IMPROVING WASTE WOOD CIRCULARITY IN THE EU: CLASSIFICATION FRAMEWORKS AND POLICY OPTIONS

Nwamaka Ikenze, Vasileios Rizos and Luca Nipius

CEPS IN-DEPTH ANALYSIS

November, 2024-14

Summary

Given the importance of wood as a renewable resource, efficient waste wood utilisation is central to visions for a climate-neutral, sustainable, and competitive Europe. Against this backdrop, it is critical to leverage waste wood as a sustainable resource to meet Europe's rising demand for wood-based products while also combating deforestation, biodiversity loss, and emissions tied to virgin wood harvesting. In advancing the circular economy and transforming waste wood valorisation to meet future demand, construction and demolition (C&D) and furniture waste wood have been identified for their potential to be turned into valuable wood-based products.

In this CEPS In-Depth Analysis report prepared in connection with the EU-funded Wood2Wood project, we explore opportunities to advance the circular economy and overcome challenges to waste wood utilisation – particularly for C&D and municipal furniture waste wood – through supportive policy. Combining desk research on existing waste wood approaches with expert consultations, we find both variation in waste wood approaches across Member States and numerous technological, market, and policy challenges to waste wood utilisation, such as the lack of efficient waste wood processing technologies, the absence of a market for waste wood, and the need for a harmonised waste wood regulatory framework.

Drawing on comparative analysis of existing approaches to waste wood and insights from the expert consultations, the report outlines various recommendations and policy options for improving waste wood utilisation through harmonised multi-criteria waste wood classification, refined and extended targets and obligations, enabling policy, and policy which fundamentally reflects the lifecycle perspective. These recommendations and policy options serve as a point of departure to help shape the regulatory environment in support of improved waste wood valorisation.

Nwamaka Ikenze is an Associate Research Assistant in the Energy, Resources and Climate Change (ERCC) unit at CEPS. Vasileios Rizos is a Senior Research Fellow and Head of the ERCC unit at CEPS. Luca Nipius is a Research Assistant in the ERCC unit at CEPS.

CEPS In-depth Analysis papers offer a deeper and more comprehensive overview of a wide range of key policy questions facing Europe. This paper was prepared in the context of the Wood2Wood project, which has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101138789. Another version of this paper is published as a project deliverable on the Wood2Wood website.

CEPS ▪ Place du Congrès 1 ▪ B-1000 Brussels ▪ Tel: (32.2) 229.39.11

Contents

List of Tables

List of Figures

Executive summary

Given the importance of wood as a renewable resource, efficient waste wood utilisation is central to visions for a climate-neutral, sustainable, and competitive Europe. Combining desk research with expert consultations, this report synthesises knowledge on existing waste wood approaches, identifies key challenges to waste wood utilisation, and explores opportunities to advance the circular economy through supportive policy. The report has been prepared as part of the EU-funded Wood2Wood project which aims to leverage waste wood as a sustainable resource to meet Europe's rising demand for wood-based products while also combating deforestation, biodiversity loss, and emissions tied to virgin wood harvesting.

In terms of existing waste wood approaches, the report identifies key elements of the waste wood-relevant policy framework at the EU level. The substance-based European Waste Classification for Statistics (EWC-Stat) and origin- and composition-based European List of Waste (LoW) are EU classification systems for statistical reporting of waste quantities and other administrative purposes. The EU Waste Framework Directive (WFD) introduces the waste management hierarchy and promotes its application through the limited use of economic instruments and incentives such as Extended Producer Responsibility (EPR) schemes, separate collection obligations, and sectoral reuse, recycling, and recovery targets. The EU Landfill Directive reinforces the waste hierarchy and sets limited landfilling reduction targets. The EU Regulations on persistent organic pollutants (POPs), classification, labelling and packaging of substances and mixtures (CLP), and registration, evaluation, authorisation and restriction of chemicals (REACH) set human health and environmental protection requirements for various waste wood-relevant substances.

At the Member State level, our study finds that existing waste wood approaches vary by country but have features in common. These common features of Member State approaches include waste wood classifications based on chemical quality criteria reflecting the presence of various substances such as halogenated organic compounds (HOCs), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals or based on waste wood source. Common features also include use prescriptions for each waste wood class, allowing disposal (incineration, landfilling), energy recovery, or material recovery depending on the class of waste wood. Member State waste wood approaches also commonly feature reporting, documentation, and labelling obligations. They also feature reuse, recycling, and recovery targets and obligations. Our study also finds that Member State waste wood approaches sometimes feature various rules for upgrading and downgrading waste wood classes. Our study examined in detail five EU Member States – Germany, the Netherlands, Finland, France,

and Slovenia – to highlight the common features at play in each approach. This provides insight into how these features operate and differ across countries. These five countries were selected based on volume of waste wood generated, availability of information, and complementarity, with the aim to capture a broad and representative set of features from the landscape of waste wood approaches.

Our study examines challenges to waste wood utilisation under existing approaches and identifies key technological, market, and policy barriers based on expert consultations.

From a technological perspective, there is a lack of fast and efficient technologies for sorting, analysing, testing, processing and cleaning, and certifying used wood. There is a lack of technologies to characterise waste wood in terms of type and properties, a scarcity of technologies for detecting and removing contaminants and harmful chemicals, and inadequate technologies and procedures to ensure waste wood quality, material properties, and suitability to various applications, especially in terms of level of degradation and load-bearing capacity. There is also a need for further development of material use alternatives. This involves identifying and developing less risky or less mechanically demanding material applications, so that lower-quality waste wood can be used with less risk to human health and the environment and material requirements can be met without requiring waste wood of such high quality.

From a market perspective, there is a lack of market for waste wood due to various supply- and demand-side factors. In general, there is little economic incentive to utilise waste wood, due to material use restrictions, a lack of infrastructure for safe transportation of waste wood, an overall lack of consumer demand or limited awareness of the need to utilise secondary resources, the high costs associated with the extensive processing required for material use of waste wood, and the abundance of virgin wood and limited supply of secondary wood in certain countries. There is also a lack of information to underpin investment decisions and uncertainty and inconsistency regarding quality (dimensions, surface quality, purity) and quantities of available waste wood. This undermines the establishment of a market for secondary wood and the rise of preparation-stage actors to take ownership of collection and reverse logistics, sorting, screening, decontamination, and processing of waste wood for utilisation – particularly at the industrial scale. These unfavourable market conditions for efficient waste wood utilisation are further exacerbated by the renewable energy-driven competition between energy use and material use.

Finally, from a policy perspective, there are challenges related to support for or restrictions on particular waste wood uses, such as policy support for energy use, a lack of support for material uses ahead of energy uses, a lack of standards and procedures to enable material uses, and restrictive material use policies. Further, given the market barriers to prioritising material utilisation of waste wood already identified, challenges such as policy support for energy use and a lack of policy support for material use have a notable compounding effect. Addressing these policy challenges presents an opportunity to create more favourable market conditions and a climate for technological development. The policy approach to waste wood utilisation is also hindered by a lack of forward-looking, holistic policies which adopt a lifecycle approach and reflect lifecycle complexity, as well as by inconsistencies across countries. There is also the lack of a harmonised regulatory framework for waste wood at EU level, including a harmonised classification scheme for waste wood.

Based on comparative analysis of existing waste wood approaches and insights from the expert consultations, the report puts forward the following recommendations for improved waste wood utilisation in the EU:

R1. Introduce a harmonised EU waste wood classification scheme. Drawing from across the existing Member State waste wood classification schemes and reflecting the waste management hierarchy, we propose a harmonised waste wood classification scheme consisting of five categories based on chemical quality criteria – Clean, Non-Hazardous I, Non-Hazardous II, Hazardous I, and Hazardous II – and featuring priority uses for each category. These priority uses are as permissive of high-priority treatments as possible; they favour material recovery then energy recovery whenever possible, followed by disposal with and without energy recovery. As there can be high testing and analysis costs associated with waste wood classification based on chemical quality criteria, other options for a harmonised classification scheme include adopting a preliminary source-based classification as part of a streamlined hybrid approach to classification. Waste wood classified according to source-based criteria could then be upgraded based on chemical quality criteria when necessary to promote higher priority treatment. Options also include the introduction of supplemental mechanical quality criteria tailored to classification of waste wood destined for material use only. A final option is to introduce supplemental product-quality criteria that would allow any class of waste wood to be used in material recovery as long as the resulting waste wood-based products are verified not to pose a health or environmental risk. This could help mitigate the risk that waste wood utilisation based exclusively on classification curtails innovation of safe products from low quality waste wood.

R2. Explore policy options for supporting waste wood valorisation at the EU level. As a starting point to overcome the various technological, market, and policy challenges to waste wood utilisation, policy options include

- extending reporting, documentation, and labelling obligations to help address information shortages and facilitate the smooth flow of waste wood across the EU;
- refining targets to at least match material recovery targets to existing renewable energy targets to better reflect the waste hierarchy;
- extending separate collection obligations to wood across all sectors in support of high- quality wood recycling;
- strengthening EPR to incentivise preparation-stage collection and reverse logistics, sorting, screening, decontamination, and processing of waste wood for utilisation;
- adopting limited bans such as a landfill ban for waste wood;
- developing guidance and standards on how to process and use waste wood across sectors in order to enable compliance with targets and obligations in the face of challenging market conditions;
- establishing incentives for material recovery and support for R&D on waste wood utilisation;
- and reinforcing the lifecycle perspective through ecodesign tools such as conditional market access or digital product passports to improve lifecycle traceability and availability of information.

1. INTRODUCTION

Owing to its mechanical and thermal conductivity properties, wood is used as a raw material in a range of industries, including the construction, furniture, paper and pulp,and energy industries (Besserer et al., 2021; Vis et al., 2016). Beyond its functional role in numerous industrial applications, wood holds significant potential to offer climate change mitigation benefits. These benefits can be attained through substitution of wood-based products for more carbon-intensive alternatives and by extending the lifetimes of wood-based products through cascading use (Navare et al., 2022). However, the potential of cascading wood use remains largely unexploited in the EU; in 2020, out of 40.2 Mt treated waste wood[1] in the EU-27, less than half (46 %) was recovered through recycling operations with a large share (54 %) ending up in incinerators for energy recovery (Eurostat, 2024c).

While waste wood incineration with energy recovery offers certain advantages, especially for waste coming from mixed sources containing additives and substances (Vis et al., 2016), the current mix of waste wood routes does not support the EU's objectives to move towards 'a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible' (European Commission, 2015, p.2). Reusing and recycling wood products can help to mitigate demand for virgin resources (Navare et al., 2022) and also postpone the incineration of wood until it has reached quality levels unsuitable for other uses (Mehr et al., 2018). Sustaining wood products in the economy also helps extend their role as carbon sinks (Brunet-Navarro et al., 2018).

Although the introduction of circularity principles in waste wood management and the increase of the lifetime of wood is part of the EU's strategy for forests (European Commission, 2021), several challenges remain. These challenges include large variation in collected wood materials and in the types of additives present in these materials (Pazzaglia & Castellani, 2023), a lack of transparency with regard to waste wood quality and composition (Besserer et al., 2021), and the generally low quality[2] of collected

[1] In this report, the terms 'wood waste' and 'waste wood' generally refer to both by-products from wood processing industries and post-consumer wood, though the report focuses primarily on post-consumer construction and demolition (C&D) and municipal furniture wood wastes – in line with the priorities of the EU-funded Wood2Wood project for which the report was prepared.

[2] The environmental benefits of recycling and the availability of possible applications for recycled wood increase in tandem with the quality of collected wood (Faraca et al., 2019a).

materials (Faraca et al., 2019b). A further key impediment to advancing circularity[3] for waste wood is the absence of a common EU approach for classifying wood waste (Besserer et al., 2021). Notably, harmonising national waste classifications is among the recommendations of the Letta (2024) report for developing a circular single market and further boosting the EU single market.

Against this backdrop, this report delves into challenges to waste wood utilisation and the varied EU waste classification schemes. Based on an analysis of several national classification frameworks and interviews with experts in the field, it provides recommendations for a harmonised EU approach for waste wood classification. The report is produced in the context of the EU-funded Wood2Wood project[4], which aims to extend the lifetime of wood from construction & demolition (C&D) and furniture waste and turn it into new products. Over its four-year duration, the project will develop and implement new sorting techniques, upcycling technologies, and digital tools to advance a circular economy for waste wood.

The remainder of the report is structured as follows. Section 2 provides a picture of the state of wood waste generation and treatment pathways in the EU. Section 3 presents key challenges to improving waste wood circularity in the EU as identified during interviews with academics and industry experts. Section 4 then delves into the different waste wood classification schemes across the EU and presents a number of national approaches. Section 5 concludes with recommendations for a potential common approach for an EU-wide classification scheme and policy options to improve waste wood circularity.

[3] When mentioning waste wood circularity throughout the report we refer to processes for extending the lifetime of waste wood through reuse and recycling. Other similar terms used in the report and broadly in the literature are waste wood cascading and valorisation. Vis et al. (2016, p. 10) have defined cascading use as 'the efficient utilisation of resources by using residues and recycled materials for material use to extend total biomass availability within a given system'. Tejaswini et al. (2022, p. 4) have defined valorisation as 'any process of recycling, reusing, or converting waste materials into resources'.

[4] Launched in January 2024, the Wood2Wood (A Wood-to-Wood Cascade Upcycling Valorisation Approach) project is funded by the EU's Horizon Europe funding programme.

2. WASTE WOOD TRENDS ACROSS THE EU

As a point of departure for this report, this section describes current waste wood trends across the EU. The first part of the section gives an overview of EU waste wood generation in terms of quantities and key sources, as well as current waste wood pathways. The section then concludes with a brief discussion of environmental impacts linked to waste wood generation and treatment.

2.1. WASTE WOOD GENERATION IN THE EU

Wood has long been used as a material across many sectors of the economy. Buildings, furniture, and many everyday products have historically been made – and continue to be made – from wood. In some sectors, there is even ongoing development of novel applications (Cherry et al., 2019). This extensive use of wood as a material generates significant and heterogenous waste wood streams.

In 2020 – the most recent year for which data are available – a total of 48.2 Mt of waste wood was generated in the EU-27 following an overall downward trend in waste wood generation. Between 2004 and 2020, wood waste generation decreased by 22.25 %, from 62.8 to 48.3 Mt. After the 2007-2008 financial crisis, waste wood generation declined steeply until 2014. Waste wood generation then began to decline again after 2016, albeit at a slower pace.

In terms of particular sources of waste wood, the decrease in overall waste wood generation can be attributed to the decrease of waste wood from the manufacturing sector and the agriculture, forestry and fishing sector. Waste wood from waste collection[5] from households, businesses and public places has increased more than threefold in the same period, while the construction sector's waste wood generation has increased by about one third (Eurostat, 2024a)[6]. Figure 1 shows trends in waste wood generation by sector in the EU-27 between 2004 and 2020.

