one commercial method of recycling wood, currently incorporating 50% of recovered wood on average.

Recovered wood remained a major source of raw material in 2025 for several countries, notably Belgium, Luxembourg, Denmark, and the UK (79%), as well as Italy, where it accounted for an exceptionally high share (90%) of total wood procurement (see Figure 8 below). Significant use of recovered wood was also observed in Germany (50%), France (53%), Central European countries (45%, including Austria, the Czech Republic and Switzerland) and Iberia (76%, Portugal and Spain), reflecting ongoing constraints in the availability of virgin wood resources.

By contrast, roundwood continued to be the primary raw material in Eastern European countries (Estonia, Latvia, Lithuania, and Slovakia) and in South-East Europe (Bulgaria, Greece, Hungary, and Romania). Meanwhile, industrial by-products represented the dominant source of raw materials in Poland (53%), Scandinavia (64%), and South-East Europe (39%).

As shown in Figure 8, recovered wood and industrial by-products are already widely used in particleboard production, although their respective shares vary by region.

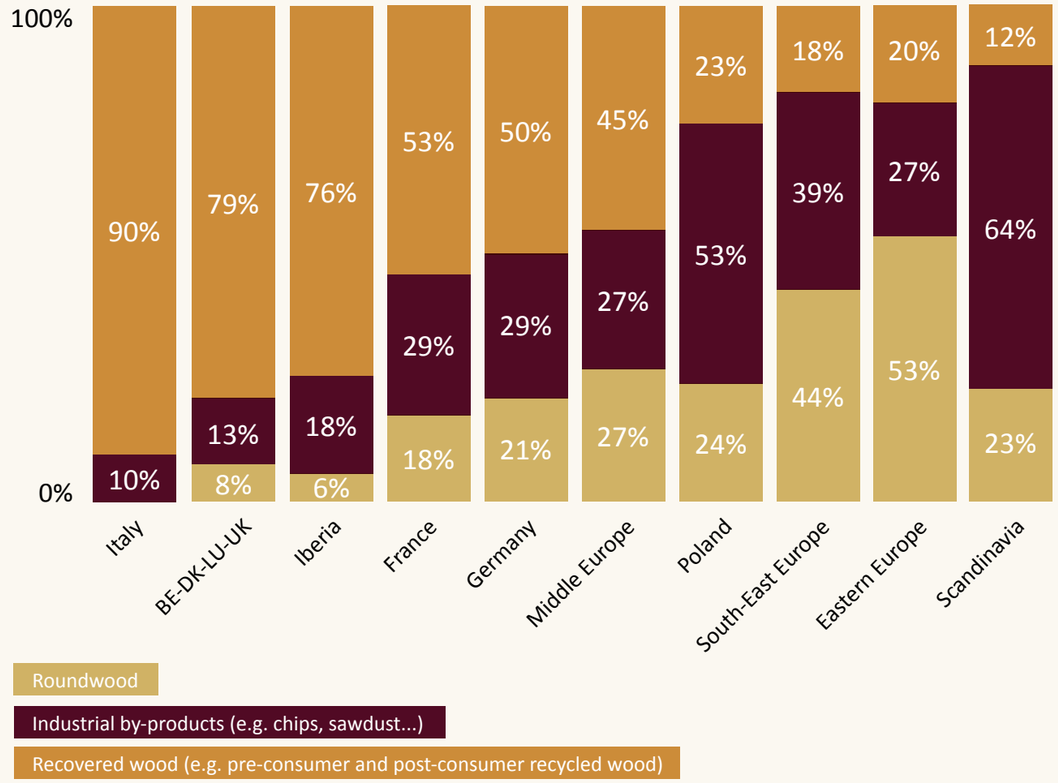


Figure 8 - Regional composition of the raw wood consumption mixes in the European particleboard industry, 2025 [13]

Sources: European Panel Federation - Members data (2025)
Regional definition:
BE-DK-LU-UK: Belgium, Denmark, Luxembourg and the UK,
Eastern Europe: Estonia, Latvia, Lithuania and Slovakia,
Iberia: Portugal and Spain,
Middle Europe: Austria, Czech Republic and Switzerland,
Scandinavia: Finland, Norway and Sweden,
South-East Europe: Bulgaria, Greece, Hungary and Romania



OSB (credit: Egger)

OSB (credit: Medite Smartply)

8.2 - OSB

Definition

Oriented strand board (OSB) is an engineered wood-based panel made by bonding long and slender wood strands with a synthetic resin and consolidating them under heat and pressure. During forming, the strands are arranged in layers with a predominant orientation (typically with the face layers aligned mainly in the panel's length direction), which enhances stiffness and strength in the principal axis. OSB is produced in a range of grades for dry and humid service conditions, including load-bearing applications [27].

Manufacture / Composition

In Europe, OSB is typically manufactured predominantly from fresh roundwood, including thinnings, tree tops and veneer cores, as this feedstock is generally preferred for producing consistent, high-quality strands. At the same time, the industry is increasingly exploring the incorporation of recovered wood, particularly in the core layer. The raw material is primarily sourced from softwoods such as spruce and pine, while certain hardwoods, including aspen, may also be used to achieve specific mechanical characteristics.

The manufacturing route is comparable in principle to particleboard production, but OSB uses strands (not chips) and the mat is formed with oriented layers (commonly at least three layers laid with perpendicular orientation between adjacent layers and parallel outer layers).

OSB is manufactured mainly from small-diameter roundwood, which is converted into strands and dried to a controlled moisture content. After drying, strands are normally separated and handled in closed systems, where undersized material and fines are commonly removed to reduce resin demand and for process safety. The strands are blended with proprietary resin systems and, where relevant, additives to deliver specific performance characteristics (e.g., moisture resistance and process stability). The resinated strands are formed into a multi-layer mat with controlled strand orientation, commonly comprising three layers. The mat is then hot-pressed, usually in a continuous press, to consolidate it and cure the resin. After pressing, the continuous board is cut, cooled and trimmed to the required dimensions. Finished products are available with square or profiled edges, including tongue-and-groove, and may also be supplied with proprietary coatings for construction applications.

OSB production commonly uses isocyanate resins, particularly polymeric methylene diphenyl diisocyanate (pMDI), which is formaldehyde-free as a binder. Where pMDI is used, the final moisture content of the dried wood strands is typically controlled to an optimal range of about 5% to 10% to support effective bonding and pressing performance [27].

Density, mass and size

Panel density varies by manufacturer, wood species, and product grade. OSB is commonly produced in a wide range of thicknesses for construction and industrial uses, and is available in standard sheet formats as well as construction-oriented formats, including flooring and roofing panels.

In European production, OSB is produced in a smaller density range than particleboard, with indicative densities commonly reported around 600–680 kg/m³. Panel sizes commonly available are:

- 2440mm × 1200mm
- 2440mm × 1220mm
- 3660mm × 1220mm

in thicknesses of: 6mm, 8mm, 9mm, 11mm, 15mm, 18mm, 22mm, 25mm and 38mm.

Dimensions other than standard formats are also available and may be produced to order.

Applications

OSB is primarily used in construction where a load-bearing wood-based panel is required, including:

- structural flooring and decking systems (including panels with profiled edges),
- structural wall sheathing in timber-frame construction,
- roof decking and pitched-roof sarking,
- general bracing and rigidity elements within timber structures.

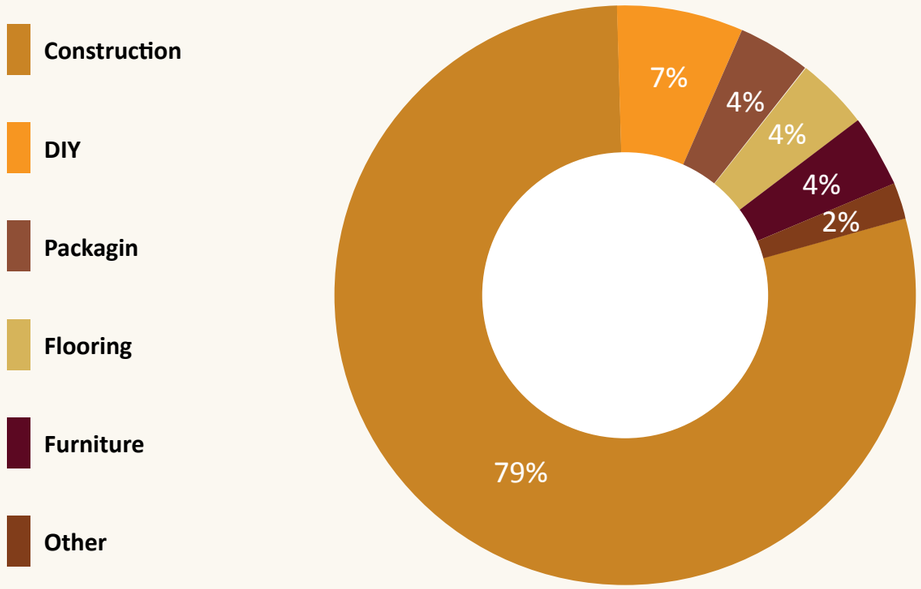


Figure 9 - OSB end-uses in 2025 [13]

Beyond construction, OSB is used for packaging and industrial applications, and in selected furniture and fit-out uses where its characteristic strand appearance is acceptable or intentionally specified. OSB products are used extensively for construction site hoardings, and even though it is predominantly dispatched as a raw board, specialist OSB panels with surface coatings may be specified for non-structural temporary applications (such as certain site-protection uses) where improved surface durability or weathering resistance is required or in some special applications such as improved air tightness.

Load-bearing panels suitable for structural use in humid conditions, called OSB/3 panels (according to EN 300), continue to be the major category of OSB produced in Europe, accounting for approximately 94% of OSB production output in 2025 [13].

Standards / Specifications

In Europe, OSB is normally manufactured to meet the requirements of EN 300 (Oriented strand boards (OSB) – Definitions, classification and specifications). Where OSB is placed on the market for use in construction, it must also satisfy the requirements of the Construction Products Regulation (CPR) [19] through the harmonised standard EN 13986 [2] (Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking). This standard calls up EN 300 for OSB performance requirements.

EN 300 groups OSB into types or grades based on the intended service conditions (dry or humid) and whether structural performance is required, including:

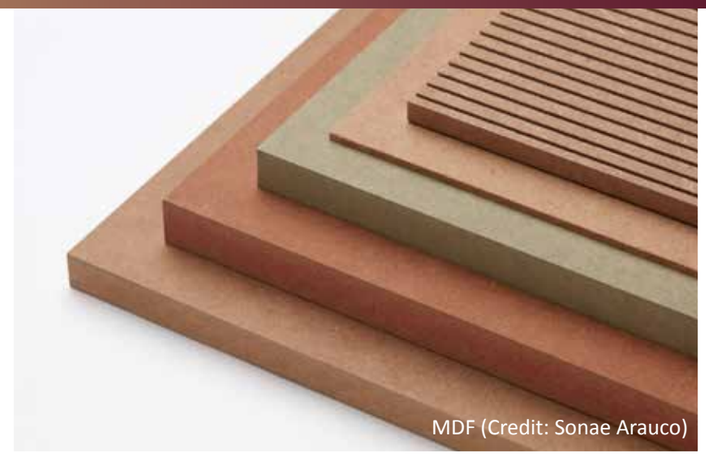
- OSB/1: General-purpose boards for use in dry conditions (typically non-structural)
- OSB/2: Load-bearing boards for use in dry conditions
- OSB/3: Load-bearing boards for use in humid conditions
- OSB/4: Heavy-duty load-bearing boards for use in humid conditions

Selecting an appropriate OSB type should be based on the in-service environment (particularly moisture exposure) and any structural demands of the application, including anticipated loading and stiffness requirements.

For structural design, the product standard EN 300 establishes the core performance and test requirements for OSB in order to meet each grade, this is achieved through testing for bending strength and stiffness (EN 310), internal bond (EN 319), 24-hour swelling (EN 317) and for humid conditions – moisture resistance testing (EN 321 or EN 1087-1). For design calculations to EN 1995-1-1 (Eurocode 5), characteristic values of mechanical properties and density for structural purposes for OSB are given in EN 12369-1 (Wood-based panels – Characteristic values for structural design – OSB, particleboards and fibreboards).

