Assessing and Estimating the Presence of Fibreboard in Post-Consumer Wood Waste

EcoReFibre project consortium wishes to know how much MDF waste is currently in European wood waste streams and how much will be available in the future. To do this, it is also essential to know how much fibreboard has been consumed in the past. The study is divided into 2 distinct parts: the creation of a prediction model based on data collected online; and the implementation of a field investigation from June 2022 to June 2025[1].

Creation of a waste prediction model

Although the whole consortium contributed to the development of the predictive model, the main contributing partners were ESB, EPF and FCBA. Predicting waste fibreboard generation requires three sources of information:

1. The European Apparent Consumption rate of fibreboards,
2. The proportion of fibreboard production allocated to the manufacture of different product categories
3. The average lifespans of products containing fibreboard.

The premise of the model is that when fibreboard is used to make a product, then that product will eventually become waste. The lifespan of a product will determine when it is likely to become waste. Each product type will have a different lifespan, e.g. a toy is likely to have a shorter life than a door. The data gathering for this part of the research was focussed on consumption of fibreboard products and their respective lifespans.

The European Apparent Consumption rate of fibreboards

The Food and Agriculture Organization (FAO) provides extensive historical data on a wide range of wood-based products via its FAOSTAT website (FAOSTAT 2024). This includes production, import and export data for MDF/HDF over the period 1995 to 2023. These data were cross-checked with that collected by EPF from its members, who are wood-based panel manufacturers.

The FAO data was used to calculate the annual apparent consumption of fibreboard in Europe between 1995 and 2023. Apparent consumption is calculated as follows:

$$AC = P + I - E \qquad \text{[Eq. 1]}$$

Where, AC = Apparent consumption, P = production, I = Imports and E = Exports.

It is highly likely that the vast majority of fibreboard consumed within a country or region will eventually enter the waste stream within the same geographical area. MDF panels are

[1] The evaluation of post-consumer wood waste streams will continue until the end of the project in May 2026).

not finished products, rather they are raw materials for other products as they are typically processed into components for products such as furniture, fittings, and flooring. However, regions also import and export finished and semi-finished products containing MDF, complicating estimates of actual fibreboard consumption and subsequent waste generation. The FAO database does not provide data on fibreboard traded through these indirect routes. Given that the EU is a net importer of furniture (Fordaq 2025), it can be reasonably concluded that additional quantities of MDF are consumed in Europe via imported products, beyond that produced domestically. Equation 1 must be altered to include the additional movement of fibreboard:

$$AC = P + I - E + FG \times FB_{content} \qquad \text{[Eq. 2]}$$

Where FG = quantity of finished and semi-finished products and $FB_{content}$ = fibreboard content.

Although international trade statistics are available for a wide range of products, these datasets do not include information on the raw material content of the traded goods, i.e. $FB_{content}$. This limitation was also encountered in the French Recyfibres study (Lafosse (Veri) 2017), where an estimated coefficient of 5% to 10% was applied to the tonnage of imported and exported furniture to approximate the embedded fibreboard content. The reliability of such coefficients is, however, highly uncertain. These values are difficult to justify, as they vary over time with changing market trends. For example, a very low coefficient, perhaps around 1%, may have been appropriate several decades ago when MDF use in furniture was limited. Today, however, determining an appropriate coefficient is highly challenging, as MDF is increasingly used in many types of furniture and interior products.

The ultimate objective of the model is to provide users with a practical tool for creating scenarios that generate data to support informed decision-making on matters such as policy, investment, and regulation. Consequently, instead of applying an unjustifiable coefficient to imported products, the users are given to option to choose how much additional fibreboard is consumed via the importation of products containing fibreboard. In other words, AC is multiplied by a factor between 1 and 2, i.e. consumption can be doubled by the user.

Although some products can be reused, as defined by Potting (2016), instead of being discarded, the large volumes of wood waste generated in Europe suggest that the vast majority of fibreboard products enter the waste stream. Indeed, reuse remains marginal compared to recycling across Europe (EEA 2025).

MDF/HDF end-uses

It is necessary to know how MDF is generally used in Europe: in order words, when a MDF is manufactured, what does it become? To answer this question, data collected by the EPF proved highly valuable, as it forms part of the annual survey conducted among EPF members. This allowed access to historical data on MDF applications, which has been collected systematically since 2002. An example is given in Fig. 1.