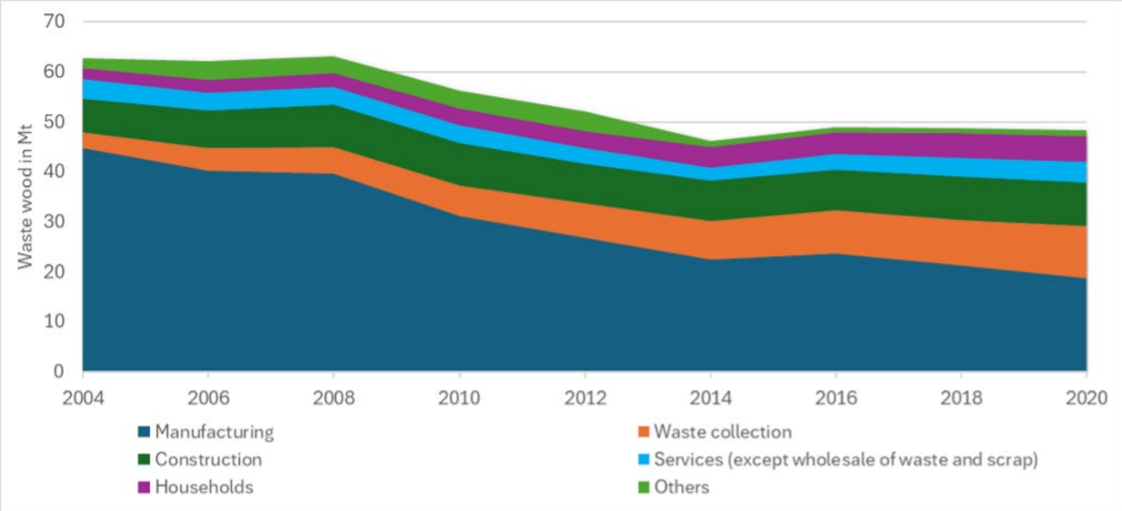
As of 2020, waste wood in the EU-27 mainly comes from three sources: the construction and demolition (C&D) sector, the commercial and industrial sector, and the waste collection sector (municipal waste). These sectors generated 8.59 Mt, 18.72 Mt, and 10.37 Mt of waste wood, respectively, in 2020.

---

[5] '"Waste collection"includes the collection, treatment, and disposal of waste materials. This also includes local hauling of waste materials and the operation of materials recovery facilities' (Eurostat, 2008).

[6] While there are multiple waste wood classification systems, this section reports statistics based on revision 2 of the Eurostat 'statistical classification of economic activities' (NACE rev. 2), which identifies 21 activities generating waste wood (UNECE, 2022). Member States' biennial statistical data are available per activity between 2004 and 2020.

Figure 1: Total waste wood generated in the EU-27 (Mt) from 2004 to 2020 based on Eurostat data (2024a).



Looking at the geographical distribution of waste wood generation, the largest waste wood streams come from Germany (13.3 Mt), France (7.7 Mt), Italy (5.1 Mt), Belgium (4.1 Mt), Finland (Mt 3.1 Mt), the Netherlands (3.1 Mt) and Romania (2.8 Mt), representing 81.5 % of the total waste wood generation. Ratios between the three main sources (C&D, manufacturing[7], and municipal waste) differ by country, with higher amounts of wood waste from the wood industry in the Nordic countries and the Baltics (Eurostat, 2024a), where a large portion of European wood is produced. In these countries, the share of waste wood from the C&D sector is also higher. This could be partially explained by the fact that wood is a more common building material in these countries than in other Member States due to abundant local wood supply. In Sweden, more than 20 % of C&D waste is wood, while in southern European countries such as Spain and Portugal, mineral building materials are more common (Moschen-Schimek et al., 2023).

Per capita waste wood also varies by Member State, with some Member States generating more waste wood per capita than the EU-27 average (107.9 kg/capita). Finland generates the most waste wood per capita (567.4 kg), followed by Belgium (360.0 kg) and Sweden (179.2 kg). This may be tied to large timber industries in these countries. Member States which generate significantly less waste wood per capita than average are

[7] Manufacture of wood and wood products includes 'the manufacture of wood products, such as lumber, plywood, veneers, wood containers, wood flooring, wood trusses, and prefabricated wood buildings. The production processes include sawing, planing, shaping, laminating, and assembling of wood products starting from logs that are cut into bolts, or lumber that may then be cut further, or shaped by lathes or other shaping tools. The lumber or other transformed wood shapes may also be subsequently planed or smoothed, and assembled into finished products, such as wood containers' (Eurostat, 2008).

Greece (5.1 kg), Spain (21.0 kg), Cyprus (10.4 kg), Hungary (9.6 kg), and Malta (19.9 kg) (Eurostat, 2024a; Eurostat, 2024b).

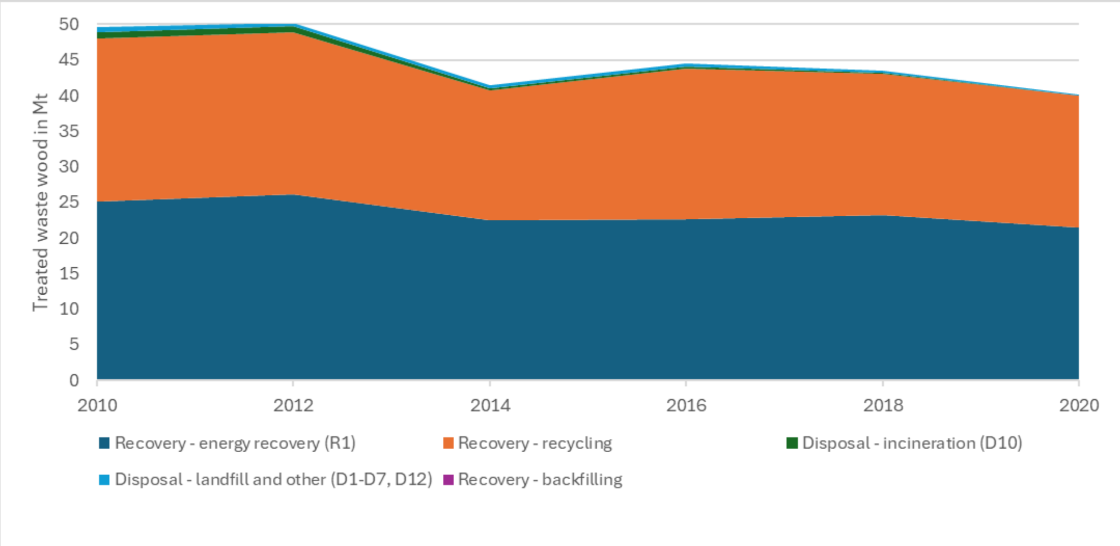
2.2. WASTE WOOD TREATMENT PATHWAYS

After wood is used for its intended purpose, it reaches its end-of-life stage, and it is generally considered waste wood. From this point, waste wood can follow a number of treatment pathways. From highest to lowest added value and in line with the EU waste hierarchy[8], waste wood can be recovered as a material via recycling[9], used in energy recovery as a fuel or other means to generate energy, or disposed of via incineration (with or without energy recovery) or landfilling. Waste wood can also be recovered for backfilling. Of the 48.3 Mt of waste wood generated in the EU-27 in 2020, 40.2 Mt underwent treatment, declining year over year since 2012 in line with declining overall generation of waste wood. Particular treatment pathways vary by waste wood source and by country. The recycling of waste wood is often complicated due to the presence of additives (glue, varnish, or paint), pollutants (heavy metals and other harmful substances), and contaminating materials (e.g., glass, plastic, or metal) (Besserer et al., 2021). Figure 2 shows the prevalence of the different pathways as a portion of overall waste wood treatment in the EU-27 from 2010 to 2020, recovery being far more prevalent than disposal via incineration and landfilling. In 2020, 99.38 % of waste wood was recovered (53.36 % energy recovery, 46.02 % recycling), while only 0.59 % of waste wood was disposed of (0.32 % landfill, 0.27 % incineration) (Eurostat, 2024c).

[8] Directive 2008/98/EC (Waste Framework Directive), last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20240218#M5-2 (consolidated text).

[9] Eurostat does not distinguish between waste wood recycling and reuse, so for the purposes of this section, the two are not distinguished.

Figure 2: Waste wood pathways in the EU-27 from 2010 to 2020 based on Eurostat data (2024c).

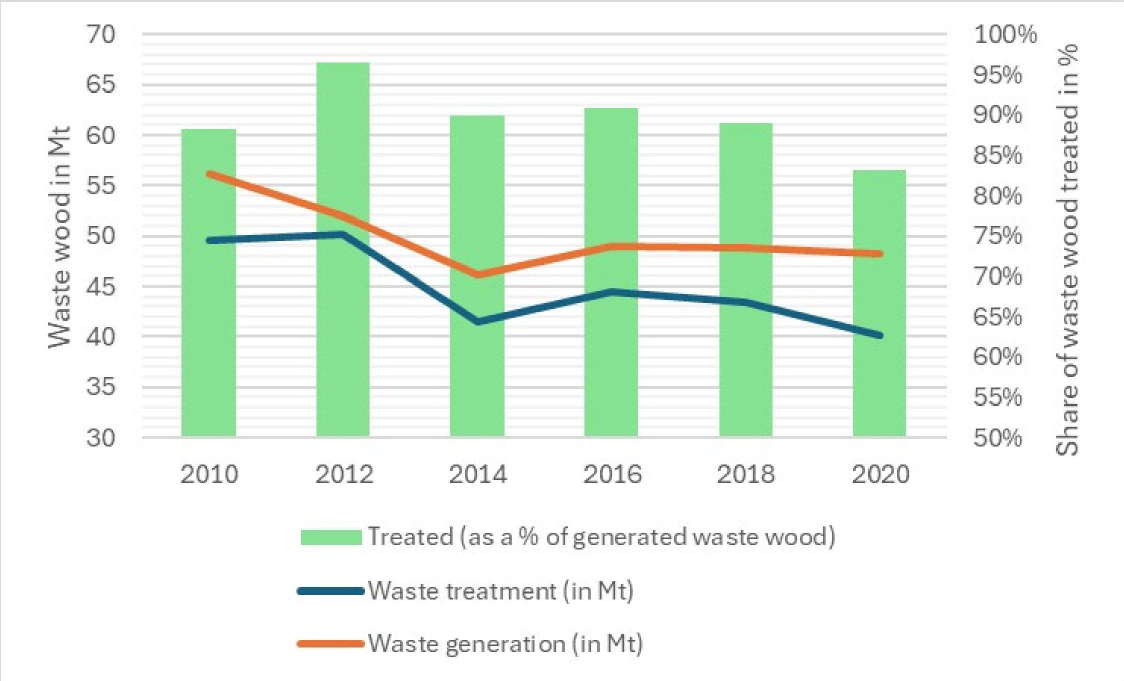


Looking at the treatment pathways by Member State, there are significant differences. Based on Eurostat data for 2020, some Member States recycle more than 80 % of their recovered waste wood. These Member States include the Czechia (93.3 %), Denmark (80.1 %), Spain (87.5 %), Italy (83.1 %), Cyprus (84.7 %), Latvia (93.8 %), Lithuania (80.6 %), Hungary (98.4 %), and Portugal (98.4 %). Others, such as Germany (29.6 %), Malta (1.3 %), Slovakia (25.1 %), Finland (5.1 %) and Sweden (1.7 %), recycle smaller portions of waste wood (Eurostat, 2024c). Of the limited landfilling which does occur (0.32 %), about 35 % takes place in France, while the Netherlands and the Czechia are responsible for 15.1 % and 14.2 %, respectively. Malta notably disposes of nearly all of its waste wood through landfilling, rather than recovering it. An additional 0.27 % of the total waste wood in the EU is disposed of through incineration, with the Netherlands being the primary contributor at 54.2 %. Belgium and France also contribute significantly to waste wood incineration, being responsible for 25.3 % and 16.9 % of incinerated waste wood in the EU, respectively (Eurostat, 2024c).

In terms of particular applications for recycled waste wood, much of usable waste wood is mixed with plastic to make insulation panels for the construction sector (Grigoriadis et al., 2019). However, the most common material application of waste wood in the EU is to recycle it into particle boards. In Italy, 100 % of the recovered waste wood that is recycled is turned into particle boards, while in Belgium and Denmark this number is between 50 and 70 %. Waste wood is also turned into pulp for various applications or used in concrete and mortar production, chemicals production, and biological decontamination. Although these material applications have the potential to contribute to decarbonising various sectors, waste wood is only marginally exploited for these applications (Pazzaglia & Castellani, 2023).

Looking at overall waste wood treatment across available pathways, data indicate that a portion of generated waste wood is not collected for treatment in the Member States. Figure 3 compares quantities of waste wood treated to quantities of waste wood generated in the EU from 2010 to 2020, highlighting the gap between waste wood generation and treatment. To increase waste wood circularity in the EU and reduce the environmental impact of wood use, it is essential to close this gap.

Figure 3: Waste wood generation and treatment in the EU from 2010 to 2020 based on Eurostat data (2024a; 2024c).



2.3. ENVIRONMENTAL IMPACTS LINKED TO WASTE WOOD GENERATION AND TREATMENT

In general, harvesting wood can lead to harmful emissions, deforestation, biodiversity loss, and other environmental impacts (ETC/CE, 2023). However, the particular environmental impacts of waste wood generation and treatment differ based on the treatment pathway the waste wood follows. When waste wood is landfilled, harmful emissions can result. When waste wood is not disposed of in suitable landfills, greenhouse gases such as methane are emitted as the waste wood anaerobically decomposes (O’Dwyer et al., 2018). Regarding disposal via incineration, because waste wood often contains contaminants and pollutants as a result of various treatments, incinerating waste wood can release pollutants and negatively impact air quality. Ashes resulting from waste wood incineration can also contain pollutants which can negatively impact human health and the environment (Sjöblom & Kumpiene, 2015). Household burning of waste wood for residential heating, or as leisure activity, can also pose challenges with regard to air quality, human health, and global and regional climate change impacts (Cincinelli et al., 2019; Orru et al., 2022).

When it comes to higher priority pathways, it is important to keep in mind that energy recovery can also have an impact on the environment. Although waste wood is generally regarded as a renewable energy source, burning it for energy emits carbon that is stored in the wood, which must be considered in carbon accounting. As with incineration, burning waste wood in energy recovery can also release pollutants into the air or result in polluted ashes (Sjöblom & Kumpiene, 2015). On the other hand, cascading waste wood recovery has the potential to mitigate a number of environmental challenges by helping to lower demand for virgin wood and thereby helping to reduce deforestation, biodiversity loss, and greenhouse gas emissions tied to wood harvesting (ETC/CE, 2023).

3. CHALLENGES TO UTILISING WASTE WOOD

Given the substantial quantities of waste wood generated in Europe and the importance of wood as a renewable resource, efficient utilisation of waste wood is essential to achieving the vision of a competitive, resource-efficient, and climate-neutral Europe. However, Europe must overcome numerous technological, market, and policy challenges to pave the way. Indeed, there has been focused research on technological innovations and processes to facilitate waste wood utilisation ranging from sorting technologies to chemical screening technologies and use case innovations[10]. There has similarly been research on industry implementation of cascading and circularity-compatible business models to address market challenges, as well as on policy alignment toward a circular wood economy[11].

Moving beyond this literature, in order to more comprehensively gather cross-cutting insights about the wide-ranging challenges to waste wood utilisation, we conducted interview consultations with academics and industry experts from various wood-centred industries. We used purposeful sampling (Palinkas et al., 2015) to select interviewees, seeking experts in the field with in-depth topical knowledge. Experts were primarily identified via academic publications and written reports published in connection with EU-funded projects. They were also identified based on their leadership roles in industry associations and trade groups or affiliation with relevant academic departments or EU-funded project consortia. Topical experts were also drawn from within the Wood2Wood consortium. In total, nine experts working in seven different EU countries – Finland, France, Germany, Italy, Poland, Slovenia, Spain – were interviewed (see Annex A).

The interviews were semi-structured in terms of their format. A set of guiding questions (see Annex B) was shared with the experts prior to the interviews to provide a framework for discussion. The aim of this approach was to facilitate a series of open, well-considered discussions which would elicit a wide range of challenges based on a breadth of expert perspectives. The interviews also solicited insights on the EU policy framework for waste wood, as well as insights regarding national waste wood classification schemes and approaches, aiming to understand challenges to waste wood utilisation in a multilevel way. Following the interviews, the interview transcripts were analysed to code common

---

[10] See, for example, Mancini and Rinnan (2021) on infrared technology for rapid assessment of waste wood quality, Hyvärinen et al. (2020) on mechanical sorting of C&D wastes, Tamanna et al. (2020) on the use of waste wood ash in construction, Berger et al. (2020) on the recycling potential of wood waste into cement composites, Caldas et al. (2021) on wood waste as CO2-sink in bio concrete.