Circularity

OSB is a product that is entirely recyclable. In 2025, the wood consumption by the European OSB industry amounted to 6.1 million dry tonnes under bark. This consumption was mostly composed of roundwood (95%), especially pine (50%) and spruce (33%). Increasing quantities of recovered wood have been used in OSB production in recent years, rising by 1% to account for 5% of total wood consumption in 2025.



MDF (Credit: Sonae Arauco)



HDF (Credit: Homanit)

8.3 - DRY PROCESS FIBREBOARDS (MDF)

Definition

Medium density fibreboard (MDF) is commonly used as an umbrella term for dry process fibreboards, covering a range of densities and grades. They are an engineered wood-based panels manufactured by bonding wood fibres with a synthetic resin and consolidating the fibre mat under heat and pressure. The different types of dry process fibreboards are differentiated primarily by the resulting mechanical and end-use performance. In general, dry process fibreboards are characterised by a fine, uniform structure and smooth surfaces, enabling precision machining and high-quality finishing. The key difference between dry-processed and wet-processed fibreboards lies in the fibre moisture content at the forming stage: in MDF it is typically below 20%, whereas in wet-processed fibreboards it is above 20% [27].

Manufacture / Composition

Dry process fibreboards manufactured in Europe are primarily composed of fresh roundwood (58%) and industrial by-products (38%). The roundwood component consists predominantly of softwoods, with pine and spruce accounting for 73% of the volume, while the industrial by-products are mainly in the form of sawmill chips [13].

The raw material is first reduced to chips and then converted to fibres in a thermo-mechanical refining process. In typical industrial production, the refined fibres leave the refiner with high moisture content and are conveyed through a blow line, where resin and relevant additives are applied as water-based solutions or dispersions to achieve the required processing behaviour and end-use performance. The fibres are then dried, commonly in directly heated tube dryers with high-throughput, before mat formation.

The dried (or partially dried) fibres are formed into a mat (typically a single-layer structure for standard products) and hot-pressed to cure the resin and consolidate the panel to its target thickness and density. After pressing, the panel is cut, cooled then further cut into finished board sizes. Sanding is commonly applied where tight thickness tolerances and surface quality are required. Depending on the intended end use, products may be supplied as raw board or further processed, such as profiled edges, surface coating, or lamination, etc... [27].

Density, mass and size

Density and mass vary according to product type, thickness and manufacturer. Although fixed density thresholds are not used to define product types in the relevant European product standards, the terms LDF, MDF and HDF continue to be commonly associated with broad density ranges. These ranges are indicative rather than normative:

LDF: typically < 650 kg/m³

MDF: typically 700–800 kg/m³ (typical standard MDF average density)

HDF: typically > 800 kg/m³

MDF is produced in an extensive range of thicknesses (approximately 1.8 mm to 60 mm) and is available in a wide range of sheet formats. Common widths include 1220 mm, 1525 mm and 1850 mm, with lengths up to 3660 mm (most commonly 2400 mm). Dry process fibreboards are also supplied in cut-to-size formats and profiles for specific applications (e.g., flooring substrates and interior components). Dimensions other than standard formats are available and may be produced to order.

Applications

Dry process fibreboards (MDF) are widely used in both construction and non-construction markets because they combine consistent machining behaviour with a smooth, high-quality surface that takes finishes well, offering reliable working properties and broad availability in a wide range of thicknesses and sizes.

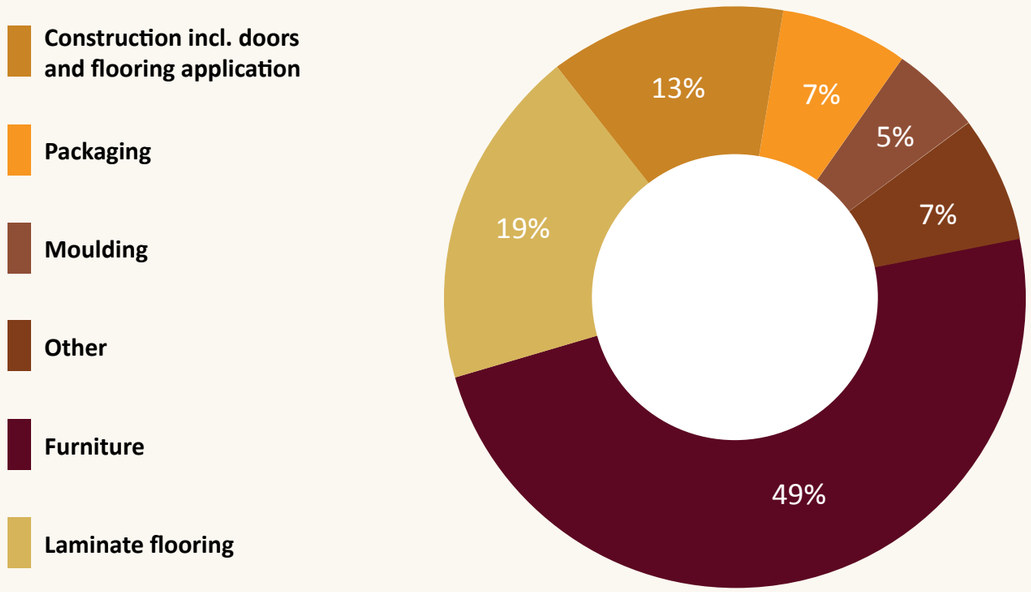


Figure 10 - MDF end-uses in 2025 [13]

Common applications include:

- Interior fit-out and furniture components, including painted or coated elements (e.g., cabinet parts, drawer components, shelving and decorative features)
- Architectural and interior joinery items, such as mouldings, skirtings, architraves and window boards, where consistent machining and finishing are important
- Flooring and interior building products, including substrate layers and profiled components (product-dependent)
- General industrial uses, including packaging, displays, shopfitting and other fabricated products where flatness and surface quality are beneficial

Standards / Specifications

In Europe, dry process fibreboards are normally manufactured to meet the requirements of the EN 622 series (Fibreboards – Specifications). General requirements are addressed in EN 622-1, while requirements specific to dry process boards (MDF) are set out in EN 622-5.

EN 622-5 sets out the performance requirements for the different MDF product types. It covers core properties with minimum requirements depending on the grade or class of MDF, such as thickness swelling, internal bond, bending strength and modulus of elasticity (these are declared product properties rather than design values). The standard also lists additional characteristics that may be specified where relevant (such as surface soundness, screw withdrawal resistance, surface absorption and dimensional stability) without assigning fixed limit values.

End-use suitability depends on the declared performance class and the service conditions (particularly humidity/moisture exposure), so the appropriate grade should be selected with regard to the expected humidity/moisture conditions and the loads the panel will need to carry in use.

Where dry process fibreboards are placed on the market for use in construction, they must also meet the requirements of the Construction Products Regulation (CPR) [19] through the harmonised standard EN 13986 [2] (Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking), under which relevant essential characteristics are declared and CE marking is applied.

Table 2 – Grades of MDF as described in EN 622-5 [28]

GRADE	USE AND CLIMATIC CONDITION
MDF	General-purpose boards for dry conditions
MDF.H	General-purpose boards for humid conditions
MDF.LA	Load-bearing boards for dry conditions
MDF.HLS	Load-bearing boards for humid conditions (these panels are restricted under humid conditions to instantaneous or short periods of loading)
L-MDF	Light MDF boards for dry conditions
L.MDF.H	Light MDF boards for humid conditions
UL1-MDF	Ultra-light MDF boards for dry conditions
UL2-MDF	Ultra-light MDF boards for dry conditions
MDF.RWH	MDF for rigid underlays in roofs and walls

Circularity

MDF is a product that is entirely recyclable. When it comes to the incorporation of recycled wood, the European MDF industry is actively working to increase circularity by expanding the use of recovered fibres alongside established sources of virgin wood and industrial by-products. Until recently, the separation of fibreboard from mixed wood waste streams and its conversion into fibres of a suitable quality for MDF production presented significant technical challenges. Advances in collection, sorting, dismantling and pre-processing are now helping to address these barriers. These include AI-supported sorting systems, advanced sensor technologies and improved methods for identifying and separating fibreboard at industrial scale.

Table 3 - Breakdown of the raw wood consumption of the European MDF industry, 2021-2025 [13]

	2021	2022	2023	2024	2025
Total raw wood consumption (on the consumption that 1m3 of MDF requires 0.78 dry stones of raw wood)	10,744,274	9,747,550	8,621,763	8,785,956	9,148,622
Roundwood	59%	55%	56%	58%	65%
Chips	34%	34%	33%	31%	26%
Sawdust	4%	6%	6%	7%	3%
Other	3%	5%	4%	3%	4%
Recovered wood	0%	0%	1%	1%	2%
Total			100%		

The EcoReFibre project is making an important contribution to closing this technological gap, answering to the industry's commitment to developing more circular material flows. Several innovative recycling technologies are being demonstrated within the project, including a moisture-modifying thermo-mechanical pulping process (mTMP), a steam-based process and a dry-impact reactor. These technologies are being developed to convert recovered fibreboard into high-quality fibres and fines suitable for use in new products.

Although the transition remains at an early stage, recovered wood has recently begun to be used in small quantities by the European MDF industry, accounting for approximately 2% of its total fibre demand in 2025. In parallel, the share of the "other" category of virgin wood, including sources such as thinnings, increased from 3% in 2024 to 4% of the industry's total raw wood consumption in 2025.

The raw wood consumption by the European MDF industry increased by 4% in 2025 amounting to nearly 9.2 million dry tonnes under bark. Roundwood increased slightly its share from 58% in 2024 to 65% in 2025. Industrial by-products, mainly composed of chips, accounted for 33% of the wood procurement (38% in 2023). Pine and spruce remained the principal roundwood species, together accounting for 73% of roundwood consumption in 2025.



Hardboard (Credit: Fundermax)



Softboard (Credit: Hunton Fibre)

8.4 - WET PROCESS FIBREBOARDS

Definition

Wet process fibreboards are wood-fibre panels manufactured from a water-based fibre slurry which is formed into a mat, then dewatered and dried. The wet process family includes softboard, mediumboard and hardboard, with panel density and end-use determined by the level of consolidation achieved during manufacture. Depending on the product type, fibre bonding is usually achieved by the natural binding action of fibres felting together and that of lignin released during fibre preparation, while additives and/or resin systems may be used where needed to adjust moisture behaviour, durability or mechanical performance [27].

Manufacture / Composition

Wet process fibreboards are produced from wood fibres obtained by refining wood chips, typically after steam cooking to soften the raw material and promote fibre separation. In wet process production, the fibres are mixed with water to create a pumpable pulp, which is distributed onto a forming screen (in a process comparable in principle to papermaking) to create a continuous wet mat. Water is removed first by gravity drainage through the screen and then by mechanical pressing.

For softboard, the wet-formed fibre mat is mechanically dewatered in a pre-press or press-roll section before entering the dryer, reaching an indicative dry content after pressing of around 40%. The mat is then dried in multi-stage belt or roller dryers, after which the board is cooled before trimming and cutting to size.

Hardboard manufacture follows the same early stages of fibre preparation and wet forming, but after dewatering the mat is consolidated in a heated multi-opening press under higher pressure and elevated temperature. This pressing step densifies the board and contributes to the characteristic surface features of hardboard, often including a smooth face and a reverse side showing a screen pattern from the forming process.

Mediumboard sits between softboard and hardboard in the degree of consolidation and the resulting density and performance.

Additives may be incorporated to achieve specific properties. Depending on product type and intended end use, these can include hydrophobic agents (such as, paraffin/wax emulsions/bitumen emulsion/natural oil) to improve moisture behaviour and other treatments such as fire retardant chemicals. In most wet process products, wood fibres bond to each other naturally. This is mainly due to lignin (and, to a lesser extent, hemicelluloses), which becomes active in the presence of moisture and heat. In hardboard manufacture, this natural bond is set during high-pressure hot pressing. In softboard manufacture, it is set mainly during drying after the mat has been pre-pressed. However, formulations and process routes vary by manufacturer and product grade. Wet process fibreboard production is also closely linked to process-water management: significant volumes of water are circulated and reused within the fibre preparation and forming system, with solids removed by screening, decanting and sedimentation and the resulting sludge typically dewatered for energy recovery or other appropriate management [27].