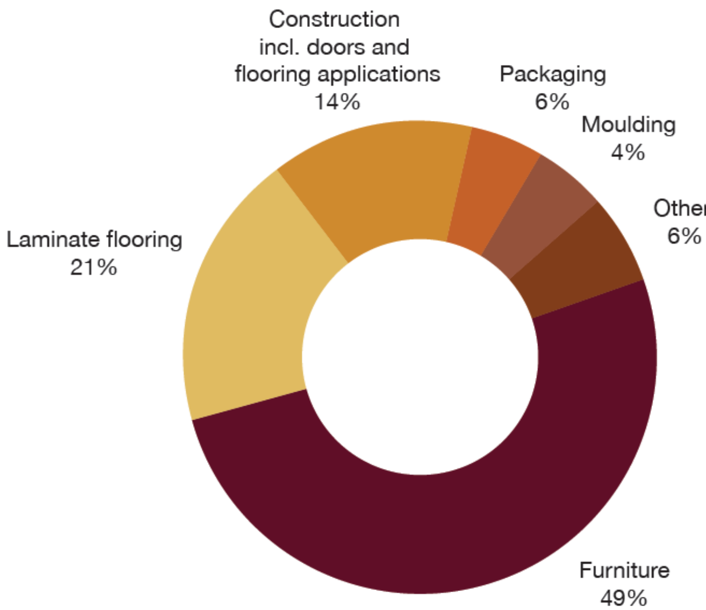


Fig. 1: End-use data for MDF/HDF in Europe for the year 2023, as reported by EPF in their 2024 Annual Report (EPF 2024)

MDF/HDF products lifespan and their conversion to waste

In this study, the lifespan of a product is defined as its useful life that is, the period from its production until it is discarded by the consumer. A product may remain in good working condition, yet it enters the waste stream once the user decides to dispose of it. Understanding the typical lifespan of products containing MDF is important, as it can vary significantly depending on the application. For instance, packaging products generally have a very short lifespan, often less than a year, whereas an MDF door may remain in use for several decades before being removed.

An online survey targeting European end-users was conducted to estimate the typical lifespan of MDF products in Europe. The survey was initially published in English, followed by versions in French and German. It was made available via the EcoReFibre project website. Participants were presented with images of 13 different products that may contain MDF and were asked to estimate the typical lifespan of each product using a slider tool, as illustrated in Fig. 2.

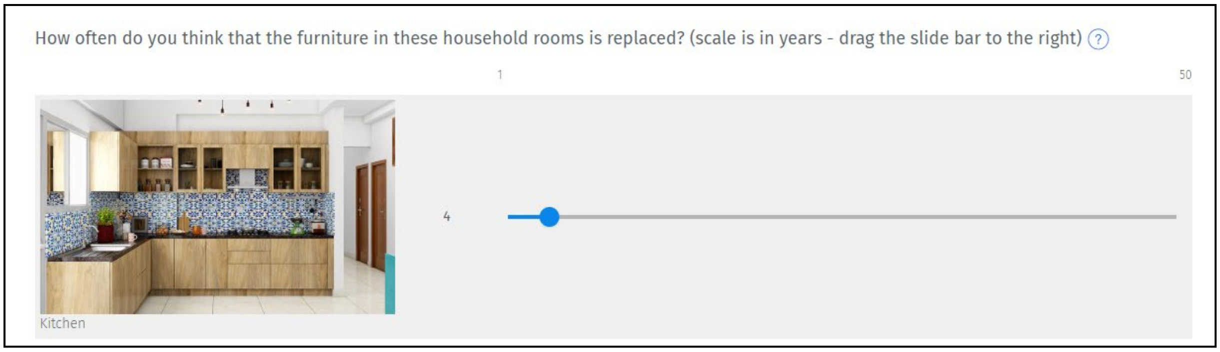


Fig. 2: Example of a question of the online survey to estimate MDF lifespan

Beyond lifespan estimates, the survey also included two questions aimed at assessing material losses during the first year following panel production:

1. The first question focused on losses caused by cutting and processing, specifically during the transformation of panels into finished products.
2. The second addressed losses related to transport, storage, and other handling factors.