[11] See, for example, de Carvalho Araújo et al. (2022) on circular business model design in the wood panel industry, Iurato and Schanz (2024) on the role of industry associations in the implementation of cascading, Husgafvel and Sakaguchi (2023) on the development of circular economy in the wood construction sector in Finland, and Pazzaglia and Castellani (2023) on policy frameworks, challenges, and decisional tools for waste wood valorisation in Europe.

challenges for waste wood utilisation, as well as to group these challenges by type. This section summarises these expert-identified challenges to waste wood utilisation, which will inform recommendations and policy options for an EU approach to waste wood in the final section of this report.

3.1. TECHNOLOGICAL CHALLENGES

Interviewed experts identified two key technological challenges to efficient waste wood utilisation: a lack of preparation technologies and procedures and a need for further development of material use alternatives.

3.1.1. Lack of preparation technologies and procedures

All but one of the interviewed experts identified a lack of technologies and procedures for preparing wood waste for utilisation as a key technological challenge. More specifically, experts cited a lack of fast and efficient technologies for sorting, analysing, testing, processing and cleaning, and certifying used wood. This includes a lack of technologies to characterise waste wood in terms of type and properties, a lack of technologies for detecting and removing contaminants and harmful chemicals from waste wood, and a lack of technologies and procedures to ensure quality of waste wood, material properties, and suitability to various applications, particularly in terms of level of degradation and load-bearing properties.

3.1.2. Need for further development of material use alternatives

In addition to a lack of technologies and procedures for preparing waste wood for utilisation, several experts also cited the need for further development of material use alternatives as a key challenge for utilising waste wood. This involves identifying and developing material uses that carry lower risk and have less demanding material requirements. This will result in less risk when using lower-quality waste wood and will ensure that waste wood does not have to meet such high-quality standards to fulfill the material requirements of the application. For example, one expert suggested that waste wood may be well suited to non-load-bearing material use in construction projects, or suited to material use on the interior of a product where it will not be visible and where consumers are less likely to come into contact with it.

3.2. MARKET CHALLENGES

Although experts seem to agree that there is a need for fast and efficient technologies and procedures for preparing waste wood for utilisation, experts also identified a number of market challenges which make investment in overcoming these technological hindrances a challenge in itself.

3.2.1. Lack of market for waste wood

While more than half of the experts interviewed cited the lack of market as a challenge to waste wood utilisation, this lack of market was attributed to a number of both supply- and demand-side factors. Experts identified a general lack of economic incentive to utilise waste wood, stemming from material use restrictions, a lack of infrastructure for safely transporting waste wood due to waste wood dimensions and contaminants, an overall lack of consumer demand or awareness of the need to utilise secondary resources, and the high costs associated with the extensive processing required for material utilisation of waste wood. These processing costs include extra wear on machinery due to the presence of contaminants, costs of certification and testing, costs of handling residual contaminants and hazardous materials, and labour costs. Other factors identified by the experts are country specific, including the abundance of virgin wood in some EU countries (e.g., Finland), as well as the limited supply of secondary wood in countries with smaller populations. The upshot of these factors is that using secondary wood is more expensive than using virgin wood, undermining the establishment of a market for secondary wood and discouraging proactive investment and innovation in wood waste utilisation. In addition, experts cited a lack of information to underpin investment decisions and uncertainty regarding quality (dimensions, surface quality, purity) and quantities of available waste wood.

3.2.2. Scalability

There is also a scalability challenge when it comes to utilising waste wood, with resource and knowledge limitations undermining scalability for the primarily SME-based woodworking industry. Additionally, inconsistencies in supply volumes and characteristics – especially from location to location and country to country – makes it difficult to scale waste wood utilisation to an industrial level. More fundamentally, the existing linear industrial system makes it challenging to achieve circular wood waste utilisation at an industrial scale.

3.2.3. Competition among uses

The majority of experts cited competition among the various uses of waste wood as a challenge for efficient waste wood utilisation. This includes competition between energy and material uses, particularly given rising the demand for wood in the energy sector in the push toward climate neutrality. With such high demand for wood in the energy sector, prices are high, and there is not much incentive to develop material possibilities for waste wood. This demand arises in part as a result of ambitious renewable energy targets and sustainability criteria for biomass[12]. Aside from energy sector demand for waste wood, there is also competing demand from the particleboard industry, which represents a downcycled material use (Ihnát et al., 2020).

3.2.4. Absence of preparation-stage actor(s)

Several experts noted the absence of an actor to take ownership of collection and reverse logistics, sorting, screening, decontamination, and processing of waste wood for utilisation as a challenge. There is a question of which actor(s) will fill this role, whether there is a need for a new enterprise or ecosystem to step into this role, or whether an existing recycling industry or wood working industry actor can fill the role. Experts stressed, however, that in order for this role to be filled, there must be an economic incentive to do so.

3.3. Policy challenges

In addition to various technological and market challenges to waste wood utilisation, experts also identified a range of overarching policy challenges. These include policy challenges related to support for or restrictions on particular waste wood uses, such as policy support for energy use, a lack of support for material uses ahead of energy uses, a lack of standards and procedures to enable material uses, and restrictive material use policies. Further, given the market barriers to prioritising material utilisation of waste wood already identified, challenges such as policy support for energy use and a lack of policy support for material use have a notable compounding effect. Finally, regarding the general nature of the policy approach to waste wood, experts also identified a lack of forward-looking, holistic policy which adopts a lifecycle approach and reflects lifecycle complexity, as well as inconsistencies across countries, as a hindrance to waste wood utilisation.

3.3.1. Preferential support for energy recovery

Most experts emphasised preferential policy support for certain waste wood uses as a challenge, either in terms of support for energy use or a lack of support for material use. For instance, experts noted that renewable energy targets and subsidies, combined with a lack of clear limitations, incentivise energy utilisation of waste wood and undermine

[12] In order to facilitate climate neutrality in the EU, the revised Renewable Energy Directive (RED III) promotes renewable energy production in the EU using binding targets and other mechanisms. This renewable energy production includes energy from biomass (bioenergy). In order to strike a balance between climate neutrality and other environmental concerns such as biodiversity, however, RED III applies sustainability criteria to the use of biomass for renewable energy production. However, waste is exempt from the application of these sustainability criteria, meaning that the RED III renewable energy targets drive energy utilisation of waste wood. Directive (EU) 2018/2001 (RED III), last amended 2024. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018L2001-20240716 (consolidated text).

cascading use. Experts also pointed out that bans on energy utilisation of certain alternative materials, such as coal and peat, are an aggravating factor. One expert suggested that there is at least a need for a ban on energy use of solid, clean waste wood to promote cascading use of high-quality wood.

In contrast to the policy support for energy utilisation of waste wood, experts highlighted a lack of parallel support (e.g., targets, subsidies, and programmes) for the proper utilisation of waste wood, which prioritises material use. For example, regarding construction and demolition specifically, one expert identified the lack of incentives to recover wood in good condition from buildings slated for demolition.

3.3.2. Lack of enabling policy

According to the experts, even if support for material utilisation of waste wood were to mirror support for energy utilisation in terms of targets and incentives, there is also a lack of policy which enables material use and facilitates the *achievement* of targets. Experts specifically noted a lack of centralised standards and procedures which would enable material use. This includes quality and strength standards for material use, for example for the reuse of old timber from buildings, or guiding principles for deconstructing buildings and sorting deconstruction waste. This also includes standardisation of cleaning, verification, and certification of waste wood destined for material uses, or of products made with secondary wood. Further, experts observed that waste wood classification schemes represent a missed opportunity to enable material utilisation of waste wood because they tend to focus on chemical information particularly relevant for wood utilisation in the energy sector, but do not contain mechanical and other information particularly useful for material use.

3.3.3. Restrictive policy approach with respect to material use

Beyond the absence of support and enabling policy for material use of waste wood, experts also identified affirmative restrictions on material use as a challenge to proper utilisation. This includes, for example, bans on the use of certain waste wood for material applications rather than general material use permission conditional on cleaning and verification for environmental and human health and safety. Policies which do not ban material use but which set quality standards for material use that are too high also belong to this category of challenges. Importantly, as waste wood is often down-sorted because of the cost and difficulty of chemical analyses and decontamination (Winder & Bobar, 2018), a policy approach which restricts material use to only the most demanding classes of waste wood results in large quantities of down-sorted wood which would otherwise be eligible for material use being ineligible for material use.

3.3.4. Absence of lifecycle perspective and lifecycle complexity

Experts also identified challenges regarding the overall nature of the policy approach to waste wood utilisation, highlighting a general lack of policy which sufficiently reflects a lifecycle perspective and which captures lifecycle complexity. For example, although there is policy focused on end-of-life and waste management for existing waste wood, experts noted insufficient policy focus on early lifecycle phases such as the design stage which would facilitate circularity of new products. Experts suggested a need for further policy action to encourage design for disassembly of products or deconstruction of buildings, for example. Further, while there are policies focused on individual aspects of environmental impact such as energy efficiency, experts noted that limited regard for lifecycle complexity undermines waste wood utilisation. For example, one expert explained that the use of multi-materials and multi-layer solutions is a common approach to energy efficiency in buildings but leads to difficulty in separating, decontaminating, and ultimately recovering materials during deconstruction as compared to single material and single layer solutions. Ultimately, experts expressed a need for a policy framework which is holistic and reflects a lifecycle perspective, both targeting different lifecycle stages and capturing greater lifecycle complexity.

3.3.5. Lack of harmonised regulatory framework for waste wood

Finally, experts identified inconsistencies across the policy landscape from one country to another, or a lack of harmonised policy, as a significant challenge to efficient waste wood utilisation. Experts specifically identified the lack of a common EU waste wood regulatory framework which would address the various challenges to waste wood utilisation and particularly facilitate cross-border trade of waste wood across the EU. According to experts, such a regulatory framework should be harmonised, while also allowing for localised implementation. For example, such a framework would harmonise the collection and availability of information essential to waste wood utilisation. This would include information such as information about quantities of waste wood available, the quality of waste wood in terms of both mechanical and chemical properties, and appropriate uses for available waste wood. Such a framework would also harmonise and streamline waste wood classification schemes across EU countries to facilitate waste wood utilisation throughout the entire EU, which is addressed in detail in the following sections of this report. Experts at the same time emphasised the importance of a waste wood classification approach which is simple enough that it will be properly applied in practice. In their view, mixed waste wood tends to be down-sorted under complex classification schemes, resulting in waste wood utilisation being limited to lower-priority uses than would otherwise be permitted.

4. MAPPING WASTE WOOD APPROACHES

In order to establish a baseline and inform recommendations and policy options for an EU approach to waste wood, this section maps existing waste wood approaches across the EU. The section begins with an overview of key elements of the waste wood-relevant policy framework at the EU level, including key classification systems, regulations, and directives. The section then introduces common features of national waste wood approaches before delving into a more detailed survey of approaches in five different EU Member States – Germany, the Netherlands, Finland, France, and Slovenia.

4.1. EU POLICY FRAMEWORK

4.1.1. Classification at the EU level

There are two classification systems at the EU level which are particularly relevant to waste wood – the European List of Waste (LoW)[13] and the European Waste Classification for Statistics (EWC-Stat)[14]. The LoW provides a harmonised catalogue of wastes for administrative purposes, such as statistical reporting of waste quantities. This list is organised by waste codes based on the origin and composition of waste and whether the waste is considered hazardous (wastes which display hazardous properties[15] are marked with an asterisk in Table 1). Table 1 lists several LoW codes which include C&D wood wastes and municipal furniture wood waste. These codes belong to Chapter 17 (construction and demolition wastes) and Chapter 19 (wastes from waste management facilities) of the LoW, which are assigned by C&D companies and waste management facilities, respectively (Llana et al., 2020). The EWC-Stat is a substance-based catalogue of wastes used for reporting waste statistics to Eurostat, with categories which can be transposed to LoW codes via an annexed table of equivalence.

---

[13] Commission Decision 2000/532/EC, last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02000D0532-20231206 (consolidated text).

[14] Regulation (EC) No 2150/2002, last amended 2010. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02002R2150-20101018 (consolidated text).

[15] This includes wastes which are explosive, oxidising, highly flammable, harmful, toxic, carcinogenic, corrosive, and infectious, for example (Annex III, WFD).

Table 1: Example LoW codes for C&D and municipal furniture wood waste

LoW Code	Description
17 02 01	Wood (non-hazardous)
17 09 02*	Construction and demolition wastes containing PCB
17 09 03*	Other C&D wastes containing hazardous substances
17 09 04	Mixed C&D wastes (non-hazardous)
19 12 06*	Wood waste (from mechanical treatment of waste) containing hazardous substances
19 12 07	Wood other than mentioned in 191206

4.1.2. EU Regulations and Directives

Beyond classifications, there are also a number of environmental regulations and directives which are relevant to waste wood classification and management, including the Waste Framework Directive (WFD), the Landfill Directive, and the POPs Regulation.

Waste Framework Directive[16]

The WFD is the foundational piece of legislation on waste at the European level. This Directive aims to protect the environment and human health by preventing and reducing waste generation and its adverse impacts, as well as facilitating the transition to a circular economy through improved resource efficiency. In pursuing these aims, the Directive introduces the waste management hierarchy – prevention, preparing for reuse, recycling, other recovery, and disposal – as the order of waste management priorities, taking into account lifecycle thinking and overall environmental outcomes. In line with the waste hierarchy, Member States are required to take measures to prevent waste generation, such as measures encouraging reuse. Member States must also take measures to ensure that waste undergoes preparation for reuse, recycling, and other recovery operations.

[16] Directive 2008/98/EC (Waste Framework Directive), last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20240218#M5-2 (consolidated text).

To promote high-quality recycling, waste is generally subject to separate collection under the Directive, provided that separate collection is technically feasible and does not entail disproportionate economic costs. Member States are required to set up separate collection for at least paper, metal, plastic, glass, and textiles – though not for wood – and must ensure that separately collected waste is not incinerated unless incineration delivers the best environmental outcome. To facilitate reuse and high-quality recycling in the context of C&D, the WFD requires Member States to take measures to promote selective demolition and to ensure establishment of sorting systems for C&D wood and other materials. In support of these obligations, the EU Construction & Demolition Waste Management Protocol, provides guidance on C&D waste management processes at all stages of the value chain, including pre-demolition and pre-renovation audits, selective demolition, on-site separation and collection (European Commission, 2024).

Under the Directive, Member States shall also make use of economic instruments and other measures to incentivise application of the waste hierarchy. Examples of these economic instruments and measures include charges and restrictions for landfilling and incineration of waste to incentivise waste prevention and recycling, the phasing out of subsidies not consistent with the waste hierarchy, and economic incentives to intensify separate collection of waste, measures to promote uptake of products and materials that are prepared for reuse or recycled, support for research to advance recycling technologies, and public awareness campaigns (Annex IVa). Another example of measures to incentivise application of the waste hierarchy is extended producer responsibility (EPR) schemes to strengthen reuse and prevention, recycling, and other recovery of waste. The WFD explicitly permits Member States to adopt EPR schemes. The Directive does not harmonise these schemes at the European level, though Member State EPR schemes must adhere to some general minimum requirements.

Lastly, Member States must also take measures generally designed to achieve a number of targets, including a 50 % by weight target for preparing for reuse, recycling, and other material recovery for C&D waste by 2020, as well as a 55 %-65 % targets for preparing for reuse and recycling of municipal waste, including wood waste, by 2025, 2030, and 2035.

Landfill Directive[17]

Another important piece of European waste legislation is the Landfill Directive, which aims to ensure safe waste disposal through stringent operational and technical requirements for landfills, as well as the progressive reduction of landfilling in line with the waste hierarchy. Among other things, the Directive reiterates the obligation of Member States to promote the application of the waste hierarchy through incentives such as economic instruments and other measures and requires Member States to take measures to ensure that no more than 10 % of municipal waste is landfilled by 2035.