Density, mass and size

Density varies significantly across the wet process fibreboard family and is a primary differentiator of performance and application.

As an indication, the wet process product range is commonly associated with the following density bands:

- hardboard typically about 900–1100 kg/m³
- mediumboard approximately 400–900 kg/m³
- softboard around 140–400 kg/m³

Softboard is produced in a wide thickness range (commonly several millimetres up to a few centimetres), whereas hardboard is typically supplied in thinner formats (up to around 5.5 mm) [25]. Available panel dimensions and thicknesses vary by manufacturer and intended end use; standard sheet formats are widely available and other sizes are commonly offered or can be produced to order.

Applications

Hardboard

Hardboard is used where a thin, robust sheet with a dense structure and smooth surface is required, and where a good finish is important. Typical uses include furniture components, interior linings, underlays, door facing components, packaging and general industrial applications. It is also suited to use as a substrate or protective layer in fabricated products where surface durability is a key requirement, for example as drawer bottoms, back panels and cabinet bases. End-use suitability depends on the declared product type and grade and on exposure conditions, particularly the likelihood of moisture uptake and the need for protection against direct wetting.

Medium board

Low-density medium boards (MBL) were typically selected where a lightweight panel is needed, for example for noticeboards/pinboards, elements of partition systems, shopfitting and display applications, and underlay layers beneath flooring.

By contrast, higher-density medium boards (MBH) have historically been specified for wall and ceiling lining and, in some cases, as sheathing in timber-frame construction. In the EU market, however, these construction uses are now uncommon.

Softboard

Less widely used today than in the past, softboard has been used as a multi-purpose board with good insulation and sound absorption properties. Its applications include floor underlay as a height levelling board (for instance under screed systems), pinboards/noticeboards, and acoustic absorption layers. Impregnated softboards have also been used for sheathing in timber-frame construction and as a protective overlay within certain flat roofing build-ups.

Standards / Specifications

Wet-process fibreboards (hardboard, medium board and softboard) are normally manufactured to meet the requirements of the EN 622 series for fibreboards, where for product selection and specification, the entry point is EN 622-1 (general requirements).

Where wetprocess fibreboards are used in construction applications, they must also comply with the requirements of the Construction Products Regulation (CPR) [19] through the harmonised standard EN 13986 [2] (woodbased panels for use in construction: characteristics, evaluation of conformity and marking). This standard calls up the different dedicated parts that set out definitions and classification, the key product requirements (including, as applicable, tolerances on dimensions and thickness, moisture content, density and performance characteristics) and the associated test methods used to demonstrate conformity.

- EN 622-2 (hardboards),
- EN 622-3 (medium board) and
- EN 622-4 (softboards).

Table 4 – Types and grades of wet process wood fibreboards as per the EN 622 series [28].

PANEL TYPE	GRADE	REFERENCES
Softboard		
General purpose (for use in dry conditions)	SB	EN 622-4
General purpose (for use in humid conditions)	SB.H	
General purpose (for use in exterior conditions)	SB.E	
Load bearing (for use in dry conditions)	SB.LS	
Load bearing (for use in humid conditions)	SB.HLS*	
Low density medium board		
General purpose (for use in dry conditions)	MBL	EN 622-3
General purpose (for use in humid conditions)	MBL.H	
General purpose (for use in exterior conditions)	MBL.E	
High density medium board		
General purpose (for use in dry conditions)	MBH	
General purpose (for use in humid conditions)	MBH.H	
General purpose (for use in exterior conditions)	MBH.E	
Load bearing (for use in dry conditions)	MBH.LA1	
Heavy duty load bearing (for use in dry conditions)	MBH.LA2	
Load bearing (for use in humid conditions)	MBH.HLS1*	
Heavy duty load bearing (for use in humid conditions)	MBH.HLS2*	
Hardboard		
General purpose (for use in dry conditions)	HB	EN 622-2
General purpose (for use in humid conditions)	HB.H	
General purpose (for use in exterior conditions)	HB.E	
Load bearing (for use in dry conditions)	HB.LA	
Load bearing (for use in humid conditions)	HB.HLA1	
Heavy duty load bearing (for use in humid conditions)	HB.HLA2	

* these panels are restricted under humid conditions to instantaneous or short periods of loading

Circularity

Wet process fibreboard is a product that is entirely recyclable. They have good recycling potential because their principal constituent is wood fibre and, in many products, bonding relies largely on fibre felting and the natural binding action of lignin. Clean production off-cuts can be returned to fibre-based manufacturing where suitable collection and processing arrangements are available. Some low-density boards are also manufactured partly from recovered paper fibres, demonstrating that wet process production can accommodate secondary cellulosic raw materials.

At end of life, recyclability depends on the product's composition and condition. Untreated softboard and medium board generally offer the greatest potential for fibre recovery, while the higher consolidation of hardboard and the possible presence of resins, water-repellent additives, coatings or other treatments can make recovery more demanding. Nevertheless, all three product groups represent a potential source of secondary wood fibre where panels can be separately collected, correctly identified and directed towards an appropriate recycling route.

Wood fibre insulation is an insulation material made predominantly from wood fibres (typically over 80% by content). Depending on the product type and intended performance, binders and/or other additives may be included.

It is used primarily in building construction to provide thermal and acoustic insulation, and is most commonly produced from softwood. Products are supplied in several formats, including rolls, mats and boards. The fibre feedstock is often sourced from sawmill co-products (such as slabs and chips), although roundwood can also be used.

In industry practice, wood fibre insulation is commonly grouped into three product forms: rigid boards, flexible boards (mats) and loose-fill (bulk) insulation. Rigid boards can be produced using either a wet process or a dry process, whereas flexible boards are typically manufactured using a dry process.

8.5 - RIGIDBOARD

Definition

Rigid wood fibre insulation boards are factory-made rigid insulation products manufactured predominantly from wood fibres (typically softwood). They are supplied as stiff boards, often with profiled edges (for example tongue-and-groove) to support secure, continuous installation.



Credit: Soprema

Manufacture / Composition

Dry process

Rigid wood fibre insulation boards made by the dry process use wood fibres refined in a way broadly comparable to other fibreboard production, such as MDF. The fibres are dried before mat formation, after which a small quantity of polyurethane-based binder, commonly pMDI, is applied. The fibres are then formed into a mat using process steps similar to those employed on MDF lines.

The mat is typically pre-pressed and then cured in the main press by introducing steam or water vapour through the mat. The moisture promotes curing of the polyurethane-based binder, while also helping to heat the mat rapidly and uniformly. Pressing takes place at lower pressure than for many other dry-process wood-based panels, allowing the binder to cure while retaining the porous, low-density structure required for thermal insulation.

Wet process

In the wet process, much like other wet process fibreboards, fibres are soaked/suspended in water and then formed into a wet mat to create panels. The boards are subsequently calibrated to thickness and then dried as whole panels. In this process route, bonding is usually achieved through the wood's felting and natural lignin, meaning that no external adhesive should normally be required (depending on the product specification it may include the use of resin binder).

Density, mass and size

Rigidboards are produced as a homogeneous single layer board, available in a wide range of thicknesses (commonly around 18–240 mm) and densities (typically 100–270 kg/m³ for dry process, and 140-250 kg/m³ for wet process).

Applications

Rigid wood fibre insulation boards (often supplied with profiled edges) are intended for use in construction where a robust, diffusion open external insulation layer is required. Typical applications include roof sarking/over-rafter insulation on pitched roofs, external wall sheathing in timber frame build-ups (including use behind curtainwall, rear ventilated façades), and as render carrier/base boards in External Thermal Insulation Composite System (ETICS)-type façade systems. More generally, both wet and dry processed rigid boards are used for roof, wall and floor insulation, either externally or within the build-up where a stiff insulation layer is needed. Product literature also highlights their role in providing temporary weather protection during construction (subject to the manufacturer's conditions). In practice, dry process boards are typically avoided for internal wall insulation where the design relies on the insulation layer to help manage liquid moisture transport. In addition to envelope uses, rigid boards are also specified in certain interior joinery elements, including door panels, depending on the required performance and system design.

Standards / Specifications

Produced and CE marked in accordance with EN 13171.

Circularity

Rigid wood fibre insulation boards have good potential for material recycling because they consist predominantly of wood fibres. As with MDF, recycling generally requires the boards to be separately collected, cleaned and broken down so that the fibres can be recovered for use in new fibre-based products. Clean production off-cuts are particularly suitable because their composition is known and they are less likely to contain contaminants. At end of life, recyclability depends on the board remaining separable from renders, adhesives, coatings and other construction materials. The presence of pMDI or other additives in dry-process boards does not necessarily prevent fibre recovery, but it must be considered when determining the appropriate recycling route.

8.6 - FLEXBOARD

Definition

Flexible wood fibre insulation boards (“flexboards”) are low-density, compressible wood fibre insulation products designed to be bendable and to provide a friction fit when installed between framing members. They are typically supplied as slabs/boards for use within building envelope build-ups, primarily to provide thermal insulation (and, in many constructions, additional acoustic benefit).



Credit: Soprema

Manufacture / Composition

Flexboards are produced from wood that is reduced to fibres in a refining step, with the resulting fibres generally being coarser than those used for some other fibreboard products. The fibres are dried and then combined with thermoplastic/bonding fibres (commonly bi-component fibres). In some products, alternative fibres or materials from non-wood species may also be incorporated to improve flexibility and mechanical integrity.

After blending, the mat can be formed in different ways depending on the manufacturing line, including:

- forming and pressing steps broadly comparable to those used for rigid wood fibre boards; or
- formation using aerodynamic fleece-folding equipment similar to that used in non-woven textile manufacture.

The mat is then cured in a heated oven (for example using recirculating hot air). During heating, the thermoplastic/bonding fibres soften and thermally bond the structure, and the product is then gently pressed to achieve the required thickness and stability.

Density, mass and size

Flexboards are typically low density, commonly in the range of 40–60 kg/m³ (usually around 50 kg/m³). They are manufactured in a range of thicknesses. Depending on the product and line, thicknesses may be available from approximately 40 mm up to 240 mm, with thicker products enabling use in deeper frame zones.

Applications

Flexboards are used predominantly as insulation placed between timber members, where their compressibility and rigidity provide a reliable friction fit and resistance to slumping over time. Typical applications include:

- between-stud wall insulation in timber frame construction;
- between-rafter or between-joist insulation in pitched roofs and floors;
- flat roof build-ups, including both vented and unvented constructions (as part of a complete system design);
- use within external envelope solutions where the overall façade build-up may be rendered or clad, and where insulation is required within the supporting timber structure;
- pitched roof systems under tiled coverings, where insulation is installed within the timber zones.

As with all insulation products, suitability depends on the complete build-up (including vapour control, wind tightness, water management and detailing) and the manufacturer’s installation guidance for the selected system.

Flexible and vapour-permeable wood fibre insulation mat is equally suited to cavities in roof, wall and ceiling structures and to cavity insulation in partition walls, facing formwork and installation levels.

Standards / Specifications

Produced and CE marked in accordance with EN 13171.

Circularity

Flexboards have good potential for material recovery because they consist predominantly of wood fibre. In current practice, the most readily recyclable material is clean production waste and uncontaminated installation off-cuts, which can be collected separately and returned to the manufacturing process or processed for use in other fibre-based products. Reuse of intact boards should also be considered where they can be removed without damage.

Recycling post-consumer flexboards is not yet a widely established industry practice in Europe. Their low density makes collection and transport less economical, while the thermoplastic bonding fibres and any added fire retardants or water-repellent treatments must be considered when selecting a recycling route. Recovery is most feasible where the insulation remains clean, dry and separable from membranes, adhesives and other construction materials. Once collected, it may potentially be opened or shredded and reprocessed into new insulation products. This route is under active development: Fraunhofer WKI has been testing the reprocessing of used wood-fibre insulation into new insulation materials, while EcoReFibre has successfully integrated recovered fibres in new flexible boards and other insulation products (Fraunhofer WKI; EcoReFibre). These developments indicate a clear opportunity for flexboards to become part of future closed-loop or cascading recycling systems as suitable collection and processing infrastructure expands.



