ENVIRONMENTAL PRODUCT DECLARATION OF WOOD-BASED PANELS: AN ANSWER OF SUSTAINABILITY BUILDING REQUIREMENTS

Claire Cornillier, Paola Pacitto, Claire Michaud, Estelle Vial

Technological Institute FCBA

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Technological Institute FCBA Forestry Cellulose Timber-Construction, Furniture

SUMMARY

The issue of sustainable development is broad and of global concern. Consumers and businesses want to have information about the environmental impact of products. As far as the building sector is concerned, environmental information on products is now a key to the market.
The building sector is a crucial sector for sustainable development in Europe. It accounts for a large amount of land use, energy and water consumption, air pollution and impact on climate change. Constructions materials contribute in a significant way to the environmental impact of buildings.
The Environmental Product Declaration (EPD) is a tool to communicate on the environmental impact of a product. The quantified data presented in the EPD are calculated according to the Life Cycle Assessment (LCA) methodology which is standardized (ISO standards). The purpose of an EPD is to provide easily accessible, quality-assured and comparable information regarding the environmental performance of products. For now, the development of EPD is voluntary but, in some countries, environmental labelling could be made mandatory. In France, construction materials manufacturers (AIMCC) have committed themselves to produce EPDs for all construction products.
In this context, UIPP (Wood-based Panel Producers Union) has commissioned FCBA to perform the Life Cycle Assessment of the French wood based panels in order to publish EPDs.
In this paper, the methodological choices and some selected results about energy, climate change and abiotic depletion potential are presented.

INTRODUCTION

The European commission adopted a communication on Integrated Product Policy (IPP) in 2003. One of the main drivers of the IPP is the communication to consumer and market actors of environmental information on products and services. An emphasis is also placed on life cycle thinking in order to have a global approach of environmental assessment, to make comparisons and to avoid pollution transfer.

The industry and the governments have been promoting since then the use of environmental product declarations (EPDs). The EPD corresponds to the environmental profile of a product. It gives quantified environmental data based on Life Cycle Assessment (LCA) information according to the LCA ISO-standards (ISO 14040 and ISO 14044). The development of EPD is voluntary and the purpose of an EPD is to provide easily accessible, quality-assured and comparable information regarding the environmental performance of products.

The building sector is the most advanced in Europe in the definition of a common format for EPD. Standard works are in progress at European level in TC 350 (draft EN 15804 "EPD - Product category rules"). In France, a standard for building product, NF P 01-010 "Environmental quality of construction products - Environmental and health declaration of construction products", is available since 2004. As the green building market is expanding, the need for building products EPDs is growing. These EPDs are in great demand in France with the development of building designed according to High Environmental Quality(HEQ®) requirements. More generally, EPDs are more and more used to assess the contribution of each construction materials on the total impact of the building using softwares such as Elodie (developed by CSTB) and TEAM^tm Building (developed by Ecobilan). Today, various construction materials sectors have begun to produce EPDs on a large scale: from the mineral wool insulation to the plasterboard (to have a look at the French EPDs see http://www.inies.fr/).

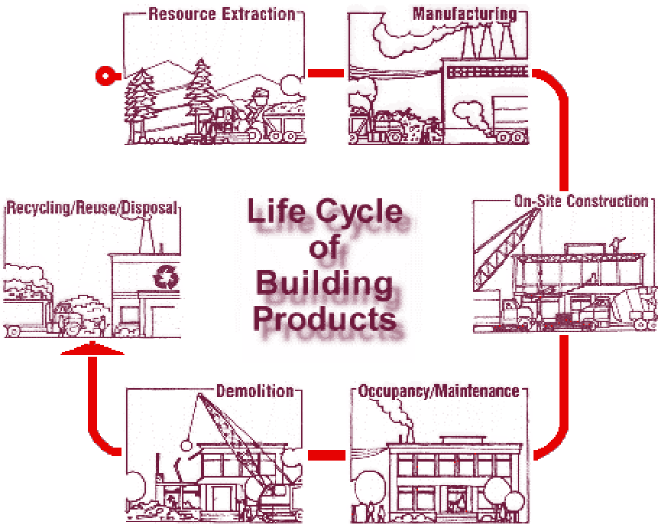


Figure 1: The life cycle of building products

Recently in France, new laws derived from the "Grenelle de l'Environnement" will make mandatory the environmental labelling of construction and mass consumption products. It will be based on LCA data.