The survey was designed to be straightforward and easy to complete. Respondents were invited to provide their opinions based on their personal experience, without the need for technical expertise. No personal information was collected. The primary objective was to gather as many responses as possible in order to apply the wisdom of the crowd approach, an idea originally introduced by Francis Galton (1907) and later popularised by James Surowiecki (Surowiecki 2005) and discussed by Patten. This approach assumes that every response has equal value, and it relies on the median value as the most reliable predictor, since the mean can be heavily skewed by outliers.

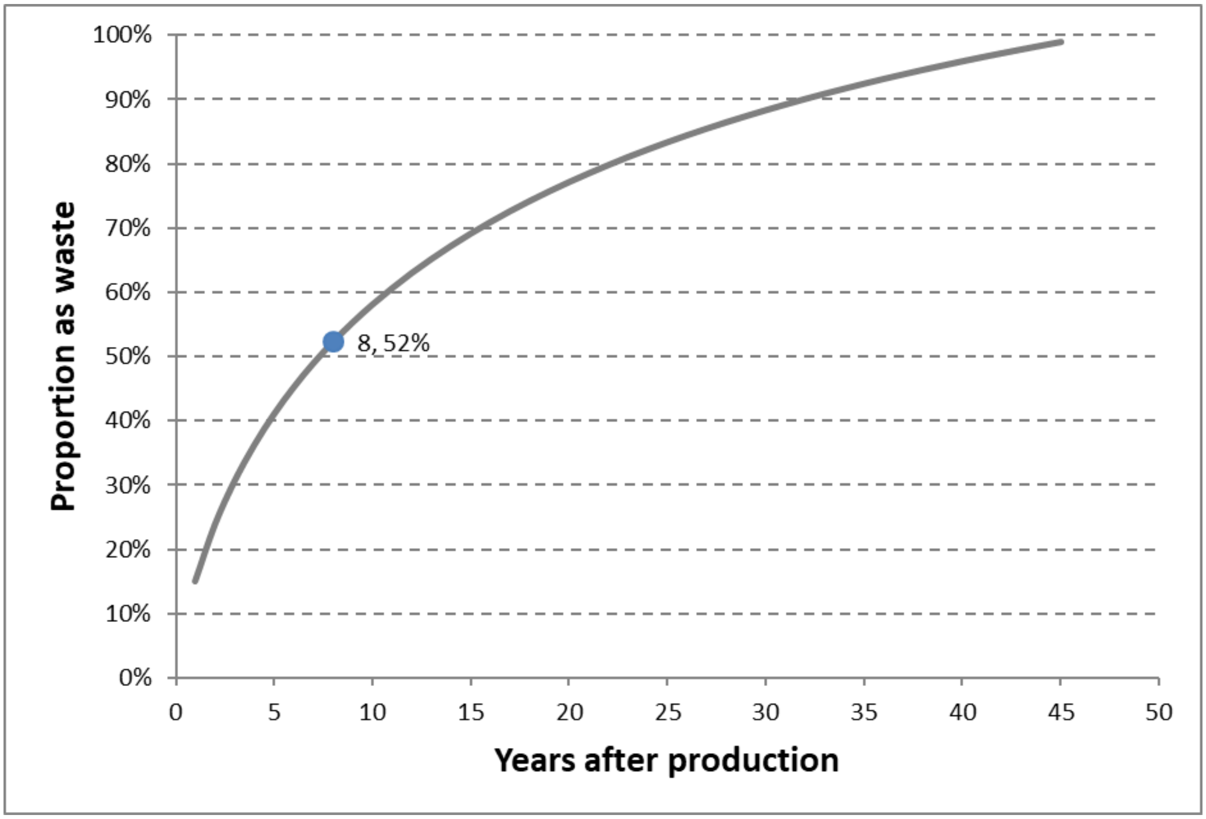
The median lifespan estimates for the 13 products were grouped according to the end-use categories shown in Fig. 1, allowing an average lifespan to be determined for each category. An overall average lifespan for MDF produced in a given year was then calculated by applying a weighted average based on the relative share of each end-use category.