Credit: Paged



Credit: Paged

8.7 - PLYWOOD

Definition

Veneer plywood is manufactured by bonding together thin layers of wood (veneers) in a defined construction (“lay-up”) to create a dimensionally stable panel with good strength both along and across the sheet. The most common form is veneer plywood, in which the surface plies are veneers laid with their planes parallel to the panel surface.

Adjacent plies are typically arranged with the grain direction at right angles (cross-lamination) to each other, and the construction is generally symmetrical and balanced about the mid-plane to minimise warping, e.g. 3, 5, 7, 9, 11 etc veneers in total. Variations in lay-up (number of plies, veneer thicknesses and grain orientation) are used to tailor performance. In addition to veneer plywood, the broader plywood family includes core plywood constructions (such as blockboard and laminboard) in which the core is formed from solid wood strips/battens or “on-edge” veneer strips, with veneers bonded to each face. These constructions are used to achieve specific combinations of stiffness, weight and stability, and may also incorporate non-wood layers where specialist properties are required [27].

Manufacture / Composition

Plywood manufacture starts with suitable logs selected for species, quality and ability to peel. Logs are commonly conditioned by soaking or steaming to soften the wood and improve the peeling/slicing process. Veneers are then produced either by rotary peeling (the main method for standard plywood veneers) or by slicing (more commonly used for decorative veneers). The veneers are clipped and dried to a controlled moisture content suitable for bonding (typically 4% to 8%). Dried veneers are then sorted into grades, typically by visual assessment, so that face veneers and inner plies can be assembled to meet the required appearance and performance class.

An adhesive system is selected to match the intended service conditions (interior, humid or exterior exposure). In European practice, commonly used adhesive families include urea-formaldehyde (UF) for mainly interior applications, phenol-formaldehyde (PF) for higher moisture resistance and exterior performance, and melamine-urea-formaldehyde (MUF) systems that can provide intermediate to high moisture resistance depending on formulation. Adhesive is applied to veneers by methods such as roller spreading, spraying, extrusion or curtain coating, after which the veneers are assembled into the specified lay-up.

The assembled lay-up is consolidated under pressure and heat (most commonly in multi-opening hot presses) where press temperature, pressure and time cure the adhesive and bond the plies into a rigid panel. After pressing, panels are cooled/conditioned, trimmed to size and, where required, sanded or calibrated to thickness. Some product types may receive additional finishing steps such as overlaying/facing or the later application of thin face/back veneers in a separate operation, depending on specification and end-use [27].

Density, mass and size

Plywood density is not normally specified as a controlled product parameter; it is largely determined by the wood species used. For construction plywood, a typical density range is about 400–700 kg/m³. Specialist, highly compressed plywood products can be significantly denser (in some cases >1000 kg/m³) and may be produced for high-performance applications.

Plywood can be manufactured in a wide thickness range (approximately 1.5 mm up to 40 mm or more, depending on product), with commonly stocked nominal thicknesses including 3, 4, 6, 9, 12, 15, 18, 22, 25 and 32 mm. Common sheet sizes include 2440 mm × 1220 mm, 2500 mm × 1220 mm, and larger formats such as 3050 mm × 1525 mm and 3050 mm × 1220 mm; narrower formats (e.g. 2440 mm × 610 mm, often supplied tongue-and-groove) are also available for certain applications. Many suppliers can provide cut-to-size services.

For core plywood products such as blockboard and laminboard, density is broadly similar to veneer plywood, again mainly governed by the species and construction of the core.

Applications

Plywood is used across construction and non-construction markets where a strong, stiff and dimensionally stable sheet material is needed. Typical construction uses include flooring and roof decking, wall sheathing and bracing applications, and other structural or semi-structural roles where panel strength is required in both directions.

In non-construction uses, plywood is widely used for joinery and interior fit-out, furniture components, packaging and transport-related applications, and for decorative or overlaid products where surface appearance and durability are important.

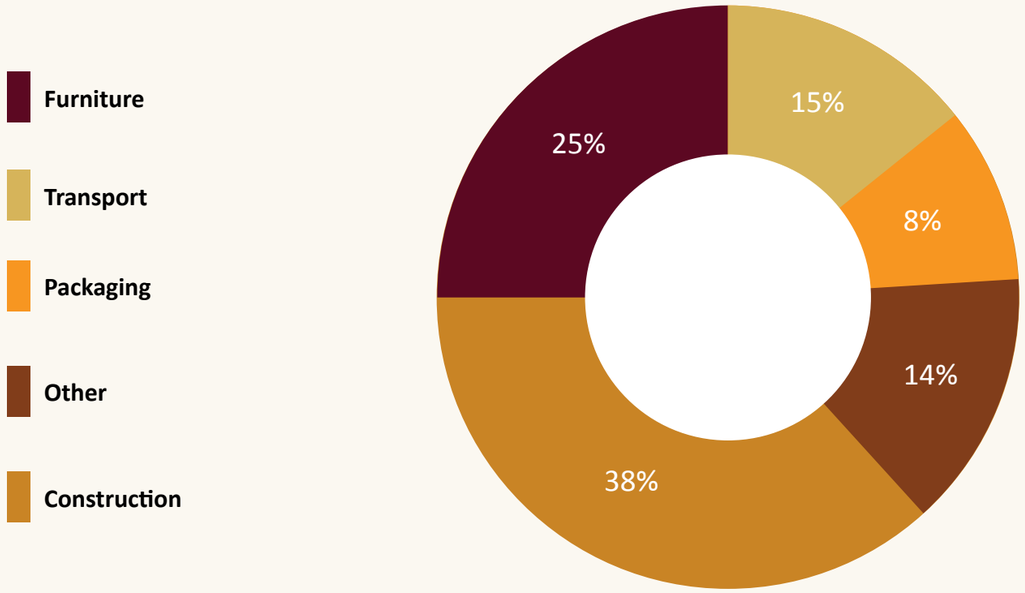


Figure 11 - Plywood end-uses, 2025 [13]

The main plywood applications in 2025 were construction (38%) and furniture (25%) followed by transport (15%) and packaging (8%). The remaining 14% was used for other applications. The transport is composed of end-uses such as heavy-duty trailer/shipping container floors, camper vans and insulating elements for LNG tankers. Other end-uses of plywood included specialised plywood for internal uses such as toys or boat construction. In 2025, 87% of the plywood produced was exterior grade.

Standards / Specifications

Plywood is normally manufactured to meet the requirements of EN 636. Where used in construction applications, they must also comply with the requirements of the Construction Products Regulation [19] through the harmonised standard EN 13986 [2] (Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking).

- EN 636 defines plywood by conditions of use (vulgo technical classes), classifying it for:
- EN 636-1 – dry conditions (Service Class 1 type environments)
- EN 636-2 – humid conditions (Service Class 2 type environments)
- EN 636-3 – exterior conditions (exposed conditions)

The product is also designated by intended application:

- S – structural application
- NS – non-structural / general purpose application

e.g. EN 636-3 S

Circularity

Plywood is currently manufactured predominantly from veneers peeled or sliced from logs, as post-consumer recovered wood generally cannot provide the continuous veneers of suitable dimensions and quality required for its production. Circularity is therefore achieved mainly through efficient log conversion, the valorisation of manufacturing residues, long product service life and the reuse of panels where practicable. At the end of their useful life, plywood panels may also be recycled into particleboard or other particle- and fibre-based products, subject to appropriate collection, sorting and processing. In this way, plywood supports the cascading use of wood, even though recovered wood is not routinely used as a direct input in new plywood production.

8.8 - RESINS

Resins

Wood-based panels are usually bonded using thermosetting resins activated by heat and pressure. The choice of resin depends on the panel type, desired moisture resistance, and colour requirements:

- Urea-Formaldehyde (UF): The most common and versatile resin, preferred for interior applications due to its light colour and cost-effectiveness.
- Melamine-Urea-Formaldehyde (MUF/MUPF): Used to provide enhanced water resistance and durability, often mixed with UF.
- Phenol-Formaldehyde (PF): Provides high durability for exterior exposure but results in a darker panel colour and requires longer press times.
- Polymeric Methylene Diphenyl Diisocyanate (pMDI): A formaldehyde-free resin that offers superior moisture resistance and faster processing.
- pMDI is currently mostly applied as a main resin in OSB production and for the production of rigidboard and flexboard, but it is also used, but not widely, in other panel product types (such as MDF).

Table 5 - Main resin types in WBP production [25]

RESIN	ABBREVIATION	MOSTLY USED IN PRODUCT
Urea-formaldehyde resin	UF	PB, MDF
Phenol-formaldehyde resin	PF	OSB
Phenol-urea-formaldehyde resin	PUF	OSB
Melamine-urea-formaldehyde resin	MUF	PB, MDF
Melamine-urea-phenol-formaldehyde resin	MUPF	PB, OSB, MDF
Polymeric methylene diisocyanate	pMDI	OSB, Rigidboard, Flexboard

Hardening agents

Hardening agents, or curing catalysts, are added to certain thermosetting resin systems (particularly UF and MUF resins) to accelerate the curing process and help achieve the required bond within the available press time. Ammonium sulphate and ammonium nitrate are among the catalysts used, although the selected chemical and dosage depend on the resin formulation, wood furnish and pressing conditions. The catalyst is generally prepared as an aqueous solution and mixed with the resin in the glue preparation system for particleboard or introduced with the resin into the blowline during dry-process fibreboard manufacture.

Release agents

Release agents are used to prevent the panel or uncured binder from adhering to press plates, caul plates or continuous press belts, thereby limiting resin build-up and facilitating release after pressing. Depending on the production process, they may be applied to the press surfaces or introduced into the furnish before pressing. Their use is particularly important for panels bonded with pMDI, owing to the binder's strong adhesion to metal surfaces. Release agents may be based on waxes or other proprietary formulations selected to suit the binder system and pressing process.

For further information on auxiliary substances and materials used in wood-based panel manufacture, refer to the Wood-based Panels BREF [25, p. 131].

9 WOOD-BASED PANELS – APPLICATIONS AND BEST PRACTICES



Credit: AdobeStock

9.1 - GENERAL

Wood-based panels are versatile engineered products used across a wide range of applications in construction, furniture, interior fit-out, packaging, decoration and other industrial uses. Their broad use is supported by the diversity of products available, including particleboard, fibreboard, MDF, OSB, plywood and wood fibre insulation products.



Credit: Sonae Arauco

These materials can be manufactured with different densities, thicknesses, surface qualities, strength properties and moisture-resistance classes, allowing them to be adapted to both structural and non-structural applications and different in-service exposure conditions. Solid wood panels and laminated veneer lumber fall outside the scope of this guidebook and are therefore not covered in the following sections.

In buildings, wood-based panels are commonly used in roofs, walls, floating floors, structural floor decking, ceilings, sheathing, linings, mouldings (e.g. skirting board) and insulation systems. Outside construction, they are widely applied in furniture manufacturing, worktops, doors, shopfitting, exhibition systems, vehicle interiors, packaging, acoustic products and decorative surfaces. Correct specification is essential: the selected panel must be suitable for the intended load, exposure conditions, fixing method, surface finish and regulatory requirements. The following sections provide practical guidance on typical applications and best practice for selecting and using wood-based panels in construction and other end uses.

The technical classes listed in this section are indicative of common practice for the relevant application and in-service exposure conditions. Structural design, fire performance, moisture control, acoustic performance and durability should be verified using the manufacturer's declared values and installation instructions, in accordance with the applicable national building codes, regulatory requirements and design rules in each Member State.



Credit: Paged

9.2 - CONSTRUCTION

Wood-based panels are widely used in construction because they combine relatively low weight with good mechanical performance, dimensional formats suited to prefabrication, and compatibility with timber, steel or masonry-based building systems. In buildings, they may serve structural, bracing, lining, decking, sheathing, substrate or finishing functions, depending on the product type, technical class and in-service exposure conditions.

The correct selection of panel type is essential. Panels used in construction must be specified according to their intended function, exposure conditions and relevant European product standard. In practice, the most important selection criteria is whether the panel is used structurally or non-structurally, whether it is installed in a dry (service class 1), humid (service class 2) or exterior (service class 3) environment, and whether it is required to provide racking resistance, load-bearing capacity, airtightness support, fire performance, acoustic performance or a substrate for finishes.