At last, wood-based products have many environmental advantages, that LCA could reveal:

- Wood is a renewable resource,
- Sequestration of CO_2 by wood in biomass carbon takes an important role in the regulation of greenhouse gases,
- Wood is recovered either as secondary raw material as recovered energy.

In this context, UIPP (Wood-based Panel Producers Union) has commissioned FCBA to perform the life cycle assessment of the French wood based panels in order to publish EPDs according to the French standard NF P01-010 and also to search ways of improvement of these environmental profiles.

MATERIALS AND METHODS

LCA is a methodology to assess the environmental impact of a product. This methodology is based on a quantified inventory of impacts sources such as material, water and energy consumption, waste generation and discharges of pollutants in water, air, and soil during the entire product lifetime. From this inventory, environmental impact indicators are computed. In a practical way, LCA relies on the modelling of physical inflows and outflows at the product system boundaries at each step of the life cycle. It is necessary to do a mass and an energy balance.

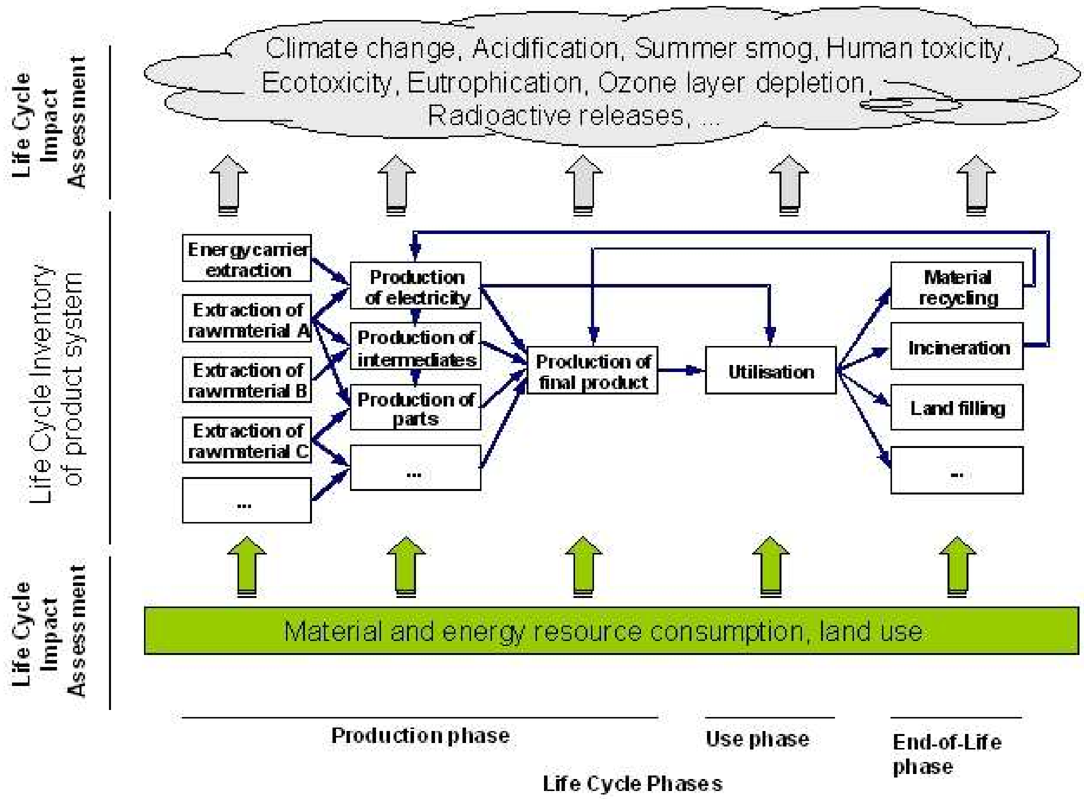


Figure 2: Scheme of a product system's life cycle with data collection of product and waste flows and resources and emissions followed by the impact assessment of the emissions and resource consumption (source http://lca.jrc.ec.europa.eu/lcainfohub/introduction.vm)