A four-parameter symmetric sigmoidal model was used to estimate the proportion of MDF produced in a given year that becomes waste in any subsequent year .

$$y = d + \frac{a - d}{1 + \left(\frac{x}{c}\right)^b}$$	Where, y = proportion now waste x = number of years after production a, b, c, d = constants calculated using curve fitting software

Fig. 3: Four-parameter symmetric sigmoidal equation

An example curve from the model is presented in Fig. [??]; it has an overall average lifespan of 12 years. According to the model, approximately 52% of the MDF production is expected to have entered the waste stream eight years after manufacture. The waste proportion in year one is derived from the early-stage losses reported in the user survey described above, while it is assumed that 99% of the material becomes waste within 45 years.



The waste generation curve can be used to calculate the fibreboard waste generate in a year by summing the contributions from the previous production years. For example, the waste generated in 1995 is a sum of the waste generated from the 1994 and 1995 consumption, whereas for 2024 it is the sum of contributions from 1994 (when reliable data on MDF production began to be published), plus 1995 and so on to 2023.

Results and discussion

MDF/HDF end-uses

Data on the end uses of MDF and HDF after production were obtained from the EPF database, covering the EU-27 countries along with the UK and EFTA[2] countries. The earliest available data date back to 2002. Initially, the database included a specific category for "Do-It-Yourself (DIY)" applications; however, this category was removed in 2012 and merged into the broader "Other" category. More recently, a new category was added to specifically track MDF and HDF panels used in packaging applications. Fig. 4 shows the evolution of the trends for using MDF. The greatest change is the swing from laminate flooring in the first decade of the millennium to furniture manufacture.

[2] European Free Trade Association (EFTA): Iceland, Liechtenstein, Norway and Switzerland.