Cutaway illustration of a timber-frame house, showing the integration of wood-based panels in walls, floors and roofing.

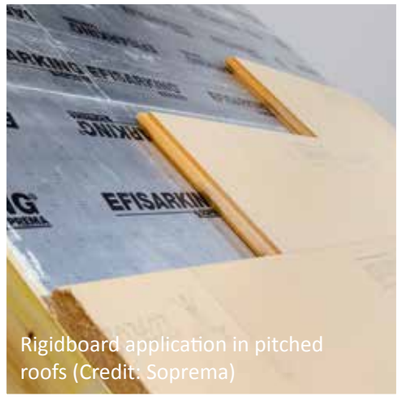
Credit: European Panel Federation

The following subsections summarise typical panel choices for roofs, walls, ceilings and floors. The tables provide indicative guidance on suitable panel types, technical classes and corresponding EN standards. Final specification should always take account of national building regulations, structural design requirements, manufacturer declarations of performance, installation instructions and the conditions of use.

Roofs and Roof Terraces

Wood-based panels used in roofs and roof terraces may act as structural decking, support for waterproofing, support for roofing membranes, sarking boards, bracing elements or substrates for insulation and roof finishes. Selection depends strongly on moisture exposure. Even when panels are not directly exposed to rainfall in service, roofs are generally treated as a higher-risk application because of possible condensation, temporary construction moisture and limited opportunities for drying once the roof build-up is closed.

For roof terraces and flat roofs, the panel may support waterproofing layers, insulation systems or trafficable build-ups. In pitched roofs, panels may be used as decking, roof sheathing, sarking or under-roof support. In all cases, the panel should be installed with appropriate expansion gaps, ventilation or vapour control measures where required, and protection from prolonged wetting during construction.



Rigidboard application in pitched roofs (Credit: Soprema)



OSB application in pitched roofs (Credit: AdobeStock)

Table 6 - Wood-based panels used in roofs and roof terraces [21, 27]

PANEL TYPE	TYPICAL TECHNICAL CLASS	TYPICAL INSTALLATION ENVIRONMENT	CORRESPONDING EN STANDARD	MAIN CONSTRUCTION USES
OSB	OSB/3, OSB/4	Humid	EN 300	Structural roof decking, sarking, sheathing and roof bracing. OSB/4 may be selected where higher load-bearing capacity is required.
Plywood	EN 636-2 S	Humid	EN 636	Roof decking, sheathing, waterproofing support and structural roof elements. EN 636-2 S is generally suited to humid conditions; EN 636-3 S is used where exterior exposure is expected.
	EN 636-3 S	Exterior		
Particleboard	P5	Humid	EN 312	Roof decking, roof sheathing or substrate where moisture-resistant load-bearing panels are required and direct exterior exposure is avoided.
MDF	MDF.HLS, MDF. RWH	Humid	EN 622-5	Specialist roofing or roof-wall applications where load-bearing or rigid underlay performance is required, subject to manufacturer approval.
Fibreboard (softboard, mediumboard, hardboard)	SB.H, SB.HLS, MBL.H, HB.HLA1, HB.HLA2	Humid	EN 622-4	Non-bracing sarking, underlay, wind-tight layers or temporary weather-protective boards, including bitumen-impregnated softboard grades, subject to product declaration.
	SB.E, MBL.E, HB.E	Exterior		Non-bracing sarking and underlay where there is a risk of occasional wetting from rain penetrating the roof covering, subject to product declaration.
Rigidboard	Product-specific grades	Protected exterior or humid, depending on product	EN 13171	Thermal insulation boards, sarking and underlay boards, including rigid insulation grades, subject to product declaration.
Flexboard	Product-specific grades	Protected, within the build-up	EN 13171	Thermal insulation between rafters and joists in pitched roofs and within flat roof build-ups, as part of a complete system design.

OSB is one of the most common panel types for roof applications. OSB/3 is generally used for load-bearing applications in humid conditions, while OSB/4 provides higher mechanical performance and may be preferred for more demanding structural uses. OSB roof panels are commonly used as decking, sarking or bracing layers in timber-frame and other lightweight construction systems.

Plywood offers a broad range of roof applications because it is available in different service classes under EN 636. Structural plywood marked “S” may be used where load-bearing performance is required, subject to verification that the performance declared by the manufacturer, including the relevant strength properties, is suitable for the intended end use. In humid roof environments, EN 636-2 S is generally relevant, while EN 636-3 S should be considered where the panel may be exposed to exterior conditions.

Particleboard used in roofs should normally be a moisture-resistant load-bearing grade such as P5. It may be suitable for roof decking or sheathing where the panel is protected from direct weathering and where the roof design controls condensation risk. Grades suitable for dry use, i.e. P4, should not be substituted for P5 in humid roof build-ups.

MDF and fibreboard products are more application-specific in roofs. Moisture-resistant or load-bearing MDF grades may be used where declared by the manufacturer for roofing or roof-wall applications.

Softboard, mediumboard and hardboard (EN 622-4, EN 622-3 and EN 622-2) may be used as non-bracing sarking, where the choice of grade depends mainly on the moisture conditions in service and the risk of occasional wetting from rain penetrating the roof covering. SB.H, SB.HLS, MBL.H, HB.HLA1 and HB.HLA2 are suitable for humid conditions, while SB.E, MBL.E and HB.E are exterior-condition grades. These boards are intended for non-bracing sarking and should not be relied on where the sarking contributes to roof bracing.

Rigidboards (rigid wood fibre insulation boards covered by EN 13171) are most commonly used in pitched roofs as over-rafter insulation and sarking, where they form a continuous, diffusion-open insulation layer above the rafters and reduce thermal bridging through the framing. Boards with profiled edges (e.g. tongue-and-groove) and, where declared by the manufacturer, water-repellent treatment may also act as a secondary water-shedding layer beneath the roof covering and provide temporary weather protection during construction, subject to the manufacturer’s limits on roof pitch, exposure duration and joint detailing. Rigidboards may also be used in flat roof build-ups where a pressure-resistant insulation layer is needed beneath the waterproofing, provided the declared compressive strength is suitable for the expected loads, including foot traffic or terrace loads. Their suitability depends on the complete roof build-up, including vapour control, wind tightness, water management and compatibility with the roof covering.

Flexboards (flexible wood fibre insulation products covered by EN 13171) are installed between rafters and joists in pitched roofs and within flat roof build-ups, where they provide thermal insulation and, in many constructions, additional acoustic benefit. They fit between the framing members by friction and are not sheathing or decking. Their suitability depends on the complete roof build-up, including vapour control, wind tightness and water management, and on the manufacturer’s installation guidance.

Walls and Ceilings

Wood-based panels used in walls and ceilings may provide structural bracing, racking resistance, sheathing, internal lining, airtightness support, impact resistance, a substrate for cladding or finishes, and acoustic or thermal functions. The choice of panel depends on its position within the building, the expected exposure conditions and the required performance. Ceilings are treated alongside interior walls because many ceiling systems use similar panel products, support arrangements, fixing methods and finishing principles to internal wall linings.



OSB application in exterior walls (Credit: EGGER)

Exterior Walls

In exterior wall construction, wood-based panels are commonly used as sheathing boards, racking panels, substrates for cladding systems, or layers contributing to airtightness and wind-tightness. The versatility of wood-based panels allows them to be incorporated into a wide range of exterior wall constructions, including timber-frame walls and cavity-wall systems, with external finishes such as brickwork, timber boarding, sheet or panel cladding, and rendered façades.

Generally speaking, there are two different timber-frame wall types that can be identified by the position of the structural wood-based panel relative to the timber frame studs. In one type, the structural panel is fixed to the inside or warm side of the timber frame studs, where it can provide racking resistance to the frame often with a more vapour permeable outer (cold side) wood-based panel. The other type is where the structural panel that is providing racking resistance is fixed to the outside or cold side of the timber frame studs.



Rigidboard application in exterior walls (Credit: Steico)

In both styles, the critical aspect is water vapour management to avoid moisture build-up throughout the year in the wall structure. The wall build-up should be designed so that the external side is more vapour permeable than its internal side, allowing any moisture entering the construction from the habitable areas to dry outwards rather than becoming trapped within the wall construction (e.g. timber studs, insulation etc...). The position and vapour resistance of the components of the wall therefore have a significant influence on the moisture movement potential. The panels, insulation, vapour-control layer, breather membrane and external finishes need to be considered as a complete build-up, with the aim of ensuring that more atmospheric moisture can escape from the wall than can enter it from the habitable areas. A condensation risk analysis should be carried out to ensure no moisture condenses in the structure for typical climatic conditions found in the region where the building is constructed.

Because exterior walls may be exposed to construction moisture, wind-driven rain during installation and vapour movement during service, panels should be selected for the appropriate conditions this would typically be either humid or exterior grade panels.

Table 7 - Wood-based panels used in exterior walls [21, 27]

PANEL TYPE	TYPICAL TECHNICAL CLASS	TYPICAL INSTALLATION ENVIRONMENT	CORRESPONDING EN STANDARD	MAIN CONSTRUCTION USES
OSB	OSB/3, OSB/4	Humid (service class 2)	EN 300	External wall sheathing, racking boards, bracing panels and airtightness support layers.
Plywood	EN 636-2 S	Humid (service class 2)	EN 636	Structural sheathing, bracing, cladding substrate and façade support layers.
	EN 636-3 S	Exterior (service class 3)		
Particleboard	P5	Humid (service class 2)	EN 312	Structural or non-structural wall sheathing in protected timber-frame systems.
Fibreboard (softboard)	SB.H, SB.HLS	Humid (service class 2)	EN 622-4	General-purpose sheathing and wind-tight boards.
	SB.E	Exterior (service class 3)		
Rigidboard	Product-specific grades	Protected exterior or humid, depending on product	EN 13171	Insulation boards, sarking-type wall boards, render carrier boards and ventilated façade support layers.
Flexboard	Product-specific grades	Protected, within the wall build-up	EN 13171	Thermal insulation between studs in timber-frame walls and within the supporting timber structure of external envelope solutions.

OSB is widely used for exterior wall sheathing in timber-frame construction. OSB/3 is suitable for load-bearing use in humid conditions, while OSB/4 may be used where higher structural capacity is needed.

Plywood is also suitable for exterior wall sheathing, particularly where high strength, good fastener holding and structural performance are required. EN 636-2 S humid , and EN 636-3 S exterior are both typically used. EN 636-3 S grade, whilst the glue bond being suitable for exterior use, must still be detailed to avoid trapped moisture and prolonged wetting.

Particleboard may be used in exterior wall systems only where the selected grade, normally P5, is appropriate for humid load-bearing conditions and where the panel is protected from direct exposure. It is generally less tolerant of wetting (e.g. during construction) than plywood or OSB.

Softboard (EN 622-4) may be used in exterior walls as general-purpose sheathing and wind-tight board. SB.H is the general-purpose grade for humid conditions and SB.E the exterior-condition grade, while SB.HLS is a load-bearing grade for humid conditions that is restricted to instantaneous or short-term loading. Racking resistance should only be assumed where it is declared by the manufacturer and verified in the wall design.

Rigid wood fibreboards are frequently used in external wall build-ups as insulating sheathing, wind-tight layers or render carrier boards. Their suitability depends on density, edge profile, water resistance, vapour permeability and the manufacturer's declared exposure limits.

Flexboards are used between the studs of timber-frame walls and within the supporting timber structure of external envelope solutions, where the façade may be rendered or clad. They provide thermal insulation and, in many constructions, additional acoustic benefit. As for roofs, their suitability depends on the complete build-up, including vapour control, wind tightness and water management.

Some products can provide temporary weather protection during construction, but this should not be assumed unless declared.

Interior Walls

Interior walls can employ wood-based panels as linings, partition boards, impact-resistant surfaces, substrates for finishes, acoustic layers, bracing panels as pattress panels. In dry internal spaces, a wider range of panel types can be used, however, in rooms with intermittent humidity, such as kitchens, bathrooms, utility rooms or unheated spaces, moisture-resistant grades should be specified.