POPs Regulation[18]

Regulation (EC) No 850/2004 on persistent organic pollutants (POPs Regulation) is a key substances regulation that aims to protect the environment and human health from certain listed substances which persist in the environment and bioaccumulate in living organisms. Under the POPs Regulation, waste consisting of, containing, or contaminated with listed POPs in concentrations above specified limits[19] must be disposed of or recovered in a way that ensures destruction of the POPs, as the recovery, recycling, reclamation, and reuse of POPs is prohibited. Permitted disposal and recovery of POPs-containing waste under the Regulation includes disposal via physico-chemical treatment and land-based incineration, as well as use principally as a fuel or other energy uses (so long as the waste does not contain PCBs). Further, the Regulation moves to phase out the formation and release of certain wood waste-relevant POPs altogether, including halogenated organic compounds (HOCs) such as polychlorinated biphenyls (PCBs) and dioxins and furans, as well as polycyclic aromatic hydrocarbons (PAHs).

Other chemicals and substances regulations covering substances relevant to wood waste classification and management, though not covering the wood waste itself, include the Regulation on classification, labelling and packaging of substances and mixtures (CLP

[17] Council Directive 1999/31/EC, last amended 2024. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20240804 (consolidated text).

[18] Regulation (EU) 2019/1021 (POPs Regulation) implementing the Stockholm Convention on POPs and the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants, last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02019R1021-20230828 (consolidated text).

[19] For instance, the limit values for PCB and PCP are 50 mg/kg and 100 mg/kg, respectively (POPs Regulation, Annex IV).

Regulation)[20] and the Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH Regulation)[21].

4.2. COMMON FEATURES OF NATIONAL WASTE WOOD APPROACHES

National waste wood approaches vary from one EU Member State to the next. However, several common features emerge across the various national waste wood schemes. These common features include the use of quality criteria related to mechanical processing and chemical treatment, as well as presence of hazardous substances and preservatives to classify waste wood. Common features also include source criteria and presumptions for classifying waste wood, as well as presumptions and rules for downgrading and upgrading waste wood classes. Additionally, catch-all waste wood class definitions are sometimes included. Beyond classification alone, waste wood schemes also commonly feature reporting, documentation, and labelling obligations; use prescriptions by waste wood class; and reuse, recycling, and recovery targets and obligations. This section will first provide a general description of these common features, drawing from the waste wood schemes across five EU countries – Germany, the Netherlands, Finland, France, and Slovenia. The subsequent section will then map waste wood approaches by country in more detail, framing the mapping exercise in terms of common features.

4.2.1. Quality criteria

Mechanical processing is commonly the first quality criterion in waste wood classification schemes, with the cleanest waste wood class being limited to wood which is not chemically treated, meaning it is natural or exclusively mechanically processed (cut, shredded, etc.). This may include cuttings or shavings from untreated solid wood; palettes, boxes, or cable reels made from solid wood; waste wood in its natural state from building sites, or solid wood furniture. On the other hand, waste wood which is painted, varnished, lacquered, bonded, or coated is considered to have undergone chemical treatment, surface treatment in particular (Alakangas et al., 2015).

The presence of hazardous substances and preservatives – as the result of treatment with preservatives, flame retardants, and other treatments – is often the second quality criterion due to a concern for human health and the environment. In some cases, a waste wood class is defined based on the presence of hazardous substances at any concentration, while in other cases a separate waste wood class exists where

[20] Regulation (EC) No 1272/2008 (CLP Regulation), last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008R1272-20231201 (consolidated text).

[21] Regulation (EC) No 1907/2006 (REACH Regulation), last amended 2024. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006R1907-20240606 (consolidated text).

concentrations of harmful substances exceed specified health and safety thresholds to render the waste wood hazardous. In some cases, a class is also defined based on whether hazardous substances are present in waste wood paints and coatings only, which can be removed either during pre-treatment or the recycling process, or whether the wood is impregnated with these substances to extend the useful life (i.e., preservative treated).

Classification schemes often recognise chlorine, bromine and fluorine **halogenated organic compounds (HOCs)** as class-defining hazardous substances. These compounds include volatile substances like trichloromethane (chloroforme), chlorophenoles and chlorobenzenes; halogenated hydrocarbons such as pentachlorophenol (PCP) and lindane, and **polychlorinated biphenyls** (**PCBs**) – particularly hazardous preservatives; as well as complex organic molecules such as dioxins and furans (EEA, EPER Chemicals Glossary; Alakangas et al., 2015). These toxic compounds pose a particular risk to human health and the environment because they can be volatile, meaning that they readily vaporise and may be transported over long distances as vapour or via water flows once re-deposited on water surfaces. These compounds also resist degradation, resulting in concentration in water, sediments, and air, as well as long-term persistence in the environment. Because halogenated organic compounds are lipophilic, they also bioaccumulate in fatty human and animal tissue, such that continuous exposure even at low levels may ultimately lead to high HOC concentrations over time (Kodavanti et al., 2023). Indeed, these substances are regulated as persistent organic pollutants (POPs) internationally and in the EU[22].

Polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, anthracene, and benzo[a]pyrene, which can pose similar risks to human health and the environment, are also class-defining substances in some classification schemes (Abdel-Shafy and Mansour, 2016; Alakangas et al., 2015) and are regulated under EU chemicals and substance regulations[23]. **Creosote** (a coal tar distillate), for example, is a complex mixture of PAHs which has historically been used as a wood preservative to protect wood used outdoors against termites, fungus, and other pests (Feenstra and Cherry, 1990). Creosote treated

---

[22] Regulation (EU) 2019/1021 (POPs Regulation) implementing the Stockholm Convention on POPs and the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants, last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02019R1021-20230828 (consolidated text).

[23] Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH Regulation), last amended 2024. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006R1907-20240606 (consolidated text); Regulation (EU) 2019/1021 (POPs Regulation) implementing the Stockholm Convention on POPs and the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants, last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02019R1021-20230828 (consolidated text).

wood is often used to make railway sleepers and utility poles, but is banned for all other applications in the EU[24].

Additionally, classification schemes often recognise **heavy metals** such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, thallium, and zinc as class-defining hazardous substances. Some schemes specifically recognise a class of **Wolmanized® wood**, which is pressure treated with a heavy metal-based **Chromium Copper Arsenate preservative (CCA treated)** preservative to protect against termites, fungal decay, and other degradation (Morais et al., 2021). Like both HOCs and PAHs, heavy metals can harm human health and the environment because of their toxicity, persistence in the environment, and potential for bioaccumulation. Some heavy metals are highly toxic, meaning they can strongly affect survival, growth, and reproduction of humans and animals through carcinogenic, mutagenic, and teratogenic properties, among other properties (Ali et al., 2019; Mitra et al., 2022). For decades, wolmanization has been restricted under EU law[25] to wood intended for professional and industrial installation and use only, where dermal contact is unlikely. However, since wolmanization extends the service life of wood products, certain applications of wolmanized wood are still allowed.

4.2.2. Reporting, documentation, and labelling obligations

In many cases, waste wood classification facilitates consistent statistical reporting and documentation of waste wood characteristics (UNECE, 2022). In light of this, some waste wood schemes feature reporting, documentation, and labelling obligations for actors throughout the value chain, such as waste generators, carriers, and processors.

4.2.3. Use prescriptions

Beyond classification-based reporting and documentation obligations, however, some waste wood schemes also feature use prescriptions by waste wood class on the basis of both quality criteria and sectoral source criteria. In general, these schemes may distinguish among disposal (incineration, landfilling), energy recovery, and material use of waste wood, which may include production of wood chips for the production of wood materials, production of synthesis gas for further chemical use, production of activated carbon/industrial charcoal, or particleboard production (Faraca et al., 2019b). Where waste wood schemes feature use prescriptions, disposal may be required for or limited to the most contaminated classes of waste wood, while material recovery may be limited

---

[24] Commission Implementing Regulation (EU) 2022/1950. EUR-Lex. https://eur-lex.europa.eu/eli/reg_impl/2022/1950/oj.

[25] Regulation (EC) No 1907/2006 (REACH Regulation), last amended 2024. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006R1907-20240606 (consolidated text).

to the cleanest classes of waste wood, such as waste wood which is mechanically processed only or waste wood which contains hazardous substances below set health and safety thresholds. Energy use, on the other hand, may be permitted for a wider range of waste wood classes, though it is sometimes limited to intermediate waste wood classes or to specific types of incineration installations. Where waste wood schemes allow for energy recovery from hazardous waste wood, for example, it is also typically required that energy recovery be carried out at large, emissions-controlled hazardous waste incineration installations.

4.2.4. Reuse, recycling, and recovery targets and obligations

Some waste wood schemes feature reuse, recycling, and recovery targets and obligations instead of or in addition to use prescriptions in order to control how waste wood is used. For instance, schemes may feature separate collection obligations, requiring all or certain classes of waste wood to be collected separately from other waste types, or they may feature obligations for producers of products under an EPR scheme. Lastly, some schemes feature waste management hierarchies in combination with targets imposing a general obligation to prioritise preparing for reuse and recycling over energy recovery, for example.

4.2.5. Source criteria and presumptions

One approach to waste wood classification is to define categories of waste wood based on the source of the wood, sometimes in the form of a list of waste by source which is aligned with the EU LoW[26]. Schemes taking this approach may distinguish among wood wastes from construction or demolition sites, furniture waste, wood packaging waste, and byproducts from the wood processing and furniture industries, for example[27]. These schemes may also classify wood based on *both* source criteria and quality criteria. In some cases, source criteria are only treated as presumptions, or sectoral allocations of common waste wood assortments as a general rule. In these cases, classification of waste wood from a particular source into another waste wood category may be permitted in particular justified or exceptional circumstances.

4.2.6. Downgrading presumptions and rules and the possibility to upgrade

Waste wood is sometimes sorted according to a downgrading presumption, where waste wood is downgraded to an adjacent class when there is uncertainty about the presence of contaminants or where waste wood from different classes is mixed. Similarly, in some

---

[26] Decision 2000/532/EC. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000D0532.

[27] As the focus of the Wood2Wood project is C&D and municipal furniture waste wood, further discussion of source criteria and presumptions will focus primarily on these wood waste streams.

cases waste wood from specific sectors, such as demolition waste wood, is presumed to belong in a lower quality class than waste wood from other sectors. In these cases, waste wood classification may lean toward lower quality waste wood classes as a result of the downgrading presumption. In some cases, where waste is generally classified according to source, there may be a downgrading rule whereby waste must be treated more restrictively because it exhibits properties of a lower quality class of waste. For instance, waste listed as non-hazardous must be treated as hazardous because it exhibits listed properties of hazardous waste. Further, in some cases waste wood is allowed to be processed according to the rules for a lower quality class, effectively downgrading the waste wood. While in some cases waste wood schemes feature these downgrading presumptions and rules, these schemes can also feature the possibility to upgrade waste wood class, by certifying that the wood meets certain quality criteria despite being from a particular source. For instance waste wood which is considered hazardous waste may be upgraded to non-hazardous waste where it does not display any hazardous properties. While in general the EU LoW is binding regarding the determination of hazardous waste, Member State upgrading and downgrading rules based on the exhibition of hazardous properties is permitted under European waste law[28].

4.2.7. Catch-all class definitions

Some waste wood schemes feature catch-all style class definitions instead of criteria-based class definitions. In these cases, one or more waste wood classes is treated as a residual class of wood defined simply as all waste wood which does not belong to another waste wood class. This limits classification criteria, simplifying the scheme.

4.3. WASTE WOOD APPROACHES BY COUNTRY

This section will briefly map individual waste wood approaches across five EU Member States - Germany, the Netherlands, Finland, France, and Slovenia – highlighting the common features at play in each approach to give a sense of how these features operate and differ by country. In selecting these five countries, multiple criteria were used. First, special attention was given to countries which generate large proportions of waste wood[29]. Countries were also selected for complementarity with respect to the common features of national wood waste approaches identified in Section 4.2, the aim being to capture a broad and representative set of features from the landscape of waste wood approaches. Lastly, countries were also selected on the basis of availability of

[28] Directive 2008/98/EC (Waste Framework Directive), last amended 2023. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20240218#M5-2 (consolidated text).

[29] Germany, France, and Finland are all among the top producers of waste wood in Europe (Garcia and Hora, 2017).

information, focusing on countries for which information was readily available online or for which subject experts were available for interview[30].

4.3.1. Germany

Quality criteria

In Germany, the Waste Wood Ordinance[31] (Altholzverordnung - AltholzV) lays out the waste wood classification scheme. The scheme consists of four standard classes – A I, A II, A III, A IV – which are defined based on whether wood is uncontaminated and has been mechanically processed only (A I) or chemically treated with glues, paints, or varnishes (A II); the presence of HOCs in a removable coating (A III); and presence of high concentrations of HOCs and heavy metals or treatment with wood preservatives or coal tar (A IV). In general, classes A I, A II, and A III are considered not harmful, while class A IV is considered hazardous (Winder & Bobar, 2018). There is also a special class for PCB treated wood, which is regulated under the PCB/PCT Waste Ordinance (Garcia and Hora, 2017).

Reporting, documentation, and labelling obligations

The Waste Wood Ordinance features reporting, documentation, and labelling obligations, requiring anyone who delivers waste wood to a treatment plant to declare its class and quantity via a standard delivery note (Annex VI). It should also be noted that waste wood treatment plant operators may only accept waste wood accompanied by this delivery note (Waste Wood Ordinance, §11).

Use prescriptions

The German waste wood classification scheme also features use prescriptions by class, distinguishing among 'material recycling procedures', 'energy recovery' according to the conditions set out in the Federal Immission Control Act - BImSchG (*Bundes-Immissionsschutzgesetz*)[32], and 'disposal.'

Under the Waste Wood Ordinance, material recycling procedures include three different processes: processing of waste wood into wood chips, production of synthesis gas for further chemical use, and production of activated carbon/industrial charcoal. Waste

---

[30] Experts were interviewed from Germany, Finland, France, and Slovenia, while information on the Dutch wood waste scheme was readily available online.

[31] German Federal Law Gazette Archive. https://www.bgbl.de/xaver/bgbl/start.xav.

[32] The German Federal Immission Control Act is harmonised with the European Industrial Emissions Directive (Directive 2010/75/EU), which imposes emissions limits, operating conditions, and technical requirements for waste incineration plants (UNECE, 2022).

wood belonging to classes A I-A IV may be used for both the production of synthesis gas for further chemical use and the production of activated carbon / industrial charcoal. However, there are additional conditions for waste wood belonging to classes A I-A III which is processed into wood chips and shavings for the production of wood-based materials. This waste wood cannot exceed the limit values[33] for heavy metals (arsenic, lead, cadmium, chrome, copper, mercury), halogens (chlorine, fluorine), and halogenated compounds (PCP, PCB) set in Annex II of the ordinance. Instead, waste wood which exceeds the limit values and must be assigned to the A IV waste wood category, which may only be recycled in the production of synthesis gas and activated carbon or used in energy recovery. Further, class A III waste wood may only be processed into wood chips and shavings for the production of wood-based materials if the halogenated organic HOC coating is removed.

Energy recovery is permitted for all four standard classes (A I-A IV), as long as recovery occurs at installations in which the feed is not dried in direct contact with exhaust gases or flames. In Germany, neither material recycling nor energy recovery is explicitly prioritised under the Waste Wood Ordinance. However, there has been support for energy recovery under renewable energy legislation.

PCB waste wood, such as insulation or soundproofing panels that contain PCB, must be disposed of according to the PCB/PCT Waste Ordinance and cannot be recycled or recovered.