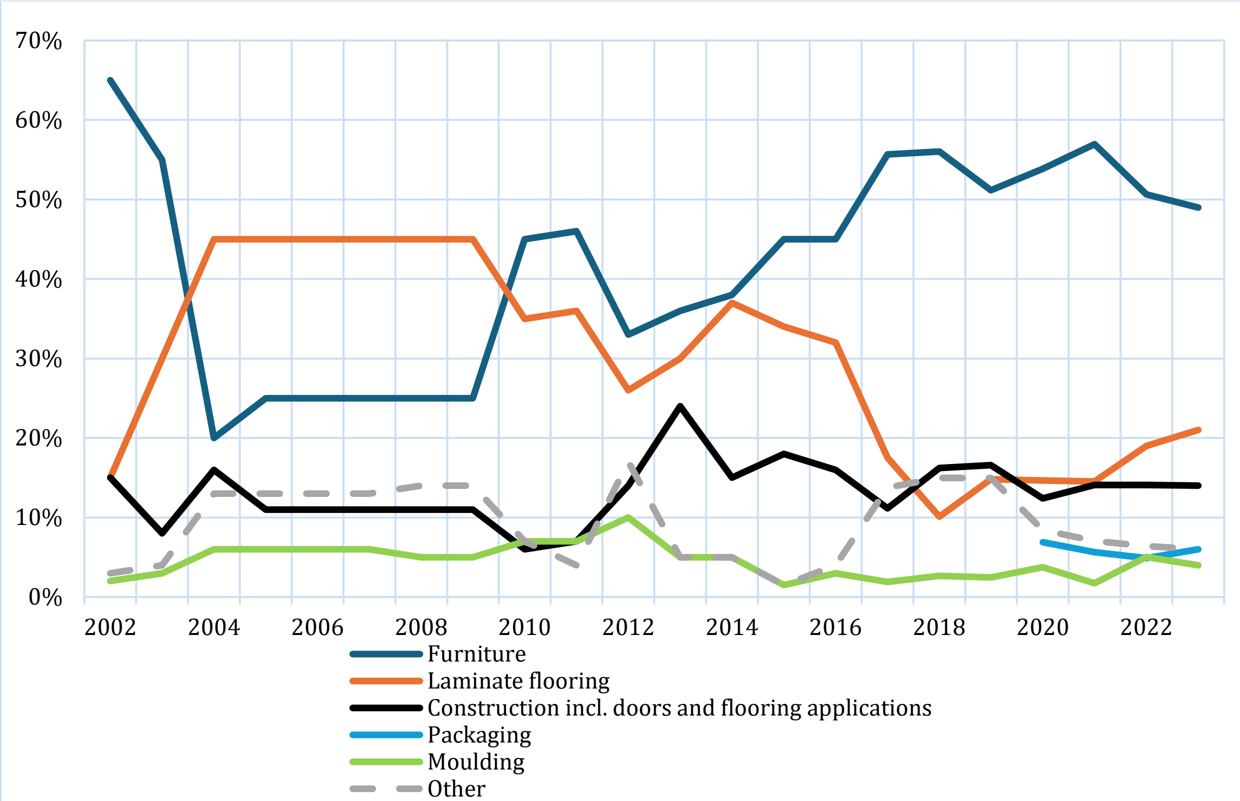


Fig. 4: Evolution of MDF end-uses over time (adapted from EPF data)

Fibreboard products lifespan

The survey obtained 208 complete responses: 99 via the English survey, 50 from the French survey and 59 from the German one. The mean and median lifespans for the 13 end-use categories are presented in Tab. 1. All categories, except kitchen furniture, have a median below the mean, i.e. positive skewness, which indicates that some respondents give much higher estimates than the others.

Tab. 1: Online survey results: average responses and median values, used as estimates of MDF product lifespans

	Kitchen	**Bathroom**	**Bedroom**	**Living room**	**Dining room**	**Office**	**Mouldings**	**Toys**	**Doors**	**Art and craft**	**Shop interiors**	**Flooring**	**Packaging**
Mean (years)	19.7	17.2	16.8	14.4	15.9	14.5	23.8	6.7	24.0	10.1	7.2	17.8	3.2
Lifespan (years) Median	20.0	15.0	15.0	13.0	15.0	12.0	20.0	5.0	22.0	5.0	5.0	15.0	1.0

Following the wisdom of the crowd principle, the median values are retained as the estimated lifespans of MDF-containing products.

The responses to the final question regarding material losses occurring during the first year of the panel's life are presented in Tab. 2. These losses represent the waste generated in the first year.

Tab. 2: Estimated MDF panel losses in the first year after production

	Transport and storage	Cutting and shaping	Combined losses
Mean	6.0%	9.3%	15.3%
Median	5.0%	8.0%	13.0%

These data also exhibit a positive skew. Given that most respondents had likely never considered these questions before, it is unsurprising that 72% reported low or very low confidence in the accuracy of their estimates, suggesting that the majority were essentially making educated guesses. Data from a company specializing in cutting various wood-based panels, based on the processing of 702 panels, showed an average cutting loss of 17%. Since some companies also carve panels into three-dimensional shapes, actual machining losses may exceed this 17% figure. Consequently, the survey estimates probably underestimate the true extent of machining losses. To account for this, an average of the 13% median and the 17% company data was taken, resulting in an estimated material loss of 15% during the first year.

Predicting an average lifespan for MDF-containing products

The simple average of the product lifespans reported in Table 2 yields an average lifespan of 12.5 years. However, this estimate is not representative, as it does not account for differences in production volumes, some products are manufactured in far greater quantities than others. Therefore, a weighted average must be calculated, combining the estimated lifespans with the relative production shares of the different product categories. First, the survey responses must be allocated to appropriate end-use categories, as shown in Tab. 3.

Tab. 3: Link between fibreboard end-uses and the estimated lifespans of products, as determined by the online survey

Fibreboard end usages categories	Elements of the survey
Furniture	Kitchen, Bathroom, Bedroom, Living room, Dining room, Office
Laminate flooring	Flooring
Construction incl. doors and flooring applications	Doors, Shop interiors
Packaging	Packaging
Mouldings	Mouldings
Other	Toys, Art and craft

An example of the predicted lifespan for products made in 2014 is shown in Tab. 4. As a reminder, the end-use data was provided by EPF. These data were corrected in order to take into account the processing and transport losses. The corrected proportion is multiplied by the corresponding lifespan, as derived from the survey, to obtain an overall weighted average lifespan for that production year.