The required panel class depends on whether the wall is load-bearing or non-load-bearing i.e. whether the panel contributes to racking resistance, and the in-use climatic conditions i.e. whether the space is "dry" or "humid". Panels used behind finishes should be compatible with the selected coating, lining, tile system, acoustic treatment or fire protection layer.

Table 8 - Wood-based panels used in interior walls [21, 27]

PANEL TYPE	TYPICAL TECHNICAL CLASS	TYPICAL INSTALLATION ENVIRONMENT	CORRESPONDING EN STANDARD	MAIN CONSTRUCTION USES
OSB	OSB/1	Dry	EN 300	Internal sheathing, bracing, partition linings, fixing boards and exposed decorative-industrial finishes.
	OSB/2			
	OSB/3	Humid		
	OSB/4			
Plywood	EN 636-1; S or NS as required	Dry	EN 636	Internal wall linings, structural bracing, impact-resistant surfaces, joinery substrates and backing panels.
	EN 636-2; S or NS as required	Humid		
	EN 636-3; S or NS as required	Exterior		
Particleboard	P2, P4	Dry	EN 312	Internal lining, partition boards, backing boards, non-structural surfaces or load-bearing internal sheathing where appropriate.
	P3, P5	Humid		
MDF	Standard MDF	Dry	EN 622-5	Smooth internal linings, decorative wall panels, painted surfaces, acoustic linings and interior fit-out.
	MDF.LA			
	MDF.H	Humid		
	MDF.HLS			
Hardboard	HB	Dry	EN 622-2	Thin wall linings, backing boards, door facings, protective layers and interior panels.
	HB.H where humidity resistance is required	Humid		

OSB may be used as a structural sheathing board to provide racking resistance or bracing, or as a non-structural lining board or fixing substrate (pattressing). OSB/1 is intended for general-purpose non-structural use in dry conditions, while OSB/2 is suitable for load-bearing use in dry conditions. OSB/3 and OSB/4 are used where humid conditions or higher structural requirements apply.

Plywood is suitable for a wide range of internal wall applications, including linings, bracing, impact-resistant panels and substrates for finishes. EN 636-1 is intended for general-purpose use in dry conditions, while EN 636-2 is suitable for use in humid conditions. EN 636-3 is used where exterior or more severe exposure is expected. The S designation should be used where structural performance is required.

Particleboard is suitable for many interior wall uses, especially as a lining or backing board. P2 is used for non-load-bearing applications in dry conditions, while P4 is used for load-bearing applications in dry conditions. Where the wall may be exposed to increased humidity and/or improved structural capabilities is required, P5 should be considered.

MDF is frequently used for internal wall linings and decorative surfaces because it provides a smooth, uniform substrate for painting, laminating or veneering. Standard MDF is generally limited to dry conditions, while moisture-resistant grades such as MDF.H or load-bearing grades such as MDF.LA and MDF.HLS should be selected where relevant.

Hardboard and other thin fibreboards may be used for backing, protective linings, door facings or lightweight internal wall applications. Moisture-resistant grades are required where the board may be exposed to intermittent humidity.



MDF application in interior wall (Credit: Unilin)

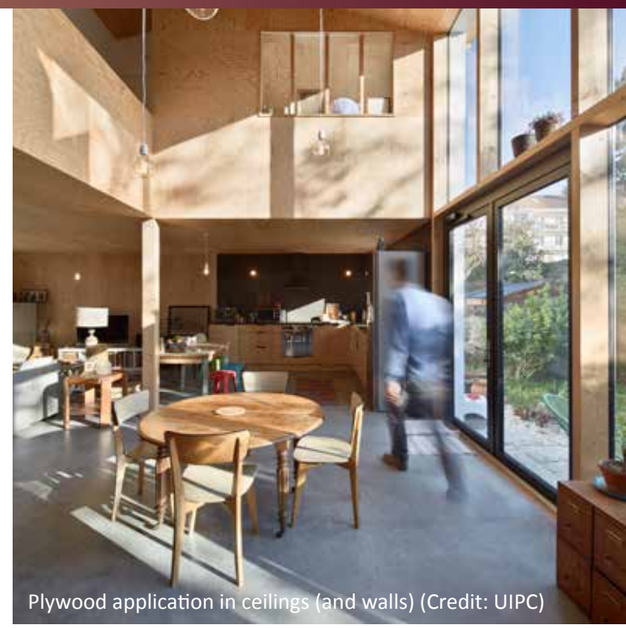


OSB application in interior walls (Credit: AdobeStock)

Ceilings

Wood-based panels may be used in ceilings as lining boards, suspended ceiling panels, acoustic elements, decorative finishes, fire protection substrates or support layers for services. In some cases, ceiling panels may also contribute to diaphragm action or structural performance, but this requires specific design.

Ceiling applications require particular attention to fixing. Panels are installed overhead and must be adequately supported to prevent sagging, detachment or deformation. The spacing of battens, joists or suspension members should be selected according to the panel type, thickness, orientation, load and manufacturer's installation guidance. Allowance should also be made for dimensional movement and for the weight of insulation, finishes or services supported by the ceiling system.



Plywood application in ceilings (and walls) (Credit: UIPC)

Table 9 - Wood-based panels used in ceilings [21, 27]

PANEL TYPE	RECOMMENDED TECHNICAL CLASS	TYPICAL INSTALLATION ENVIRONMENT	CORRESPONDING EN STANDARD	MAIN CONSTRUCTION USES
OSB	OSB/1, OSB/2	Dry	EN 300	Ceiling sheathing, service backing boards, structural ceiling diaphragms or exposed panel finishes.
	OSB/3, OSB/4	Humid		
Plywood	EN 636-1; S or NS as required	Dry	EN 636	Ceiling linings, structural ceiling panels, acoustic rafts, decorative ceilings and impact-resistant overhead linings.
	EN 636-2; S or NS as required	Humid		
	EN 636-3; S or NS as required	Exterior		
Particleboard	P2, P4	Dry	EN 312	Ceiling linings, suspended ceiling panels, backing boards and load-bearing ceiling applications where designed.
	P3, P5	Humid		
MDF	Standard MDF, MDF.LA	Dry	EN 622-5	Smooth ceiling linings, decorative suspended ceilings, acoustic panels and painted ceiling surfaces.
	MDF.H, MDF.HLS	Humid		
Fibreboards (softboard, mediumboard, hardboard)	Product-specific class	Dry or humid, depending on class	EN 622-2, EN 622-3, EN 622-4	Lightweight ceiling linings, acoustic panels, backing boards and decorative ceiling systems.

OSB is suitable for ceiling applications where robustness, screw-holding capacity or structural contribution is required. It may be left visible as an architectural finish or concealed behind other linings. In humid areas or roof-adjacent ceiling build-ups, OSB/3 or OSB/4 should be selected.

Plywood is widely suitable for ceiling linings, particularly where strength, visual quality, curved forms, acoustic design or impact resistance are required. Structural plywood should be specified where the ceiling panel contributes to load-bearing or diaphragm behaviour.

Particleboard may be used in ceilings where adequate support is provided and the correct grade is specified/selected. For dry, non-load-bearing ceilings, P2 may be sufficient. Where load-bearing performance and/or higher humidity resistance is required, P4 or P5 should be used.

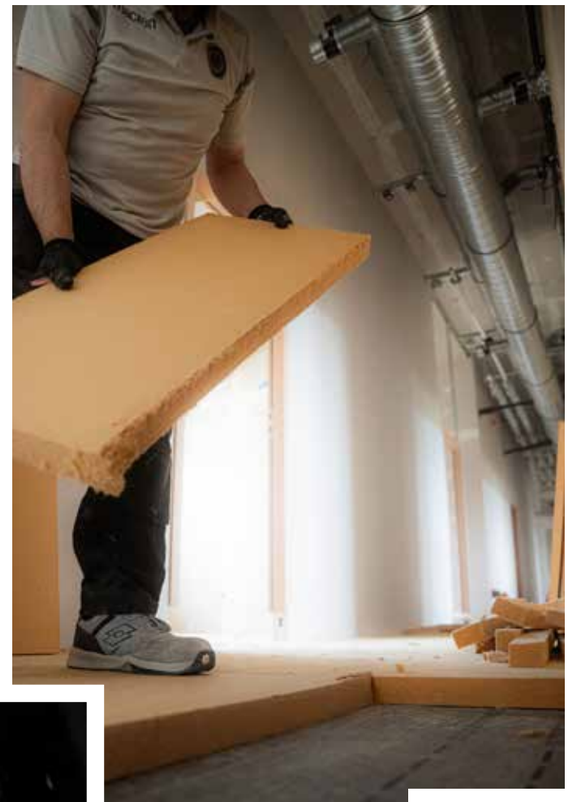
MDF is particularly suited to decorative and painted ceilings because of its smooth surface. Moisture-resistant MDF grades should be selected in humid internal environments. Where panels are used overhead, the fixing pattern and support spacing are critical to limit sagging.

Fibreboards, including hardboard and softboard products, may be used for lightweight linings, acoustic ceilings or backing layers. Their use should be matched to the required mechanical performance and moisture exposure.

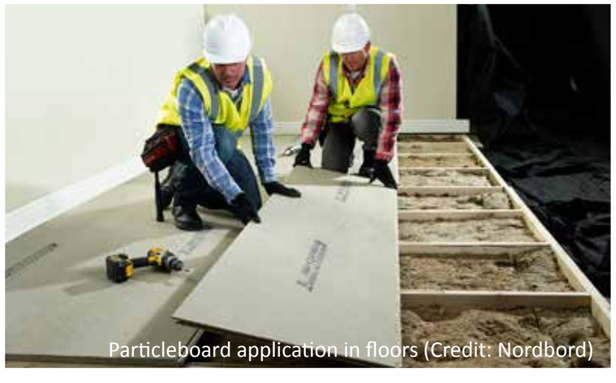
Floors

Wood-based panels are extensively used in floors as load-bearing decking, floating floor substrates, underlays, acoustic layers, dry screed components and support layers for floor finishes. In timber construction, panels are commonly fixed to joists, beams or battens. In renovation and dry construction systems, they may be installed over existing substrates or combined with insulation and acoustic layers. Manufacturers may also provide variants with protective layers attached to improve their weather and/or slip resistance during construction.

Floor panels are subject to concentrated loads, impact loading, dynamic loading, moisture during construction and seasonal dimensional movement. Correct panel selection, support spacing, edge support, fixing pattern and allowance for expansion are therefore essential. Tongue-and-groove edges are often used to speed up construction and provide a continuous and even surface whereas square edge boards will require generally require additional support or blocking beneath unsupported panel joints.



Rigidboard application in floors (Credit: Soprema)



Particleboard application in floors (Credit: Nordbord)

Table 10 - Wood-based panels used in floors [21, 27]

PANEL TYPE	RECOMMENDED TECHNICAL CLASS	TYPICAL INSTALLATION ENVIRONMENT	CORRESPONDING EN STANDARD	MAIN CONSTRUCTION USES
OSB	OSB/2	Dry	EN 300	Structural floor decking, subfloors, floating floor panels and load-bearing platforms.
	OSB/3, OSB/4	Humid		
Plywood	EN 636-1 S	Dry	EN 636	Structural flooring, subfloors, floor decking, heavy-duty platforms and substrates for floor finishes.
	EN 636-2 S	Humid		
	EN 636-3 S	Exterior		
Particleboard	P4, P6; P2 for non-structural dry uses	Dry	EN 312	Load-bearing floor decking, floating floors, underlays and dry floor systems. P5 is commonly used where humid conditions may occur.
	P5, P7	Humid		
MDF	MDF.LA	Dry	EN 622-5	Flooring underlays, dry floor systems and, where declared, humid systems, load-bearing panels where declared, and substrates for finishes.
	MDF.H, MDF.HLS	Humid		
HDF	Product specific (high density dry process fibredoard)	Dry	EN 622-5 (board), EN13329 (finished laminate floor covering)	Core board for laminate floor covering)
Fibreboard (softboard, mediumboard, hardboard)	SB.LS, MBH.LA 1, MBH.LA 2,	Dry	EN 622-2, EN 622-3, EN 622-4	Floor underlay, acoustic insulation, impact sound reduction layers and thermal insulation in dry floor build-ups.
	SB.HLS, MBH.HLS 2, HB.H	Humid (limited to short term loading, not for wet rooms)		
Rigidboard	Product-specific class	Dry or humid, depending on product	EN 13171	Floor underlay, impact sound reduction layers and thermal insulation in floor build-ups.