Source criteria and presumptions

Annex III of the Waste Wood Ordinance allocates common waste wood assortments, and these allocations are to be observed as a general rule[34]. The waste wood assortments which are allocated in Annex III are organised by source, with separate allocations for wood waste from the wood processing industry, furniture wood waste, and C&D wood waste, for example. As a general rule, waste wood from the wood processing industry is mostly allocated to AI and AII, furniture wood waste is allocated to A I-A III, and C&D waste wood is mostly allocated to A II-A IV (Annex III).

Downgrading presumptions and rules

The German waste wood classification scheme applies a downgrading presumption under the Wood Waste Ordinance, meaning that if there is a mixture of waste wood from

[33] These limit values are as follows: As, 2 mg/kg dry matter; Pb, 30 mg/kg; Cd, 2 mg/kg; Cr, 30 mg/kg; Cu, 20 mg/kg; Hg, 0.4 mg/kg; Cl, 600 mg/kg; F, 100 mg/kg; PCP, 3 mg/kg; PCB, 5 mg/kg.

[34] Classification into another waste wood category is permitted in particularly justified exceptional cases. This must be justified and documented in the operations log.

different classes, recovery requirements are based on the highest waste wood class present. Further, if a waste wood mixture contains hazardous waste, the entire mixture is to be classified as hazardous waste. Additionally, if waste wood cannot be clearly assigned to a waste wood class, it must be transferred to a higher waste wood category to be classified.

Table 2 provides a summary of the German waste wood classification scheme, highlighting the quality criteria for each class, prescribed uses and special conditions by class, as well as allocations of common waste wood assortments by source (Annex III of Waste Wood Ordinance).

Table 2: German waste wood classification scheme: quality criteria, permitted uses, and source presumptions

A I	A II	A III	A IV
Untreated, non-hazardous	(Surface) Treated, non-hazardous	Contaminated, non-hazardous	Hazardous
Untreated or mechanically processed wood	Glued, varnished, painted, or otherwise treated wood; no HOCs in coating, must not exceed limit values for HOCs and heavy metals; no preservatives	Treated wood with HOC in coating; must not exceed limit values for HOCs and heavy metals; no preservatives;	Wood treated with preservatives; wood that exceeds limit values for HOCs and heavy metals; PAHs (tar oil); no PCB treated wood within meaning of PCB/PCT Waste Ordinance
Material recycling procedures and energy recovery	Material recycling procedures and energy recovery (*only* in installations in which feed is not dried in direct contact with exhaust gases or flames)	Material recycling procedures (*only* if coating is removed) and energy recovery (*only* in installations in which feed is not dried in direct contact with exhaust gases or flames)	*Some* material recycling (production of synthesis gas and activated carbon *only* in accordance with §4 of Federal Immission Control Act; no processing to wood chips); energy recovery (*only* in installations in which feed is not dried in direct

			contact with exhaust gases or flames)
Wood processing (sections and chips, solid wood pallets and crates); C&D (solid wood from construction sites), furniture (solid wood)	C&D (formwork wood, floorboards, false floors, door leaves and frames of interior doors, ceiling panels, decorative beams, building chipboards); furniture (without HOC coating)	Wood processing (composite pallets); furniture (with HOC coating)	C&D (wooden framework and roof rafters, exterior impregnated timber, windows frames; exterior doors); railway sleepers, power poles; wood processing (cable drums); furniture (impregnated garden furniture)

4.3.2. The Netherlands

Quality criteria

The waste wood classification scheme in the Netherlands is laid out in the wood sector plan (Sectorplan 36) as part of the National Waste Management Plan 3 (LAP3)[35]. The scheme consists of A, B, and C classes, with the C further divided into two subclasses – wolmanized C-wood and non-wolmanized C-wood. As under the German scheme, the first two classes are defined based on whether wood has been mechanically processed only (A-wood) or chemically treated with glues, pains, or varnishes (i.e. with a coating)(B-wood). C-wood is impregnated wood which is treated, either under pressure or not, with substances to extend the useful life (i.e., with preservatives). This wood can be either wolmanized – treated with heavy metals like copper, chromium, and sometimes arsenic – or non-wolmanized – treated with PAHs like creosote or HOCs like quaternary ammonium compounds.

Use prescriptions

The Dutch classification scheme sets minimum standards[36] and conditions for processing waste wood, which together function as use prescriptions. While the sectoral plan

[35] Dutch Ministry of Infrastructure and Water Management website. https://lap3.nl/sectorplannen/sectorplannen/hout/.

[36] This means the lowest form of processing permitted, so setting the minimum standard to recycling for A-wood would mean that A-wood cannot be used for energy recovery.

acknowledges that material recycling of A and B wood is possible and does occur, it sets 'other useful application'[37], which includes energy recovery, as the minimum standard for processing this wood due to insufficient capacity to recycle all A and B wood. The minimum standard for non-wolmanized C-wood is 'main use as fuel', meaning that this wood must be burned with energy or heat recovery in an emissions-controlled facility. However, this use is only permitted if all risks of harmful consequences for public health and contamination of soil or water are prevented. Otherwise, this wood must be landfilled. Other forms of recovery are not permitted, unless it concerns recycling of creosoted wood to the extent possible under the European REACH Regulation[38]. Finally, the minimum standard for wolmanized C-wood is landfilling, which is an exception to the dumping ban for wood under the Landfills and Waste Dumping Ban Decree (Bsssa)[39]. For C-wood, recovery is explicitly prohibited to prevent the diffusion of heavy metals in the environment, unless the wood is used as a fuel or incinerated as a form of disposal in installations where generated residues (ashes) are landfilled in order to avoid diffusion of the metals, or unless recycling is permitted under the REACH Regulation.

Catch-all class definitions

The Dutch classification scheme features a catch-all definition for B-wood, which defines the B class as painted, varnished, or glued wood which is *not* A- or C-wood. This means that wood which is treated but not impregnated falls into class B without having to meet additional criteria, potentially saving time and lowering costs associated with chemically analysing wood waste.

Table 3 provides a summary of the Dutch waste wood classification scheme, highlighting the criteria for each class, as well as prescribed uses and special conditions by class.

---

[37] Under the European WFD, other useful application includes energy recovery and appears in the waste hierarchy after prevention, preparation for re-use, and recycling, but before removal.

[38] Regulation (EC) No 1907/2006 (REACH Regulation), last amended 2024. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006R1907-20240606 (consolidated text).

[39] Dutch Ministry of Infrastructure and Water Management website. https://www.afvalcirculair.nl/afvalregelgeving/afval-storten/bssa/.

Table 3: Dutch waste wood classification scheme: quality criteria and permitted uses

A	B	C (non-wolmanized)	C (wolmanized)
Untreated, non-hazardous	Treated, non-hazardous	Hazardous	Hazardous
Unpainted and untreated wood	Glued, varnished, or painted, wood which is not A- or C-wood	Preservative treated (impregnated with PAHs, HOCs, etc.)	Preservative treated (impregnated with CCA/chromated copper arsenate)
Other useful application (incl. energy recovery); no landfilling	Other useful application (incl. energy recovery); no landfilling	Main use as fuel in emissions-controlled facilities; no landfilling	Dispose of in a suitable landfill; no recovery (unless used as fuel or incinerated in suitable facility or recycled under EU REACH Regulation)

4.3.3. Finland

Quality criteria

In Finland, VTT – the Technical Research Centre of Finland – compiled the Finnish waste wood classification scheme and guidelines for use in 2015 (Alakangas et al., 2015). The scheme has four classes: Class A, Class B, Class C, and Class D. Class A wood is untreated virgin wood, or wood which is mechanically processed only. Class B wood is coated, lacquered, or otherwise chemically treated wood which does not contain HOCs or preservatives in the coating. Additionally, the Class B wood may contain chlorine or heavy metals below tabulated threshold values[40]. Class C wood contains HOCs (expressed as chlorine[41]) and heavy metals above these tabulated threshold values, or HOCs in the coating. Class D wood is preservative treated (i.e., impregnated), hazardous wood which contains copper, chromium, and arsenic, for example. This includes railway sleepers and transmission and telephone line poles.

[40] These limit values are as follows: Pb, 50 mg/kg dry matter; Cd, 1 mg/kg; As, 10 mg/kg; As+Cr+Cu (combined), 70 mg/kg; Hg, 0.1 mg/kg.

[41] Waste Incineration Act. Finnish Law Archive. https://www.finlex.fi/en/laki/kaannokset/2013/en20130151_20151303.pdf.

Reporting, documentation, and labelling obligations

The Government Decree on Waste (978/2021)[42] features reporting, documentation, and labelling obligations, requiring waste producers and waste treaters, as well as waste carriers, brokers, and collectors to keep records and disclose information regarding the quantity of waste, the list-of-waste entry and a description of waste type, the character of the waste, the activity from which the waste was generated, any hazardous properties if the waste is hazardous, among other things.

Use prescriptions

The Finnish classification scheme focuses heavily on fuel and energy use of waste wood, setting use prescriptions which relate to whether wood belonging to each class can be recovered for energy and in which kinds of energy plants. The Finnish guidelines specify that Class A virgin wood, for example, can be used in all kinds of biomass plants. Class B wood should be burned in energy plants with output exceeding 20 MW, or in new plants with output greater than 5 MW, which satisfy more demanding emission regulations under the Small-scale combustion plant Act (750/2013)[43] (Alakangas et al., 2015). Class C wood should be incinerated according to the standards set out in the Finnish Waste Incineration Act (151/2013)[44]. Lastly, Class D wood may only be disposed of in an environmentally hazardous landfill or in a plant specifically designed for incineration (Verkasalo et al., 2020).

Reuse, recycling, and recovery targets and obligations

While the Finnish classification scheme does not feature material use prescriptions alongside its energy-focused use prescriptions, under the Finnish Waste Act, there is a general obligation in line with the waste management hierarchy to prioritise preparing for reuse, followed by recycling, above energy recovery, and finally disposal (Verkasalo et al., 2020). Under the Government Decree on Waste, this hierarchy is explicitly applied in the C&D context, imposing an obligation to reclaim and reuse all usable construction components and materials and to generate as little C&D waste as possible. The Government Decree on Waste also sets a target for C&D waste recovery of 70 % by weight for purposes other than energy or fuel production, excluding hazardous waste. The target is to be reached via application of the waste hierarchy and separate collection of C&D waste, including of unimpregnated wood. The Decree also sets 2025, 2030, and

---

[42] Finnish Law Archive. https://www.finlex.fi/en/laki/kaannokset/2021/en20210978.

[43] Finnish Law Archive. https://finlex.fi/sv/laki/kaannokset/2013/en20130750.

[44] Finnish Law Archive. https://www.finlex.fi/en/laki/kaannokset/2013/en20130151_20151303.pdf.

2035 targets for preparing for reuse and recycling of municipal waste, which includes wood furniture.

Source criteria and presumptions

The Finnish scheme also features source criteria, sorting waste wood into classes by source. Class B wood, for example, specifically excludes demolition wood. Instead, demolition wood belongs to Class C by default, unless it is possible to prove that the demolition waste is not chemically treated (e.g., house frames, building timber) (Alakangas et al., 2015).

Possibility to upgrade

In contrast to a downgrading presumption, in Finland, it is possible to upgrade waste wood from a lower class to a higher class. For example, it is possible to certify with chemical analyses that the chlorine and heavy metal levels do not exceed threshold values for Class B wood, allowing the wood to be considered Class B wood despite containing HOCs such as PVC in the coating (Alakangas et al., 2015). This means that the effective difference between Class B and Class C wood is whether concentrations of HOCs and heavy metals exceed threshold values.

Table 4 contains a summary of the Finnish waste wood classification scheme, highlighting the criteria for each class, as well as the energy-focused use prescriptions and relevant source criteria.

Table 4: Finnish waste wood classification scheme: quality criteria, permitted uses, and source criteria

A	B	C	D
Untreated, non-hazardous	Chemically treated, non-hazardous	Chemically treated, non-hazardous	Preservative treated, hazardous
Virgin wood which is untreated or mechanically processed only	Coated, lacquered, or otherwise chemically treated wood; no HOCs in coating; HOCs or heavy metals below thresholds	Chemically treated; HOCs in coating; HOCs or heavy metals above thresholds	Impregnated with preservatives (e.g., CCA treated)
Can be used in all kinds of biomass plants	Should be burned in energy plants > 20 MW or new plants > 5 MW	Incineration according to Waste Incineration Act	Disposal in suitable landfill
	No demolition wood	Demolition wood	

4.3.4. France

Quality criteria

In France, three main classes of waste wood have been established by the wood sector – A, B, and C – with a subdivision of Class A into subclasses A1 and A2 depending on the source of the wood waste (Verkasalo et al., 2020; FCBA, 2022). Class A wood is natural wood which is uncoated and untreated. Subclass A1 wood is uncoated, untreated wooden packaging waste while subclass A2 wood is uncoated, untreated wood from the wood processing industry such as raw wood, bark, shredded wood, sawdust, sanding dust, or scrap wood. Class B wood is glued, coated, or surface-treated wood. This wood is non-hazardous, contains limited amounts of additives or contaminants, and may include furniture waste and C&D waste (UNECE, 2022). Class C wood contains heavy metals or HOCs (Verkasalo et al., 2020).

Use prescriptions

In France, use prescriptions depend on whether waste wood is hazardous or non-hazardous (Verkasalo et al., 2020). For material recovery, waste wood must not be hazardous (Verkasalo et al., 2020), which limits material recovery to wood belonging to Class A and Class B. Use prescriptions focused on energy recovery are regulated under the ICPE regulation[45] (Installations Classées pour la Protection de l'Environnment). In general, non-hazardous wood waste not contaminated with halogenated organic compounds or heavy metals can be combusted. This corresponds to Class A and Class B wood. On the other hand, hazardous waste containing these substances must be disposed of in an authorised incineration facility (Verkasalo et al., 2020; UNECE, 2022), though France has also set a target to reduce incineration by half by 2025/2026 (EEA, 2023). This corresponds to Class C wood. Concerning landfilling, France has excluded waste wood from landfilling from 2025 (Verkasalo et al., 2020) and has also set a target to reduce landfill capacity by half compared to 2010 levels by 2025 (EEA, 2023).

Reuse, recycling, and recovery targets and obligations

France promotes recovery and recycling of waste wood via a number of obligations and targets. The French Environmental Code[46] requires separate collection of certain waste streams, including wood waste (EEA, 2023; UNECE, 2022), and sets recovery and recycling

---

[45] French Law Archive. https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006074220/LEGISCTA000006143748/#LEGISCTA000006143748.

[46] French Law Archive. https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006074220/LEGISCTA000006143752/#LEGISCTA000006143752.

targets for various streams like furniture waste and C&D waste (Verkasalo et al., 2020; Vernier, 2021; UNECE, 2022; EEA, 2023). Further, France has a well developed EPR system which covers both (wood) furniture and construction products (Vernier, 2021). This EPR system aims to reduce waste by requiring product producers to take responsibility for waste management, either directly or through a Producer Responsibility Organisation (PRO) – a state-approved organisation which specialises in collecting, transporting, sorting, and processing waste for reuse and recycling – to which producers pay an eco-contribution (Vernier, 2021). This eco-contribution can be modulated to encourage or discourage certain product features for improved overall environmental performance (Vernier, 2021). French environmental law[47] also aims to implement the hierarchy of waste treatment methods, favouring preparation for reuse and recycling over other recovery such as energy recovery, as well as over disposal.

Table 5 contains a summary of the French waste wood classification scheme, highlighting the criteria for each class, as well as use prescriptions by class.

Table 5: French waste wood classification scheme: quality criteria and permitted uses

A	B	C	A
Natural, untreated, and uncoated, non-hazardous	Surface treated, non-hazardous	Heavy metal or HOC-treated, hazardous	Natural, untreated, and uncoated, non-hazardous
Material recovery; energy recovery	Material recovery; energy recovery	Incineration	Material recovery; energy recovery

4.3.5. Slovenia

Quality criteria

Slovenia has adopted the EU LoW[48] classification of hazardous (and non-hazardous waste) in its Waste Regulation[49], which is based on the display of hazardous properties or the concentration of hazardous substances, where necessary[50]. In Slovenia, non-hazardous waste is classified into three categories – unpolluted biomass waste, contaminated biomass waste, and other waste – according to the list of waste under the

---

[47] French Law Archive. https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006074220/LEGISCTA000006143752/#LEGISCTA000006143752.