Tab. 4: Combination of EPF data for 2014 with online survey results to provide a weighted lifespan estimate for fibreboard panels manufactured in 2014. Cells highlighted in green contain data calculated from the online survey.

Fibreboard end usages categories	End-use data for MDF/HDF in Europe	Corrected proportion	Typical lifespan (years)	Weighted average lifespan
Furniture	38%	32%	15.0	12.3
Laminate flooring	37%	31%	15.0	
Construction incl. doors and flooring applications	15%	13%	13.5	
Packaging	0%	0%	1.0	
Mouldings	5%	4%	20.0	
Other	5%	4%	5.0	
Processing & transport losses	-	15%	1.0	

While this example relates to the year 2014, the weighted calculation has in fact been applied annually, reflecting the temporal variations in fibreboard applications as reported by EPF. The aggregated results are presented in Tab. 5.

Tab. 5: Weighted average lifespan of fibreboard depending on the year of production

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Average lifespan	12.3	12.4	11.6	11.7	11.7	11.7	11.8	11.6	12.3	12.6	11.5
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Average lifespan	12.2	12.3	12.4	12.3	11.5	11.3	11.3	11.2	11.3	11.6	11.5

The shortest average lifespan was observed in 2020 (11.2 years), while the longest occurred in 2011 (12.6 years); however, the differences remain minimal, with a coefficient of variation of 3.7%. The overall average lifespan across all years presented in Table 5 is 11.8 years. Consequently, it can be concluded that the average lifespan of MDF produced over the past 20 years is approximately 12 years, and this is the default value chosen for the waste prediction model.

Fibreboard Waste Modelling

Below is a screenshot showcasing the interactive front-end of the MDF waste flow model developed for the European region (Fig. 5). It was developed and is hosted on the website www.tableau.com and can be accessed via a link on the EcoReFibre website, www.ecorefibre.com.