OSB is frequently used as structural floor decking. OSB/2 is suitable for load-bearing floors in dry conditions, while OSB/3 is generally selected for humid conditions. OSB/4 provides higher load-bearing capacity and stiffness and may be used where greater mechanical performance is required.

Plywood is appropriate for structural floors, heavy-duty floor decking and applications where high strength, impact resistance or improved fastener holding are needed. The appropriate EN 636 class should be selected according to the service environment, with structural “S” plywood used where load-bearing performance is required.

Particleboard can be used in flooring, particularly as tongue-and-groove decking. P4 is suitable for load-bearing applications in dry conditions, while P5 is commonly used for load-bearing floors where humid conditions may occur during construction or in service. Higher-performance grades such as P6 and P7 may be selected for heavy-duty or situations that require high-load capacity floors. P2 may be used for non-structural applications in dry conditions.

MDF is less commonly used as primary structural floor decking than OSB, plywood or particleboard, but load-bearing MDF grades may be used in dry floor systems where declared by the manufacturer. MDF and fibreboard products are also used as underlays or as substrates for resilient, laminate or other floor finishes.

Softboard and other fibreboard products (EN 622), as well as rigid wood fibre insulation boards (EN 13171), may be used as underlay or acoustic layers below floor finishes. Hardboard HB.H, for example, is used as a fabricated underlay beneath resilient and textile floor coverings. These products are generally selected for impact sound reduction, thermal improvement or smoothing of the substrate, rather than for primary structural capacity. The exception is the load-bearing high-density mediumboard grades, which may be used for suspended and floating floors in dry conditions (MBH.LA 1 and MBH.LA 2) and, with loading limited to short periods, for non-domestic floating floors in humid conditions (MBH.HLS2).

Rigid wood fibre insulation boards (EN 13171) are used in floor build-ups as underlay, impact sound reduction layers and thermal insulation. Some products are designed to carry dry or wet screeds and have a declared compressive strength for that purpose, so the product should be selected according to its declared performance and the manufacturer's guidance.

9.3 - NON-CONSTRUCTION APPLICATIONS

Furniture

Furniture is one of the largest non-construction markets for wood-based panels.

Within this sector, panel types are used to differing degrees. Particleboard and MDF in particular have secured a substantial share of a market traditionally dominated by solid timber, owing to their dimensional stability, consistent surface quality, machineability and suitability for a wide range of applied facings.

In fibreboard, furniture accounts for the largest single application at 49% of European fibreboard use, ahead of laminate flooring (19%) and construction uses including doors and flooring (13%) [13, Figure II.5]. Particleboard shows an even higher concentration in furniture: 68% of European particleboard production went into furniture applications in 2025 – the highest share, and the largest absolute volume, of any wood-based panel sector supplying the furniture industry – most notably in kitchen units and worktops, dining-room and bedroom furniture, ready-to-assemble (RTA) furniture, cabinetry and shelving [13, Table II.3]. As for plywood, in 2025, 25% of European plywood output went into furniture, second only to construction at 38% (Source: EPF-derived data).

Panels used in furniture applications are expected, in general terms, to combine a high-quality surface appearance with adequate strength, stiffness, impact resistance, fastener (screw) performance and dimensional stability, together with good machining characteristics. Because raw board surfaces are rarely used as-is in furniture, panels are typically supplied or finished with an applied facing – wood veneer, laminate or melamine impregnated paper being the most common – selected according to the appearance, durability and cost requirements of the specific product.



WBP in furniture applications (Credit: Unilin)



WBP in furniture applications (Credit: Sonae Arauco)

Table 11 below sets out typical panel choices, key design considerations and relevant European or international standards for the main categories of furniture application. Because furniture covers such a wide span of products, this table is indicative rather than exhaustive. For specific product development, further advice should be sought from panel manufacturers or relevant sector bodies.

Table 11 – Suitability of wood-based panels for use in furniture applications [27]

APPLICATION	TYPICAL PRODUCTS	KEY DESIGN CONSIDERATIONS	RELEVANT STANDARDS
General	PW, PB, OSB, MDF	Strength, stiffness, screw holding, impact, surface quality, dimensional stability	No furniture-specific product standard; panel product specifications apply: EN 312 (particleboard); EN 300 (OSB); EN 622 (fibreboard); EN 636 (plywood);
Bookcases and shelving	PW, PB, OSB, MDF	Strength, stiffness, creep	EN 16121 (storage furniture, non-domestic, safety/strength/durability/stability); EN 16122 (storage furniture, domestic and non-domestic, test methods); EN 14749 (domestic and kitchen storage units, safety requirements and test methods)
Contract and office furniture	PW, PB, MDF	Strength, stiffness, screw holding, impact, surface quality	EN 15372 (tables, non-domestic); EN 16121 (storage furniture, non-domestic); EN 16122 (storage furniture, test methods); EN 14727 (laboratory storage furniture); EN 527-2 (office work tables, safety/strength/durability); EN 1730 (tables, test methods for stability, strength and durability)
Educational furniture	PB, MDF, PW	Strength, stiffness, screw holding, impact, surface quality, dimensional stability, fire	EN 1729-2 (chairs and tables for educational institutions, safety and test methods)
Beds	OSB, PB, MDF, FB, PW	Strength, stiffness, stability, screw holding	EN 747-1 (bunk beds/high beds, safety/strength/durability); EN 747-2 (bunk beds/high beds, test methods); EN 1725 (domestic beds and mattresses, safety); EN 1130 (cribs, safety requirements and test methods)
Tables	PB, MDF, PW	Surface quality, dimensional stability, strength, stiffness, screw holding	EN 12521 (domestic tables, strength/durability/safety); EN 1730 (tables, test methods for stability/strength/durability)
Foil/veneer laminates	PW, PB, MDF, FB	Surface quality, dimensional stability	EN 14322 (melamine-faced boards for interior use, definitions and requirements); EN 14323 (melamine-faced boards, test methods)
Seating	PW, PB, OSB, MDF	Strength, stiffness, impact resistance	EN 12520 (domestic seating, strength/durability/safety); EN 16139 (non-domestic seating, strength/durability/safety); EN 1728 (seating, test methods)
Kitchen units	PW, PB, MDF	Strength, stiffness, moisture resistance, surface quality, screw holding	EN 14749 (domestic and kitchen storage units and worktops, safety requirements and test methods)
Storage units	PW, PB, MDF	Strength, stiffness, moisture resistance	ISO 7170 (storage units, determination of strength and durability)
High chairs	—	Dependent on design	EN 14988 (children's high chairs, safety requirements and test methods)

Table 12 – Suitability of wood-based panels for use in furniture applications [27]

APPLICATION	TYPICAL PRODUCTS	KEY DESIGN CONSIDERATIONS	RELEVANT STANDARDS
Playpens	—	Dependent on design	EN 12227 (playpens for domestic use, safety requirements and test methods)
Children's furniture	PW, PB, MDF	Strength, stiffness, durability, safety	EN 17191 (seating for children, safety requirements and test methods); EN 716-1 (children's cots and folding cots, safety requirements); EN 716-2 (children's cots and folding cots, test methods)
Kitchen worktops	PW, PB, MDF	Moisture resistance, surface quality, impact, dimensional stability, strength, stiffness	EN 14749 (as above)
Upholstered furniture frames	PW, PB, OSB, MDF	Strength, stiffness, screw holding	No frame-specific standard; the finished article is assessed under EN 12520 (domestic seating); EN 16139 (non-domestic seating); EN 1728 (seating, test methods)

Key: PW = plywood; OSB = oriented strand board; PB = particleboard; MDF = medium density fibreboard; FB = fibreboard;

Packaging

Wood-based panels are a mainstay of industrial and export packaging, most visibly through timber pallets. Pallets and packaging together consume more than 25 million m³ of timber in Europe every year, and FEFPEB (the European Federation of Wooden Pallet and Packaging Manufacturers) estimates that around 3.2 billion wooden pallets are in circulation across the EU, with its member companies alone manufacturing some 570 million new pallets annually [22]. Plywood contributes to this market: in 2025, packaging accounted for 8% of European plywood use [13].



OSB in packaging application (Credit: Norbord)

Panels used in packaging applications are generally selected for their low weight compared with their strength, stiffness, fastener performance, impact resistance and, depending on end-use, moisture resistance and durability. Because packaging is frequently reused, stacked and handled mechanically, fastener holding and resistance to repeated impact are often the deciding factors in panel selection, alongside cost.



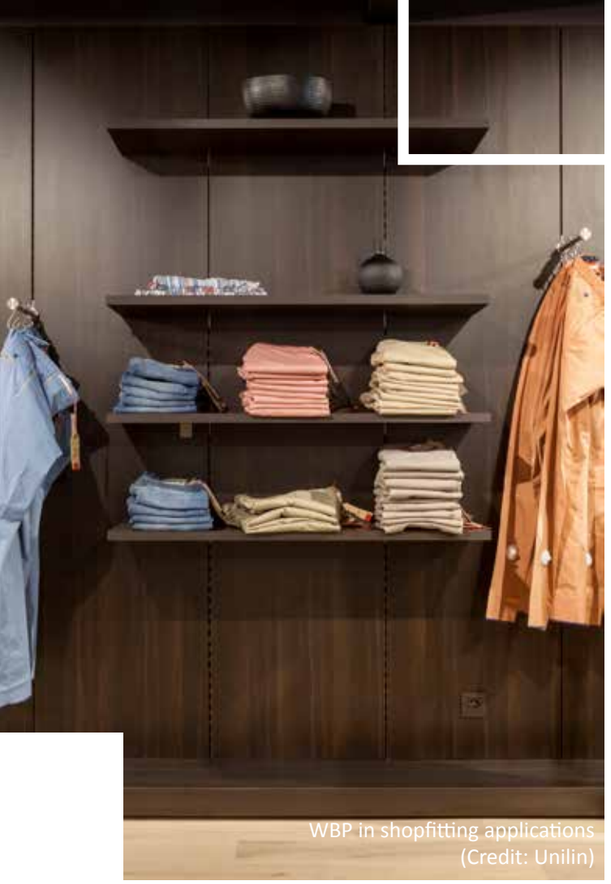
Plywood in packaging application (Credit: AEFCON)

Wood packaging placed on international markets is also subject to phytosanitary controls independent of any panel product standard. Under International Standard for Phytosanitary Measures No. 15 (ISPM 15) [24], solid wood packaging material such as pallets, crates and dunnage above a certain thickness must be debarked and either heat-treated or fumigated before being marked with the IPPC stamp; the European Commission confirms that wood packaging and dunnage entering the EU from non-EU countries must comply with these requirements [15]. Wood-based panels have an advantage in this respect as they are already heat treated as part of their manufacturing process.

Table 13 - Suitability of wood-based panels for packaging applications [27]

APPLICATION	TYPICAL PRODUCTS	KEY DESIGN CONSIDERATIONS	RELEVANT STANDARDS
General	PW, PB, OSB	—	No specific standard
Boxes and packing cases	PW, PB, OSB	Strength, stiffness, fastener performance, impact resistance, moisture resistance	No specific standard
Containers for agricultural produce	PW, OSB	Strength, stiffness, fastener performance, impact resistance, moisture resistance, durability	No specific standard
Pallets	PW, PB, OSB	Strength, stiffness, fastener performance, impact resistance, moisture resistance, durability	EN 12246 (quality classification of timber for pallets and packaging); EN 13545 (pallet superstructures – pallet collars, test methods); EN 13698-1 (construction specification, 800×1200 mm flat pallets); EN 13698-2 (construction specification, 1000×1200 mm flat pallets)

Key: PW = plywood; OSB = oriented strand board; PB = particleboard;



WBP in shopfitting applications
(Credit: Unilin)

Shopfitting

Wood-based panels are widely used in shopfitting because of their workability, wide range of finishes and suitability for rapid fit-out of retail and display environments. Dry-process fibreboard (MDF) in particular is noted for general industrial uses including packaging, displays, shopfitting and other fabricated products where flatness and surface quality are beneficial.Typical shopfitting applications include wall panelling, storage racks, counters and bars, and display or exhibition units. Selection criteria vary by element: surface quality, dimensional stability and impact resistance dominate for visible display and counter surfaces, while strength, stiffness and resistance to long-term deflection («creep») are the primary concerns for load-bearing elements such as shelving. Shopfitting elements are generally installed as fitted furniture or fixtures rather than as part of the building's structure, so they typically fall outside the scope of the Construction Products Regulation (CPR) [19] and its CE marking requirements, which apply specifically to construction products as defined under that Regulation; unless a shopfitting element is fixed permanently as part of the building fabric as opposed to a more furniture or fitting type role.