[48] Decision 2000/532/EC. EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000D0532.

[49] Slovenian Law Archive. https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina/2015-01-1513?sop=2015-01-1513.

[50] WFD, Article 7, empowering the Commission to adopt the LoW.

Regulation on the processing of non-hazardous waste into solid fuel and its use (PISRS)[51]. Relevant to the Wood2Wood project, the list of waste for processing into solid fuel is coded by source and includes municipal waste such as wood furniture (20 01 38) and C&D (17 02 01) waste wood. For these types of waste wood, classification as unpolluted biomass waste, contaminated biomass waste, or other waste depends on whether the content of hazardous substances[52] exceeds annexed threshold values. The content of hazardous substances in municipal furniture waste wood and C&D waste wood which is classified as unpolluted biomass waste does not exceed the annexed limit values for unpolluted biomass[53]. Correspondingly, the content of hazardous substances in municipal furniture waste wood and C&D waste wood classified as contaminated biomass waste does not exceed the more permissive annexed threshold values for contaminated biomass[54], while the content of hazardous substances in other waste exceeds the values for contaminated biomass. Further, waste wood in any of these classes must not contain preservative agents and coatings containing coal tar such as creosote, which contains high concentrations of PAHs, among other chemicals (Cheremisinoff et al., 2008).

Reporting, documentation, and labelling obligations

The Slovenian Waste Regulation features extensive administrative requirements for actors throughout the value chain, including waste generators, collectors, carriers, processors, dealers, and brokers. These include requirements related to registration, permitting, record sheet management, quantitative and qualitative reporting, labelling of waste.

Use prescriptions

In Slovenia, use prescriptions are set out in the Regulation on the processing of non-hazardous waste into solid fuel and its use (PISRS)[55] and are thus focused on the energetic use of waste wood. In general, the PISRS prohibits the processing of waste into solid fuel, unless the waste is listed as unpolluted biomass, contaminated biomass, or other waste in the Regulation. However, the Regulation permits the processing of listed waste into solid fuel. As mentioned above, the list of waste for processing into solid fuel includes both municipal waste such as wood furniture and C&D waste wood. Thus, it is generally

---

[51] Slovenian Law Archive. https://pisrs.si/pregledPredpisa?id=URED6504.

[52] These substances include heavy metals (arsenic, lead, cadmium, chrome, copper, mercury), halogens (chlorine, fluorine), and halogenated compounds (PCP, PCB).

[53] The limit values for unpolluted biomass are as follows: As, 1 mg/kg dry matter; Pb, 15 mg/kg; Cd, 1 mg/kg; Cr, 15 mg/kg; Cu, 10 mg/kg; Hg, 0.2 mg/kg; Cl, 400 mg/kg; F, 50 mg/kg; PCP, 1.5 mg/kg; PCB, 2.5 mg/kg.

[54] The threshold values for contaminated biomass are as follows: As, 2 mg/kg dry matter; Pb, 30 mg/kg; Cd, 2 mg/kg; Cr, 30 mg/kg; Cu, 20 mg/kg; Hg, 0.4 mg/kg; Cl, 600 mg/kg; F, 100 mg/kg; PCP, 3 mg/kg; PCB, 5 mg/kg.

[55] Slovenian Law Archive. https://pisrs.si/pregledPredpisa?id=URED6504.

permitted to process these wastes into solid fuel under the Regulation provided environmental and human health requirements for the use of the solid fuels in small heating devices and medium and large heating plants are observed. Specifically, it is permitted to use solid fuel from unpolluted biomass in small heating devices, while it is permitted to use municipal and C&D wood waste that belongs to the contaminated biomass and other waste categories in medium and large heating plants. On the other hand, hazardous waste which is outside the scope of the list of non-hazardous waste may not be processed into solid fuel under the Regulation.

Reuse, recycling, and recovery targets and obligations

Like other Member States, Slovenia has adopted the waste management hierarchy in its Waste Regulation, prioritising waste prevention, preparation for reuse, and recycling over energy processing and disposal. This Regulation generally requires that waste be handled in such a way as to enable processing in accordance with the waste management hierarchy, as well as that waste be processed rather than disposed of. The Waste Regulation also sets reuse and recycling targets. For paper, metal, plastic, and glass household waste the target has been to increase preparation for reuse and recycling by 50 % before the year 2020. However, wood is not included in this target. For C&D waste, the target has been to increase preparation for reuse, recycling, and material processing by 70 % by 2020.

Source criteria and presumptions

As the list of waste under the PISRS is coded by source, the Slovenian scheme is heavily based on source presumptions. Under this scheme, only wood waste from listed sources may be processed into solid fuel. On the other hand, use of this solid fuel in small, medium, and large heating plants depends on the presence of pollutants in the waste wood, and in general, Slovenian waste processors are required to measure these pollutants in order to classify waste wood as unpolluted biomass, contaminated biomass, or other waste for use in appropriate heating plants. However, there is also a source dimension to this measurement requirement because the regulation only requires the measurement of PCBs in C&D waste wood.

Downgrading presumptions and rules

Slovenia has a number of downgrading presumptions and rules related to the classification of waste as hazardous or non-hazardous. Under the Waste Regulation, waste which can be labelled as both hazardous and non-hazardous according to the EU LoW is considered hazardous until it has been evaluated. In addition, waste which can only be classified as non-hazardous according to the list of waste but that exhibits hazardous properties must be treated as hazardous waste. In contrast, waste which can only be classified as hazardous according to the list of waste but does not exhibit hazardous properties must continue to be treated as hazardous. These rules tend to downgrade non-hazardous waste to hazardous waste, rather than the reverse.

There are also a number of downgrading rules related to the processing of waste into solid fuel. Under the PISRS, only waste from unpolluted biomass is permitted to be processed into solid fuel from unpolluted biomass. However, the PISRS permits fuel from contaminated biomass to be processed from both contaminated biomass and unpolluted biomass, effectively allowing for the downgrading of unpolluted biomass to contaminated biomass. Similarly, other waste may be processed from other waste, contaminated biomass, and unpolluted biomass, allowing for the downgrading of both unpolluted biomass and contaminated biomass to other biomass.

Table 6 contains a summary of the Slovenian waste wood classification scheme, highlighting the project-relevant source criteria for each class, quality criteria, and use prescriptions by class.

Table 6: Slovenian waste wood classification scheme: source criteria, quality criteria, and use prescriptions

Unpolluted biomass waste	Contaminated biomass waste	Other waste	Hazardous biomass waste
Non-hazardous	Non-hazardous	Non-hazardous	Hazardous
Furniture made of natural wood and chipboard (20 01 38); wood from materials used in construction and used wood from demolition and renovation, such as beams, panelling, door leaves, frames, linings, decorative mouldings and the like from interior design (17 02 01)	Furniture made of wood and chipboard (20 01 38); wood from materials used in construction and used wood from demolition and renovation, such as beams, panelling, door leaves, frames, coverings, decorative mouldings and the like from interior design (17 02 01)	Furniture made of wood and chipboard (20 01 38); wood from materials used in construction and used wood from demolition and renovation, such as beams, wooden drawers, rafters and the like from the external arrangement (17 02 01)	Waste wood exhibiting hazardous properties; waste wood containing coal tar
Content of hazardous substances in the wood does not exceed the value for unpolluted biomass; must not contain coal tar	Content of hazardous substances does not exceed the value for contaminated biomass; must not contain coal tar	Content of hazardous substances; exceeds the values for contaminated biomass; must not contain coal tar	
Processing into solid fuel permitted	Processing into solid fuel permitted; use in small heating device prohibited	Processing into solid fuel permitted; use in small heating device prohibited	Processing into solid fuel prohibited

5. RECOMMENDATIONS AND POLICY OPTIONS FOR ENHANCING WASTE WOOD CIRCULARITY IN THE EU

In previous sections, we first contextualised waste wood management in the EU with an overview of waste wood trends, then presented key expert-identified challenges for waste wood utilisation, as well as a survey of national waste wood approaches. This section draws on this information to present options for a harmonised EU approach to waste wood oriented toward overcoming the various market, technological, and policy challenges to waste wood utilisation. The options draw on both specific expert recommendations and general insights from expert interviews, as well as on comparative analysis of the surveyed national waste wood approaches.

In terms of structure, this section begins by proposing a harmonised EU classification scheme for wood waste in terms of quality criteria and use prescriptions, the use of source criteria and presumptions, upgrading and downgrading waste wood classes, the introduction of material quality criteria, and the introduction of product-quality criteria. The second part of the section then delves into policy options for supporting waste wood valorisation, including extending reporting, documentation, and labelling obligations; refining targets; extending separate collection obligations; strengthening EPR; adopting limited bans; developing guidance and standards; establishing incentives and R&D programmes; and reinforcing the lifecycle perspective. The recommendations and policy options presented in this section represent a starting point to overcome the various technological, market, and policy challenges to waste wood utilisation – and to achieving a sustainable future for the EU.

5.1. TOWARDS A HARMONISED EU APPROACH FOR WASTE WOOD CLASSIFICATION

Harmonising quality criteria and use prescriptions

Comparison of Member State approaches to waste wood highlights variation when it comes to quality criteria and use prescriptions for the different classes of waste wood. Of the five countries assessed in this study, Germany, Slovenia, and Finland have three separate classes for non-hazardous waste wood. However, Germany has an additional two classes for hazardous waste wood, while Slovenia and Finland have only one class for hazardous waste wood. In contrast, the Netherlands has only two classes for non-hazardous waste wood but also has two separate classes for non-hazardous waste wood. Finally, France has the fewest classes in total, with only two classes for non-hazardous waste wood and one class for hazardous waste wood. As discussed previously, these various classes are characterised by quality criteria such as the presence of chemicals and substances above certain thresholds, treatment with CC/CCA, PCB, and coal tar preservatives, and the display of hazardous properties. Table 7 presents a simplified comparison of the various waste wood classes, quality criteria, and use prescriptions by country.

Table 7: Comparison of waste wood classes, quality criteria, and use prescriptions by country

		Non-hazardous			Hazardous	
Slovenia	Quality Criteria	Below HOC and heavy metal limit values for unpolluted biomass	Below HOC and heavy metal threshold values for contaminated biomass	Above HOC and heavy metal threshold values for contaminated biomass[56]	Hazardous properties; PAHs (coal tar treated)	
	Use prescription[57]	Energy recovery	Energy recovery	Energy recovery	Disposal	
Germany	Quality Criteria	Untreated or mechanically processed	Chemically treated; no HOCs in coating; below limit values for HOCs and heavy metals; no preservatives	Chemically treated wood; HOCs in coating only; no preservatives; below limit values for HOCs and heavy metals	Preservative treated; above limit values for HOCs and heavy metals; PAHs (tar oil); not PCB treated	PCB treated
	Use prescription	Material recovery; energy recovery	Material recovery; energy recovery	Material recovery (HOC coating removed); energy recovery	Some material recovery; energy recovery	Disposal

[56] These threshold values are the same as the limit values under the German scheme and are as follows: As, 2 mg/kg dry matter; Pb, 30 mg/kg; Cd, 2 mg/kg; Cr, 30 mg/kg; Cu, 20 mg/kg; Hg, 0.4 mg/kg; Cl, 600 mg/kg; F, 100 mg/kg; PCP, 3 mg/kg; PCB, 5 mg/kg.

[57] No material uses are specified in the table because the Finnish scheme focuses on energy use.

Finland	Quality Criteria	Untreated or mechanically processed	Chemically treated; no HOCs in coating[58]; HOCs or heavy metals below thresholds; no preservatives	Chemically treated; HOCs in coating; HOCs or heavy metals above thresholds; no preservatives	Preservative treated with CCA	
	Use prescription[59]	Energy recovery	Energy recovery	Disposal (incineration)	Disposal (landfill)	
The Netherlands	Quality Criteria	Untreated	Surface treated		Preservative impregnated with HOCs and PAHs (creosote)	Preservative impregnated with CC/CCA
	Use prescription	Material recovery; energy recovery	Material recovery; energy recovery		Energy recovery	Disposal (landfill)
France	Quality Criteria	Untreated	Surface treated		Contains HOCs or heavy metals	
	Use prescriptions	Material recovery; energy recovery	Material recovery; energy recovery		Disposal (incineration)	

Across the national waste wood schemes, there is generally agreement that the first waste wood class consists of untreated or mechanically processed wood and is suitable for material recovery. There is then some divergence regarding the second class for material recovery, which may be limited to surface treated wood or which may more generally include chemically treated wood containing hazardous substances below threshold values. There is also divergence regarding subsequent classes, with threshold

[58] This class also includes waste wood with HOCs in the coating if it is certified that the overall HOC and heavy metal content falls below the limit values.

[59] No material uses are specified in the table because the Slovenian scheme focuses on energy use.

values being applied only in some cases for restricted material recovery, energy recovery, and disposal, and with different substances being singled out for disposal.

Drawing from across the Member State waste wood schemes and favouring the highest priority uses – in line with the EU waste hierarchy – a possible harmonised classification scheme can be proposed in terms of quality criteria and priority uses (see Table 8). Such a scheme would consist of five classes – Clean, Non-Hazardous I, Non-Hazardous II, Hazardous I, and Hazardous II – which would be characterised as follows:

- **Clean.** This class would include untreated or mechanically processed wood, drawing on the German, Dutch, Finnish, and French classification schemes. The highest priority use for wood belonging to this class would be material use, drawing on the German, Dutch, and French schemes.
- **Non-Hazardous I.** This class would draw its criteria from the German and Finnish schemes and consist of chemically treated wood which falls below the thresholds[60] for HOCs and heavy metals and which is not treated with an HOC-containing coating. This class would be suitable for material use, drawing on the German scheme.
- **Non-Hazardous II.** This class would similarly draw its criteria from the German and Finnish schemes and include chemically treated wood which falls below the thresholds for HOCs and heavy metals. It would also include wood which has been treated with an HOC-containing coating. Drawing on the German scheme, this class would also be suitable for material use if the HOC coating is removed.
- **Hazardous I.** This class would draw on the Dutch and German schemes and include chemically treated wood which exceeds the threshold values for HOCs and heavy metals or is treated with PAHs. This class would be suitable for limited material recovery (e.g., production synthesis gas and activated carbon), as well as emissions-controlled energy recovery.
- **Hazardous II.** This class would include PCB and CC/CCA treated wood, drawing on the German, Dutch, and Finnish classification schemes. For PCB treated wood, the class would be suited to disposal via emission-controlled incineration (ideally with energy recovery, then without). For CC/CCA treated wood, the class would be

[60] Under the EU WFD (Article 25), where relevant, Member States are to lay down limit values for content of hazardous substances in waste for carrying out different forms of recovery. Setting these threshold values is highly technical and is beyond the scope of this report. However, these values should be informed by safe material use and thus may be aligned with the limits set under the German scheme, for example, which currently allow for unrestricted material recovery when not exceeded and also allow for limited material recovery and energy recovery when exceeded.

suited to disposal via landfilling if appropriate incineration is not possible and in the absence of a landfill ban[61].

Notably, the priority uses in this harmonised scheme would not be strictly prescribed uses. The priority uses would instead reflect the highest added value uses *possible* for each class of waste wood, favouring a permissive approach and allowing waste wood to be utilised in various ways up to and including the priority uses. This approach could then be supported by limited bans, targets, incentives, and enabling policies to ensure cascading and enforce the waste hierarchy, which will be discussed in greater detail below.