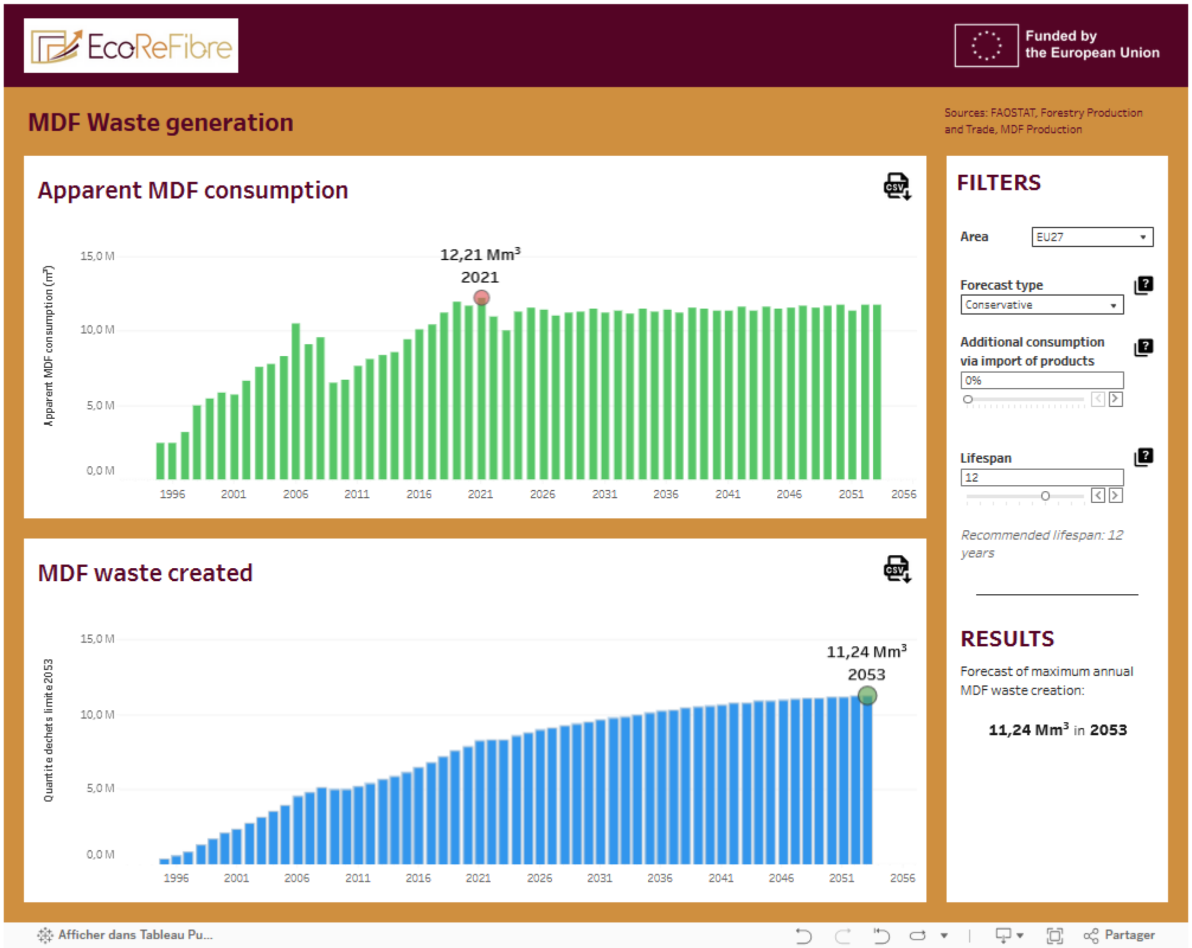


Fig. 5: Overview of the online model

This user-friendly interface allows stakeholders to create scenarios by adjusting the parameters, and then visualize the estimated availability of MDF waste over time. The interactive platform facilitates scenario analysis and supports decision-making for sustainable recycling strategies. Indeed, the model enables users to customise several parameters:

- Geographic scope, with options currently including the World, EU27, France, Germany, and Sweden
- Forecast type, including:
  - *Actual* (only the published data is fed into the model)
  - *Optimistic* (30% increase in consumption by 2050)
  - *Conservative* (3% increase in consumption by 2050)
  - *Pessimistic* (40% decrease in consumption by 2050)
- Import-driven consumption adjustment, allows users to increase fibreboard consumption to account for imports of MDF-containing products. The adjustment range is from 0% to 200%. This option is, however, disabled when the “World” region is selected, as it would not be meaningful in that context.
- The lifespan of MDF products, is adjustable between 6 and 15 years

This configuration allows for the generation of up to 270 distinct scenarios per region. Users also have the option to download the displayed data as a CSV file.

The interface makes it very easy for someone to create a scenario or several, download the results and compare them. For example, the model predicts 14.3 Mm^3 of fibreboard waste in Europe by 2030, if the optimistic forecast is used in conjunction with an additional 30% of consumption via imports and a short average lifespan of 6 years. Although the parameters were deliberately chosen to generate a lot of fibreboard waste, they are not totally unrealistic. If, on the other hand, the pessimistic forecast is combined with no additional consumption via imports and a longer 15 year lifespan then the predicted volume falls to 8.8 Mm^3, which is still a lot of material.

Model Limitations

The primary limitation of the model lies in the inability to reliably estimate import volumes; this is partially mitigated by allowing users to manually adjust import values. Additionally, the lifespan of products containing fibreboards are fixed, based on survey responses collected in recent years. However, these values may not accurately reflect historical lifespans (for instance, furniture may have been retained longer in households during the 1990s). The typical lifespan currently used in the model is 12 years, though this may vary over different periods.

Moreover, the distributions of MDF end-uses provided by EPF are considered for the whole of Europe; however, these proportions could vary significantly depending on the country. The model could therefore be adjusted accordingly.

It is important to emphasize that this tool is based on a model designed to provide general trends rather than precise figures. Alternative methodologies exist for developing waste generation models. For example, researchers in Japan estimate the service life of wooden buildings using half-life functions to forecast future waste generation as well as wood carbon storage (Sanjo et al. 2025).

Future improvements are planned for the interface, including enabling users to input negative additional consumption shares via imports, which would reflect scenarios where exports exceed imports. Expanding the model to cover other geographic regions is also under consideration.

This model is based on data collected from companies and users; however, it is valuable to verify it through a field survey to gain a clearer understanding of the actual proportion of fibreboard panels present in wood waste. The field survey conducted in France is described in the following sections.