Table 14 - Suitability of wood-based panels for shopfitting applications [27]

APPLICATION	TYPICAL PRODUCTS	KEY DESIGN CONSIDERATIONS	RELEVANT STANDARDS
Bars/counters	PW, PB, MDF	Moisture resistance, surface quality, impact, dimensional stability, strength, stiffness	No specific standard
Display/ exhibition cabinets	PW, PB, MDF	Strength, stiffness, dimensional stability, impact resistance, surface quality	No specific standard
Shelving	PW, PB, OSB, MDF	Strength, stiffness, creep	No specific standard
Exterior signs and fascias	PW, MDF	Moisture resistance, durability, fastener performance, surface quality, strength, stiffness	No specific standard

Key: PW = plywood; OSB = oriented strand board; PB = particleboard; MDF = medium density fibreboard

Transport

Plywood in particular has a long-established role in transport applications, including truck / lorry trailer floors, bus and coach interiors, caravans, railway wagons and carriages, and small craft. In 2025, transport accounted for 15% of European plywood use, the third-largest application after construction (38%) and furniture (25%) [13].

Design considerations for transport applications centre on strength, stiffness, moisture resistance, durability, impact resistance, fastener performance and, for flooring applications, abrasion resistance. Panels used in vehicle and container decking are subject to concentrated and dynamic loading in service, similar in character to structural flooring, while panels used in claddings or linings are chosen more for durability and finish.



Plywood in van interior applications
(Credit: UIPC)

Marine craft is a notable sub-application with its own EU legal framework. Recreational craft placed on the EU market fall under Directive 2013/53/EU on recreational craft and personal watercraft [17]. The European Commission has listed EN ISO 12215-3 (small craft – hull construction and scantlings – materials: steel, aluminium alloys, wood, other materials) as a harmonised standard drafted in support of that Directive in Commission Implementing Decision (EU) 2022/1954 [14]. This means plywood and other materials used in hull, superstructure or appendage construction for recreational craft placed on the EU market can be assessed against this harmonised standard as part of demonstrating conformity with the Directive's essential requirements.

Table 15 - Suitability of wood-based panels for transport applications [27]

APPLICATION	TYPICAL PRODUCTS	KEY DESIGN CONSIDERATIONS	RELEVANT STANDARDS
Aircraft	PW	—	No specific standard; aerospace specifications apply
Vehicles and containers (decks, sides, etc.)	PW, OSB	Strength, stiffness, moisture resistance, durability, impact resistance, fastener performance, abrasion resistance	No specific standard
Marine craft	PW	Durability, moisture resistance, surface quality, strength, stiffness, impact resistance	EN ISO 12215-3 (small craft – hull construction and scantlings – materials), harmonised under Directive 2013/53/EU [14, 17]
Exterior signs and fascias	PW, MDF	Moisture resistance, durability, fastener performance, surface quality, strength, stiffness	No specific standard

Key: PW = plywood; OSB = oriented strand board

Agricultural

Wood-based panels are used in a range of farm structures, including livestock buildings, feed and storage installations,. Wood already has a strong position in this segment relative to other building types: EOS (European Organisation of the Sawmill Industry) reports that wood's market share in support structures for agricultural buildings across the EU reached 38.4% in 2023 (up from 35.5% in 2021), the highest share of any building segment tracked in its annual survey [11]. While this figure covers timber construction generally rather than wood-based panels specifically, it indicates a building segment where wood-based solutions, including panels, already have a substantial and growing footprint.

Typical agricultural applications for wood-based panels include animal buildings, feed troughs, gates and fencing, greenhouses and staging, hoppers and feed bins, silage retaining walls, storage bins and water tanks. Panels used in these applications are generally selected for strength, stiffness, moisture resistance, durability and impact resistance, reflecting the combination of structural loading and exposure to weather, moisture and, in livestock buildings, corrosive or abrasive conditions.

Where agricultural buildings are load-bearing, the same structural design framework used elsewhere in construction applies: characteristic values for structural design with OSB, particleboard and fibreboard are provided in EN 12369-1 and EN 12369-2 for plywood or via testing, for use with EN 1995-1-1 (Eurocode 5) (see Section 9.2). Agricultural building elements placed on the market as construction products remain subject to the Construction Products Regulation [19] in the same way as other structural timber buildings; this Guidebook does not identify any agriculture-specific exemption from that framework, and any such exemption under national planning or building regulations should be verified against the applicable national rules rather than assumed.

Table 16 - Suitability of wood-based panels for agricultural applications [27]

APPLICATION	TYPICAL PRODUCTS	KEY DESIGN CONSIDERATIONS	RELEVANT STANDARDS
Agricultural buildings	PW, OSB	Strength, stiffness, moisture resistance, durability, impact resistance	No specific standard (see EN 12369-1, EN 12369-2 / Eurocode 5 discussion above for structural design)
Retaining walls	PW, OSB		No specific standard
Silos/storage bins	PW, OSB		No specific standard

Key: PW = plywood; OSB = oriented strand board;

10 REFERENCES



[1] Besserer, A., Troilo, S., Girods, P., Rogaume, Y. and Brosse, N. (2021). Cascading Recycling of Wood Waste: A Review. Polymers, 13(11), 1752. HTTPS://DOI.ORG/10.3390/POLYM13111752

[2] CEN – European Committee for Standardization (2015). EN 13986:2004+A1:2015 Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking.

[3] Council of the European Union (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. OJ L 182, 16.7.1999, pp. 1–19. HTTP://DATA.EUROPA.EU/ELI/DIR/1999/31/OJ

[4] EcoReFibre (2025). Deliverable D1.3 – Open-access modelling tool of European fibreboard consumption and waste availability. Irle, M. et al., February 2025. Horizon Europe grant no. 101057473. Model available at HTTPS://ECOREFIBRE.EU/MODEL/

[5] EcoReFibre (2025). Deliverable D1.4 – Fibreboard market dataset 1995–2023. Lead author: Irle, M. (ESB). 17 December 2025. Horizon Europe grant no. 101057473.

[6] EcoReFibre (2026). Deliverable D4.1 – Sustainability: applications and recycling value chains. Lead authors: Péchenart, E. and Deroubaix, G. (FCBA); Elginoz Kanat, N. (IVL). Revised version 28 September 2026. Horizon Europe grant no. 101057473.

[7] EcoReFibre (2026). Deliverable D4.2 – Sustainability: general and technology recommendations for optimised implementation. October 2026. Horizon Europe grant no. 101057473.

[8] EcoReFibre (2026). Deliverable D5.3 – Strategic Roadmap: Unlocking circularity and market potential from wood waste. Lead authors: Carvalho, D., Jancke, O., Steckel, V., Wijnendaele, K., Baño, V. and Kies, U. Zenodo. HTTPS://DOI.ORG/10.5281/ZENODO.17473127

[9] EcoReFibre (2026). Policy Conference "Unlocking Circularity and Market Potential from Wood Waste". Zenodo. HTTPS://ZENODO.ORG/RECORDS/20581585

[10] EcoReFibre (2026). Results and Recommendations from the Policy Conference "Unlocking Circularity and Market Potential from Wood Waste". Zenodo. HTTPS://ZENODO.ORG/RECORDS/23008544

[11] EOS – European Organisation of the Sawmill Industry. Annual Report 2024–25. HTTPS://EOS-OES.EU/WP-CONTENT/UPLOADS/2025/06/EOS-ANNUAL-REPORT-2024-25.PDF

[12] Eurostat (2026). Generation of waste by waste category, hazardousness and NACE Rev. 2 activity (env_wasgen), waste category W075 «Wood wastes», EU27. Luxembourg: Eurostat. HTTPS://DOI.ORG/10.2908/ENV_WASGEN

[13] EPF – European Panel Federation. Annual Report 2025–2026. Brussels: EPF.

[14] European Commission (2022). Commission Implementing Decision (EU) 2022/1954 of 12 October 2022 on harmonised standards for recreational craft and personal watercraft drafted in support of Directive 2013/53/EU of the European Parliament and of the Council. OJ L 269, 17.10.2022, pp. 20–28 (as amended). HTTP://DATA.EUROPA.EU/ELI/DEC_IMPL/2022/1954/OJ

[15] European Parliament and Council of the European Union (2016). Regulation (EU) 2016/2031 of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, pp. 4–104. http://data.europa.eu/eli/reg/2016/2031/oj

[16] European Parliament and Council of the European Union (2008). Directive 2008/98/EC of 19 November 2008 on waste and repealing certain Directives (Waste Framework Directive). OJ L 312, 22.11.2008, pp. 3–30. HTTP://DATA.EUROPA.EU/ELI/DIR/2008/98/OJ

[17] European Parliament and Council of the European Union (2013). Directive 2013/53/EU of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC. OJ L 354, 28.12.2013, pp. 90–131. HTTP://DATA.EUROPA.EU/ELI/DIR/2013/53/OJ

[18] European Parliament and Council of the European Union (2023). Directive (EU) 2023/2413 of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (RED III). OJ L, 2023/2413, 31.10.2023. HTTP://DATA.EUROPA.EU/ELI/DIR/2023/2413/OJ

[19] European Parliament and Council of the European Union (2024). Regulation (EU) 2024/3110 of 27 November 2024 laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011 (Construction Products Regulation). OJ L, 2024/3110, 18.12.2024. HTTP://DATA.EUROPA.EU/ELI/REG/2024/3110/OJ

[20] Faraca, G., Boldrin, A. and Astrup, T. (2019). Resource quality of wood waste: The importance of physical and chemical impurities in wood waste for recycling. Waste Management, 87, 135–147. HTTPS://DOI.ORG/10.1016/J.WASMAN.2019.02.005

[21] FCBA (2025). Les panneaux à base de bois : guide des applications dans le bâtiment. Version 01, September 2025. FCBA.

[22] FEFPEB – European Federation of Wooden Pallet and Packaging Manufacturers. Facts & Figures. HTTPS://WWW.FEFPEB.EU/CMS/FILES/FACTSHEETS/FACTS-FIGURES.PDF

[23] Ikenze, N., Rizos, V. and Nipius, L. (2024). Improving waste wood circularity in the EU: classification frameworks and policy options. CEPS In-Depth Analysis 2024-14. Brussels: Centre for European Policy Studies (CEPS), November 2024. Prepared in connection with the EU-funded Wood2Wood project.

[24] IPPC – International Plant Protection Convention (2019). ISPM 15: Regulation of wood packaging material in international trade. International Standards for Phytosanitary Measures. Rome: FAO on behalf of the IPPC Secretariat.

[25] JRC – European Commission, Joint Research Centre (2016). Best Available Techniques (BAT) Reference Document for the Production of Wood-based Panels (Wood-based Panels BREF).

[26] Cazzaniga, Noemi; Tandetzki, Julia; Camia, Andrea (2026): Sankey diagrams of woody biomass flows in the EU Member States from 2012 to 2021. European Commission, Joint Research Centre [Dataset] doi: 10.2905/JRC.MXM8310 PID: HTTP://DATA.EUROPA.EU/89H/7693D92F-561A-4200-8AF9-834837F0CEDE

[27] PanelGuide. Wood Panel Industries Federation (WPIF), Timber Development UK. PanelGuide, version 5 (revised 2026). HTTPS://WPIF.ORG.UK/PANELGUIDE

[28] European Committee for Standardization (CEN). EN 622 series: Fibreboards - Specifications. Brussels: CEN.

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