Table 8: Proposed harmonised classification scheme in terms of quality criteria and priority uses

	Clean	Non-Hazardous I	Non-Hazardous II	Hazardous I	Hazardous II
Quality Criteria	Mechanically processed	Chemically treated; no HOCs in coating; HOCs, heavy metals below thresholds	Chemically treated; HOCs in coating; HOCs, heavy metals below thresholds	Chemically treated; HOCs, heavy metal above thresholds; PAH treated	PCB, CC/CCA treated
Priority Uses	Material recovery	Material recovery	Material recovery (coating removed)	Material recovery (limited); energy recovery	Disposal[62]

Using source criteria and presumptions

While the proposed harmonised classification scheme captures important chemical quality criteria, experts stressed the high costs associated with chemical analysis for waste wood classification. These costs often result in waste wood being undersorted in practice (Winder & Bobar, 2018), so source criteria tied to the existing EU LoW could be preliminarily used to streamline classification and lower costs. Specifically, source criteria could be used as presumptions about the quality of waste wood, with the option to certify through chemical analysis that waste wood is in fact of higher quality according to quality criteria than is typical of a given source. These source presumptions may need to be

[61] Incineration must be consistent with regulations implementing the EU Industrial Emissions Directive, which imposes emissions limits, operating conditions, and technical requirements for waste incineration plants (UNECE, 2022).

[62] With respect to disposal, emission-controlled incineration with energy recovery should be prioritised, followed by incineration without energy recovery. Waste wood should only be landfilled in the absence of a landfill ban and when appropriate incineration is not possible.

relatively conservative to ensure the protection of human health and the environment, but they may nonetheless also allow for simpler and less costly classification in order to strike a balance. This approach would resemble the Finnish approach, as discussed in the previous section of this report.

Downgrading and upgrading classes

Although the use of source criteria may streamline classification, the possibility to downgrade or upgrade source-based classifications is essential to safe and efficient waste wood utilisation because source criteria may not necessarily reflect the actual chemical content of waste wood. For example, source-classified waste wood should be downgraded where there is ambiguity or uncertainty, reflecting the German approach discussed in the previous section. Similarly, where waste wood is a mixture of classes, it should be downgraded and treated according to the lowest quality class present. These downgrading rules help ensure safe waste wood utilisation while also allowing for a source-based approach to waste wood classification. Reflecting the Finnish approach, there should also be the possibility to upgrade through certification all but hazardous source-classified waste wood to ensure waste wood utilisation favours the highest priority uses possible. These rules for upgrading and downgrading also reflect the Slovenian approach, which is closely linked to the source-based EU LoW. Together, source-based classification and the possibility to upgrade and downgrade arguably strike a balance between efficient and safe utilisation of waste wood.

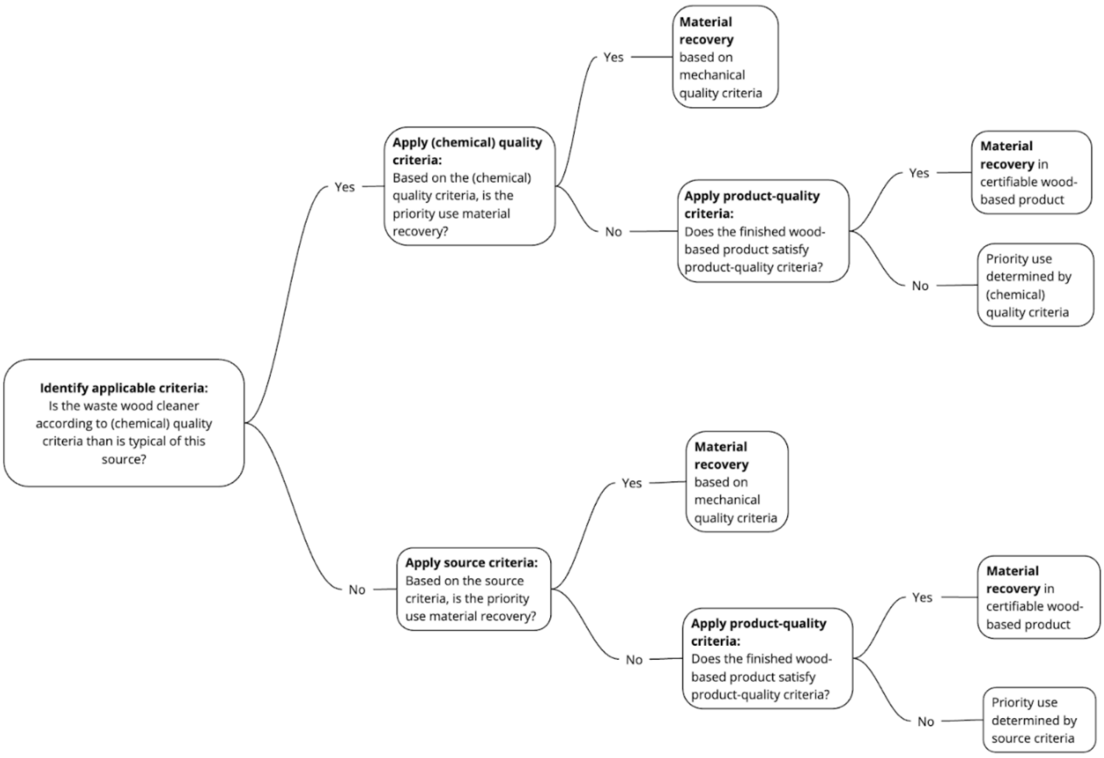
Introducing mechanical quality criteria

For the most part, waste wood classifications are substance based, featuring (chemical) quality criteria focused on which chemical substances are present in waste wood or what portion of other materials is present. Providing chemical information ensures that waste wood is utilised in a safe way for both the environment and human health. However, interviewed experts emphasised the need to extend quality criteria to include mechanical criteria because mechanical characteristics such as waste wood size, strength, and overall physical condition often dictate which material applications are possible. For instance, mechanical characteristics dictate whether waste wood can be reused or must be chipped or used in particleboard or fibreboard. Further, characteristics like strength and overall physical condition can be difficult to ascertain without destructive testing, strengthening the case for capturing this information via classification. Because mechanical criteria are most relevant to material use, one option for incorporating mechanical quality criteria into classification schemes would be to apply mechanical quality criteria supplementally only to waste wood already determined to be suitable for material recovery according to the chemical quality criteria or source criteria. This approach would ensure that it is not only safe to use waste wood in material recovery based on chemical quality criteria and source criteria, but also that it is mechanically possible to do so according to mechanical quality criteria.

Introducing product-quality criteria

While classification contributes to ensuring that waste wood is able to flow smoothly through the market as a commodity with clear and consistent characteristics, an exclusively classification-based approach can risk over-restricting utilisation according to the experts; if certain types of utilisation are pre-empted for low quality waste wood out of concern for human health or the environment, then there is no possibility to innovate safe products from this low quality waste wood. Introducing a supplemental product-quality approach could help mitigate this risk. Such an approach would permit waste wood to be used in material applications even when sorted into a class which is typically not suitable for material use, so long as any finished product is verified and does not pose a health or environmental risk. This approach would leave market actors a higher degree of freedom regarding how they go about producing a wood-based product which is ultimately compliant with product-quality standards – potentially developing new product applications for lower-quality wood. Introducing supplementary product-quality criteria could be one way to strike a balance, securing both the market and the health and environmental benefits of classification based on (chemical) quality criteria and source criteria while also leaving room for innovation toward utilisation. Figure 4 illustrates this hybrid approach in a flow chart, showing how (chemical) quality criteria, source criteria, mechanical criteria, and product-quality criteria could function together to determine priority uses under such an approach.

Figure 4: Flow chart of a possible hybrid approach for identifying applicable priority uses via the application of (chemical) quality criteria, source criteria, mechanical quality criteria, and product-quality criteria



5.2. POLICY OPTIONS FOR SUPPORTING WASTE WOOD VALORISATION

Extending and harmonising reporting, documentation, and labelling obligations

As discussed in Section 3, experts emphasised during interviews that information shortages and inconsistencies make investment in waste wood utilisation uncertain and unattractive and hinder waste wood flows across Europe. Administrative obligations at the Member State level such as information requirements to label waste wood and document and report waste wood quantities and characteristics can help address information shortages, while a consistent minimum core of administrative requirements at the EU level could facilitate the smooth flow of waste wood across MS. Indeed, experts also emphasised that the availability of secondary wood can be quite localised, and facilitating movement of waste wood could help stabilise supply across the EU. Drawing on the Finnish and Slovenian approach, a harmonised set of administrative obligations for actors throughout the value chain could include obligations to keep records and disclose information regarding the quantity of waste, the list-of-waste entry and a description of waste type, the character of the waste, the activity from which the waste was generated, and any hazardous properties. Requirements could also be extended to include recording and disclosing information which is critical to material utilisation in particular, as experts also identified the need for waste wood approaches to better capture material properties for material utilisation. Finally, these information requirements could also be streamlined through a digital product passport, which is discussed as an option below.

Refining targets

The proposed harmonised classification scheme introduced earlier in this section reflects a more permissive approach to use prescriptions which identifies the highest possible priority use for each class of waste wood. While this approach may enable cascading by minimising use restrictions, refining targets may more strictly reinforce the waste management hierarchy. Experts agreed that it is important for material use targets and incentives at all levels to at least match existing targets and incentives for energy utilisation, such as EU renewable energy targets. In practice, when targets do not align with the waste management hierarchy, use tends to reflect those targets rather than the hierarchy. On the other hand, when targets and incentives instead favour priority uses such as reuse and material recycling, high-priority use follows naturally and there is less need to restrict low-priority uses. This is particularly so when policy also *enables* achievement of the targets, which is discussed in further detail below. One expert suggested that the setting of ambitious targets will also have the diagnostic benefit of revealing challenges to meeting those targets, which can then be addressed via enabling policy. Targets which favour material use might include targets for recycling or targets for recycled wood content in new wood-based products. Given the importance of wood as a renewable and high-demand resource, sectoral reuse, recycling, and material recovery targets (e.g., municipal waste and C&D targets) might also include specific targets for wood.

Extending separate collection obligations

In addition to material recovery targets, there are also various separate collection obligations at the EU level to promote high-quality recycling. However, these obligations do not all extend to wood waste. For example, the WFD requires Member States to set up separate collection for paper, metal, plastic, glass, and textiles only (see Section 4). Member State approaches also feature separate collection obligations for certain waste streams, sometimes including wood in general or wood from only certain sources[63]. These separate collection obligations could be extended at some stage at the EU level to wood across sectors to support high-quality wood recycling.

[63] For example, the French waste wood scheme requires separate wood collection in general, and the Finnish waste wood scheme requires separate collection of C&D waste wood (see Section 4).

Strengthening Extended Producer Responsibility (EPR)

One of the key market challenges to waste wood utilisation identified by experts was the absence of a value chain actor for waste wood processing and the lack of economic incentives to fill this role. As discussed in Section 4, eco-organisations can fill this role under EPR schemes, as is the case for municipal furniture waste in France. These eco-organisations specialise in collection and reverse logistics, sorting, screening, decontamination, and processing of waste wood for utilisation; the economic incentive for occupying this niche comes from eco-contributions paid by product producers. While the EU WFD permits Member States to adopt EPR schemes to incentivise application of the waste hierarchy, these schemes are currently neither harmonised nor mandated for waste wood at the EU level. More robust EPR policy at the EU level could offer an opportunity to address a key market challenge and facilitate establishment of specialised eco-organisations to process waste wood.

Adopting limited bans

According to several experts, waste wood policy should permit and enable as far as possible – rather than restricting. In line with this view, bans should not be the primary policy tool for promoting waste wood cascading. Indeed, one expert emphasised that cascading is about prioritising certain waste wood uses *first*; both energy and material use are essential, but cascading simply calls for material use to precede energy use. Waste wood which has been cyclically reused and recycled and has reached the end of its material lifespan should ultimately be utilised in lower-priority applications such as energy recovery. Bans can be expected to interfere with this cascading by eliminating lower-priority uses altogether. On the other hand, if there are targets and incentives for high-priority uses such as material use, experts believe these uses will naturally become the primary pathway for waste wood without the need for disincentives or restrictions on other uses. This being the case, most of the interviewed experts advocated only a landfill ban for waste wood at the EU level (assuming suitable incineration facilities are available for the safe incineration of hazardous waste wood such as CC/CCA-treated wood). Otherwise, experts advocated for the use of targets and incentives over the extensive use of bans.

Developing guidance and standards

While experts identified a need to extend various reuse, recycling, and recovery targets and obligations, they also emphasised a need to simultaneously *enable* compliance through enabling policy such as the development of guidance and standards. As discussed earlier in this report, various market challenges make investment in waste wood utilisation unattractive, particularly for the primarily SME-based woodworking industry.

Under such challenging market conditions, there is little margin to address technological challenges such as the lack of waste wood preparation technologies and procedures and the need for further development of material use alternatives. To lower these market and technological barriers to utilisation, experts suggested that there is a need for further development of common guidance and standards on how to process and use waste wood across sectors. Development of common guidance and standards could empower even resource-limited enterprises to improve waste wood utilisation. Moreover, this enabling policy could draw inspiration from approaches already taken in Member States by active waste wood-based industries, leveraging tried-and-true practices. According to one expert interview, Italy has an established panel production industry with various quality control procedures already in place throughout the production chain. Such established practices could be the basis for guidance and standards for waste wood utilisation in panel production, and similar inspiration could be drawn upon for other waste wood-based products. Finally, given the general reflection that there is a lack of guidance and standards for waste wood utilisation despite existing guidance such as the EU Construction & Demolition Waste Management Protocol, there is likely also a need to further promote existing guidance (European Commission, 2024).

Establishing Incentives and R&D programmes

In addition to the development of guidance and standards, utilisation-enabling policy might also include incentives and R&D support programmes. Incentives such as tax breaks on products containing secondary wood or low- interest rate loans for the development of products containing secondary wood could help create a market for secondary wood, according to one expert. Instruments at the EU level such as the WFD and the Landfill Directive already oblige Member States to make use of economic instruments and other measures to incentivise application of the waste hierarchy in general, so establishment of specific incentives for cascading waste wood utilisation could be an extension of this obligation.

Other enabling measures might include programs to support R&D on waste wood utilisation. For example, one expert suggested that where waste wood cannot be economically or safely used primarily in material recovery, it may nonetheless be possible to maximise its value along lower-priority waste wood pathways such as energy recovery and incineration through the use of statistically checked residuals (i.e., ash) in the agricultural or forestry sectors. According to this expert, however, this type of utilisation would require considerable R&D, underlining the need for R&D programmes.

Reinforcing the lifecycle perspective

Finally, one of the most fundamental policy challenges experts raised was the fact that the present policy framework does not sufficiently reflect the lifecycle perspective or lifecycle complexity. For example, experts noted that there is a need for forward-looking policy which applies to early stages of the value chain such as the design stage. One expert proposed the introduction of digital product passports (containing information relevant to waste wood classification and utilisation) to improve lifecycle traceability and availability of information. Although product passports would not address wood which is already in circulation, they could be a forward-looking solution integrated into the design and manufacturing stages of wood-based products. Although experts held mixed views on the feasibility of product passports, R&D programmes and funding could make adoption more feasible. Another expert also proposed introducing the lifecycle perspective early in the value chain by conditioning market access for wood-based products on consideration of possible recovery pathways at end-of-life. As both digital product passports and market access conditions are topics within the scope of the EU Ecodesign for Sustainable Products Regulation (ESPR)[64], such policy tools reflecting the lifecycle perspective could be addressed specifically for wood-based products within this regulatory framework.

[64] Regulation (EU) 2024/1781 (ESPR). EUR-Lex. https://eur-lex.europa.eu/eli/reg/2024/1781/oj (consolidated text).

6. ANNEXES

6.1. ANNEX A: TABLE OF INTERVIEWEES' AFFILIATIONS AND POSITIONS

Table 9: Table of Interviewees' Affiliations and Positions

Interview Number	Affiliation	Interviewee Position
1	Academia	Researcher
2	Academia	Researcher
3	Industry Association	Managing Director
4	Academia/Industry Association	Professor; Expert
5	Eco-organisation	Innovation Leader
6	Academia	Senior Lecturer
7	Industry Association	Deputy Regulatory Coordinator
8	Research Institute/Academia	Director of Research; Professor
9	Academia	Professor

6.2. ANNEX B: INTERVIEW QUESTIONNAIRE

Figure 5: Interview questionnaire.

Questionnaire

"Challenges for implementing circularity approaches for waste wood"

Role in the company/organisation of the interviewed experts:

Location:

Size of company/organisation:

Activities:

Questions

- In your view what are the main challenges for developing effective valorisation and circularity approaches for waste wood across the EU? Challenges can fit in any of these categories:
  - Policy challenges
  - Market challenges
  - Technological challenges
  - Other challenges

-Are there any policy inconsistencies and gaps in the existing EU policy framework for managing waste wood? Are there any policies that contradict each other?

-Which policy tools and actions can help overcome the above challenges/barriers and encourage circularity practices in the sector?

-How is waste wood classified in your country? How would you assess this classification? Has this classification contributed to circularity?

-Are you aware of other waste wood classification frameworks in the EU and globally? What are their advantages and disadvantages?

-In your view which should be the key elements of a common EU classification framework?

7. GLOSSARY OF ACRONYMS

Acronym	Extended Definition
W2W	Wood2Wood
CCA	Chromium copper arsenate
C&D	Construction and demolition
EPR	Extended producer responsibility
LoW	(European) List of Waste
EWC-Stat	European Waste Classification for Statistics
HOC	Halogenated organic compounds
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCP	Pentachlorophenol
POP	Persistent organic pollutant
WFD	Waste Framework Directive

8. REFERENCES

Abdel-Shafy, H. I., & Mansour, M. S. M. (2016). A review on polycyclic aromatic hydrocarbons: Source, environmental impact, effect on human health and remediation. *Egyptian Journal of Petroleum*, *25*(1), 107-123. https://doi.org/10.1016/j.ejpe.2015.03.011.

Alakangas, E., Koponen, K., Sokka, L., & Keränen, J. (2015). *Classification of used wood to biomass fuel or solid recycled fuel and cascading use in Finland*. https://publications.vtt.fi/julkaisut/muut/2015/OA-Classification-of-used-wood.pdf.

Ali, H., Khan, E., & Ilahi, I. (2019). Environmental Chemistry and Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity, and Bioaccumulation. *Journal of Chemistry*, *2019*(1), 6730305. https://doi.org/10.1155/2019/6730305.

Berger, F., Gauvin, F., & Brouwers, H. J. H. (2020). The recycling potential of wood waste into wood-wool/cement composite. *Construction and Building Materials*, *260*, 119786. https://doi.org/10.1016/j.conbuildmat.2020.119786.

Besserer, A., Troilo, S., Girods, P., Rogaume, Y., & Brosse, N. (2021). Cascading recycling of wood waste: A review. *Polymers*, *13*(11), 1752. https://doi.org/10.3390/polym13111752.

Brunet-Navarro, P., Jochheim, H., Kroiher, F. & Bart Muys, B. (2018). Effect of cascade use on the carbon balance of the German and European wood sectors. *Journal of Cleaner Production*, *170*, 137-146. https://doi.org/10.1016/j.jclepro.2017.09.135.

Caldas, L. R., Saraiva, A. B., Lucena, A. F. P., Da Gloria, M. Y., Santos, A. S., & Filho, R. D. T. (2021). Building materials in a circular economy: The case of wood waste as CO2-sink in bio concrete. *Resources, Conservation and Recycling*, *166*, 105346. https://doi.org/10.1016/j.resconrec.2020.105346.

Cheremisinoff, N. P., Rosenfeld, P., & Davletshin, A. R. (2008). The wood preserving industry. *Responsible care: A new strategy for pollution prevention and waste reduction through environment management*, 317-382. https://doi.org/10.1016/C2013-0-15522-5.

Cherry, R., Manalo, A., Karunasena, W., & Stringer, G. (2019). Out-of-grade sawn pine: A state-of-the-art review on challenges and new opportunities in cross laminated timber (CLT). *Construction and Building Materials*, *211*, 858-868. https://doi.org/10.1016/j.conbuildmat.2019.03.293.

Cincinelli, A., Guerranti, C., Martellini, T., & Scodellini, R. (2019). Residential wood combustion and its impact on urban air quality in Europe. *Current opinion in environmental science & health*, *8*, 10-14. https://doi.org/10.1016/j.coesh.2018.12.007.

de Carvalho Araújo, C. K., Bigarelli Ferreira, M., Salvador, R., de Carvalho Araújo, C. K. C., Camargo, B. S., de Carvalho Araújo Camargo, S. K., de Campos, C. I., & Piekarski, C. M. (2022). Life cycle assessment as a guide for designing circular business models in the wood panel industry: A critical review. *Journal of Cleaner Production*, *355*, 131729. https://doi.org/10.1016/j.jclepro.2022.131729.

European Environment Agency (EEA) (2023). Early Warning Assessment Related to the 2025 Targets for Municipal Waste and Packaging Waste. France. https://www.eea.europa.eu/publications/many-eu-member-states/france.

European Environment Agency (EEA). European pollutant emission register (EPER) Chemicals Glossary. https://www.eea.europa.eu/help/glossary#c4=10&c0=all&b_start=0.

European Environment Agency, European Topic Centre/Circular Economy and resource use (ETC/CE) (2023). Report 2023/7 Circular Economy and Biodiversity. https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2023-7-circular-economy-and-biodiversity.

European Commission (2015). Closing the loop – An EU action plan for the Circular Economy, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2015) 614 final.

European Commission (2021). New EU Forest Strategy for 2030, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2021) 572 final.

European Commission (2024). *EU Construction & Demolition Waste Management Protocol including guidelines for pre-demolition and pre-renovation audits of construction works : updated edition 2024*, Publications Office of the European Union. https://data.europa.eu/doi/10.2873/77980.

Eurostat (2024a). Generation of waste by waste category, hazardousness and NACE Rev. 2 activity. Retrieved 26 September 2024, from https://ec.europa.eu/eurostat/databrowser/view/env_wasgen__custom_12252389/default/table?lang=en.

Eurostat (2024b). Population on 1 January. Retrieved 26 September 2024, from https://ec.europa.eu/eurostat/databrowser/view/tps00001/default/table?lang=en&category=t_demo.t_demo_pop.

Eurostat (2024c). Treatment of waste by waste category, hazardousness and waste management operations. Retrieved 26 September 2024, from https://ec.europa.eu/eurostat/databrowser/view/env_wastrt__custom_12669529/default/table?lang=en&page=time:2020.

Faraca, G., Tonini, D., & Astrup, T. F. (2019a). Dynamic accounting of greenhouse gas emissions from cascading utilisation of wood waste. *Science of the Total Environment*, *651*(Part 2), 2689-2700. https://doi.org/10.1016/j.scitotenv.2018.10.136.

Faraca, G., Boldrin, A., & Astrup, T. (2019b). 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.

FCBA, CSF Wood Waste Plan Working Group (2022). Wood waste classification framework - Version 05/2022 (Référentiel de classification des déchets bois). https://librairie.ademe.fr.

Feenstra, S., & Cherry, J. A. (1990). Groundwater contamination by creosote. In *Presented at 11th Annu. Meet., Can. Wood Preserv. Assoc.* (p. 16). https://semspub.epa.gov/work/01/463470.pdf.

Garcia, C. A., & Hora, G. (2017). State-of-the-art of waste wood supply chain in Germany and selected European countries. *Waste Management*, *70*, 189-197. https://doi.org/10.1016/j.wasman.2017.09.025.

Grigoriadis, K., Whittaker, M., Soutsos, M., Sha, W., Napolano, L., Klinge, A., ... & Largo, A. (2019, July). Improving the recycling rate of the construction industry. In *Fifth International Conference on Sustainable Construction Materials and Technologies* (Vol. 1). https://pure.qub.ac.uk/en/publications/improving-the-recycling-rate-of-the-construction-industry.

Husgafvel, R., & Sakaguchi, D. (2023). Circular Economy Development in the Wood Construction Sector in Finland. *Sustainability*, *15*(10), Article 10. https://doi.org/10.3390/su15107871.

Hyvärinen, M., Ronkanen, M., & Kärki, T. (2020). Sorting efficiency in mechanical sorting of construction and demolition waste. *Waste Management & Research*, *38*(7), 812-816. https://doi.org/10.1177/0734242X20914750.

Ihnát, V., Lübke, H., Balberčák, J., & Kuňa, V. (2020). Size reduction downcycling of waste wood. Review. *Wood Res*, *65*, 205-220. https://doi.org/10.37763/wr.1336-4561/65.2.205220.

Iurato, C., & Schanz, H. (2024). Industry associations as levers for the implementation of cascading – A longitudinal study of post-consumer wood recycling in Germany. *Resources, Conservation and Recycling*, *207*, 107594. https://doi.org/10.1016/j.resconrec.2024.107594.

Kodavanti, P. R. S., Costa, L. G., & Aschner, M. (2023). Perspective on halogenated organic compounds. *Advances in Neurotoxicology*, *10*, 1-25. https://doi.org/10.1016/bs.ant.2023.06.001.

Letta, E. (2024). Much more than a market – Speed, Security, Solidarity. Empowering the Single Market to deliver a sustainable future and prosperity for all EU Citizens. https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf.

Llana, D. F., Íñiguez-González, G., de Arana, M., Chúláin, C. U., & Harte, A. M. (2020). *Recovered Wood as Raw Material for Structural Timber Products. Characteristics, Situation and Study Cases: Ireland and Spain*. https://www.infuturewood.info/wp-content/uploads/2021/04/Llana-et-al.-2020-SWST.pdf.

Mancini, M., & Rinnan, Å. (2021). Near infrared technique as a tool for the rapid assessment of waste wood quality for energy applications. *Renewable Energy*, *177*, 113-123. https://doi.org/10.1016/j.renene.2021.05.137.

Mehr, J. Vadenbo, C., Steubing, B. & Hellweg, S. (2018). Environmentally optimal wood use in Switzerland – Investigating the relevance of material cascades. *Resources, Conservation and Recycling*, 13, 181-191. https://doi.org/10.1016/j.resconrec.2017.12.026.

Mitra, S., Chakraborty, A. J., Tareq, A. M., Emran, T. B., Nainu, F., Khusro, A., Idris, A. M., Khandaker, M. U., Osman, H., Alhumaydhi, F. A., & Simal-Gandara, J. (2022). Impact of heavy metals on the environment and human health: Novel therapeutic insights to counter the toxicity. *Journal of King Saud University - Science*, *34*(3), 101865. https://doi.org/10.1016/j.jksus.2022.101865.

Morais, S., Fonseca, H. M., Oliveira, S. M., Oliveira, H., Gupta, V. K., Sharma, B., & de Lourdes Pereira, M. (2021). Environmental and health hazards of chromated copper arsenate-treated wood: A review. *International journal of environmental research and public health*, *18*(11), 5518. https://doi.org/10.3390/ijerph18115518.

Moschen-Schimek, J., Kasper, T., & Huber-Humer, M. (2023). Critical review of the recovery rates of construction and demolition waste in the European Union – An analysis of influencing factors in selected EU countries. *Waste Management*, *167*, 150-164. https://doi.org/10.1016/j.wasman.2023.05.020.

Navare, K., Arts, W., Faraca, G., Van den Bossche, G., Sels, B. & Van Acker, K. (2022). Environmental impact assessment of cascading use of wood in bio-fuels and bio-chemicals. *Resources, Conservation and Recycling*, 186, 106588. https://doi.org/10.1016/j.resconrec.2022.106588.

O'Dwyer, J., Walshe, D., & Byrne, K. A. (2018). Wood waste decomposition in landfills: An assessment of current knowledge and implications for emissions reporting. *Waste Management*, *73*, 181-188. https://doi.org/10.1016/j.wasman.2017.12.002.

Orru, H., Olstrup, H., Kukkonen, J., López-Aparicio, S., Segersson, D., Geels, C., ... & Forsberg, B. (2022). Health impacts of PM2.5 originating from residential wood combustion in four nordic cities. *BMC Public Health*, *22*(1), 1286. https://doi.org/10.1186/s12889-022-13622-x.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research*, *42*, 533-544. https://doi.org/10.1007/s10488-013-0528-y.

Pazzaglia, A., & Castellani, B. (2023). A Decision Tool for the Valorization of Wood Waste. *Environmental and Climate Technologies*, *27*(1), 824-835. https://doi.org/10.2478/rtuect-2023-0060.

Sjöblom, R., & Kumpiene, J. (2015). Energy generation by waste incineration: the management of impregnated wood. *WIT Transactions on Ecology and the Environment*. https://doi.org/10.2495/esus150081.

Tamanna, K., Raman, S. N., Jamil, M., & Hamid, R. (2020). Utilization of wood waste ash in construction technology: A review. *Construction and Building Materials*, *237*, 117654. https://doi.org/10.1016/j.conbuildmat.2019.117654.

Tejaswini, M.S.S.R., Pathak, P. & Gupta, D.K. (2022). Sustainable approach for valorization of solid wastes as a secondary resource through urban mining, *Journal of Environmental Management*, *319*, 115727. https://doi.org/10.1016/j.jenvman.2022.115727.

The United Nations Economic Commission for Europe/ the Food and Agricultural Organization of the United Nations (UNECE/FAO) (2022). Catalogue of Wood Waste

Classifications in the UNECE Region. https://unece.org/forests/publications/catalogue-wood-waste-classifications-unece-region.

Verkasalo, E., Möttönen, V., Kumar, A., Räty, T., Tosi, G., Balducci, F., ... & Bravi, L. (2020). WoodCircus, Underpinning the vital role of the forest-based sector in the Circular Bioeconomy. D2. 2 Resource Efficiency, Side Streams and Value Chain Analysis – WP2 Final Report. https://jukuri.luke.fi/handle/10024/545703.

Vernier, J. (2021). Extended producer responsibility (EPR) in France. *Field Actions Science Reports. The Journal of Field Actions*, *Special Issue 23*, Article Special Issue 23. https://journals.openedition.org/factsreports/6557.

Vis M., Mantau, U. & Allen, B. (2016). Study on the optimised cascading use of wood, No 394/PP/ENT/RCH/14/7689, Final report. Brussels. https://op.europa.eu/en/publication-detail/-/publication/04c3a181-4e3d-11e6-89bd-01aa75ed71a1.

Winder, G. M., & Bobar, A. (2018). Responses to stimulate substitution and cascade use of wood within a wood use system: Experience from Bavaria, Germany. *Applied Geography*, *90*, 350-359. https://doi.org/10.1016/j.apgeog.2016.09.003.

WOOD2WOOD PROJECT INFORMATION

This report has been prepared as part of the EU-funded Wood2Wood project which aims to leverage waste wood as a sustainable resource to meet Europe's rising demand for wood-based products while also combating deforestation, biodiversity loss, and emissions tied to virgin wood harvesting. Over its four-year duration, the project will advance the circular economy and transform waste wood valorisation to meet future demand by turning construction and demolition (C&D) and furniture waste wood into valuable wood-based products through cutting-edge technologies and digital tools for efficient waste wood processing. The project will facilitate effective implementation of its technological innovations through development of a supportive framework focused on policy, the market, skills development, and standardisation. This report forms a part of the Wood2Wood supportive framework, paving the way for improved waste wood circularity in the EU through recommendations for harmonisation of waste wood classification and policy options to support waste wood valorisation.

PROJECT PARTNERS

LEGAL DISCLAIMER

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them.

CEPS
PLACE DU CONGRES 1
B-1000 BRUSSELS