French wood-based panels LCAs have been made according to the ISO 14040 and ISO 14044 standards. These standards give some rules for the establishment of a LCA. It guarantees that results can be checked and are reliable. ISO 14040 defines four mains steps for a LCA (figure 3):

- Goal and scope definition,
- Inventory analysis,
- Impact assessment,
- Results interpretation.

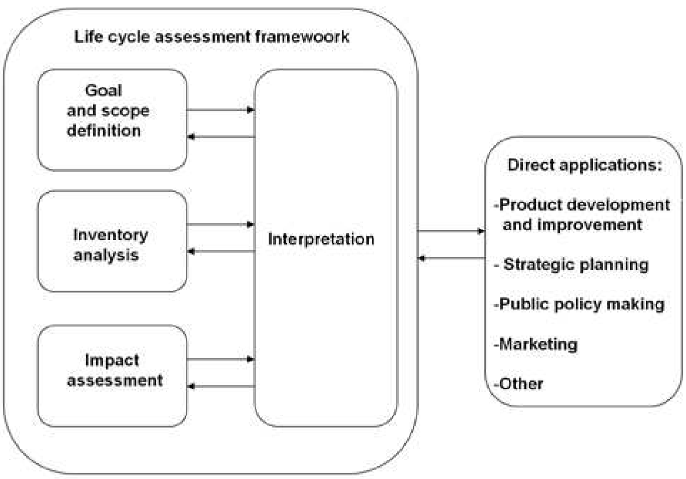


Figure 3: The 4 steps of the LCA

The first step of the LCA is to define the goal and scope definition, notably the functional unit, system boundaries and methodological choices. This step is important because results are goal dependant.
The goal of the French wood-based panels LCAs is to produce generic environmental data about main French wood-based panels. Twelve panels were studied in three distinct LCAs according to the type of the panels; the first one was particleboard, the second OSB, the third fibreboard (MDF and HDF). Table 1 summarizes the characteristics of the twelve studied panels.

Table 1: List of studied panels

Panel	Type	Glues	Finishes	Lifetime (year)	Use	
MDF	Standard MDF	UF	Raw	50	Non structural	Dry
MDF	Standard MDF	UF	Melamine	50	Non structural	Dry
MDF	Standard MDF	UF doped with melamine	Raw	50	Non structural	Wet
MDF	Standard MDF	UF doped with melamine	Melamine	50	Non structural	Wet
MDF	MDF HDF	UF doped with melamine	Raw	50	Floor	
OSB	OSB 3	UF doped with melamine, MUPF, MDI	Raw	100	Structural	Wet
PP	P2	UF	Raw	50	Non structural	Dry
PP	P2	UF	Melamine	50	Non structural	Dry
PP	P3	UF doped with melamine	Raw	50	Non structural	Wet
PP	P3	UF doped with melamine	Melamine	50	Non structural	Wet
PP	P4	UF	Raw	100	Structural	Dry
PP	P5	UF doped with melamine	Raw	100	Structural	Wet

Functional unit chosen for the French wood-based panels LCAs is **1m^3 of laid wood-based panel for different lifetimes and different use conditions (structural or non structural and dry or wet) as defined in table 1.**
Functional unit is a quantitative performance which characterizes the product function. All the flows and impacts refer to this functional unit. The study has showed that the thickness is not a significant variable beyond the variation in weight.

The wood-based panel life cycle has been divided into five steps: Production step, Transport to the construction site, Implementation, Life in use, and End of life. Figure 4 describes this life cycle and system boundaries.

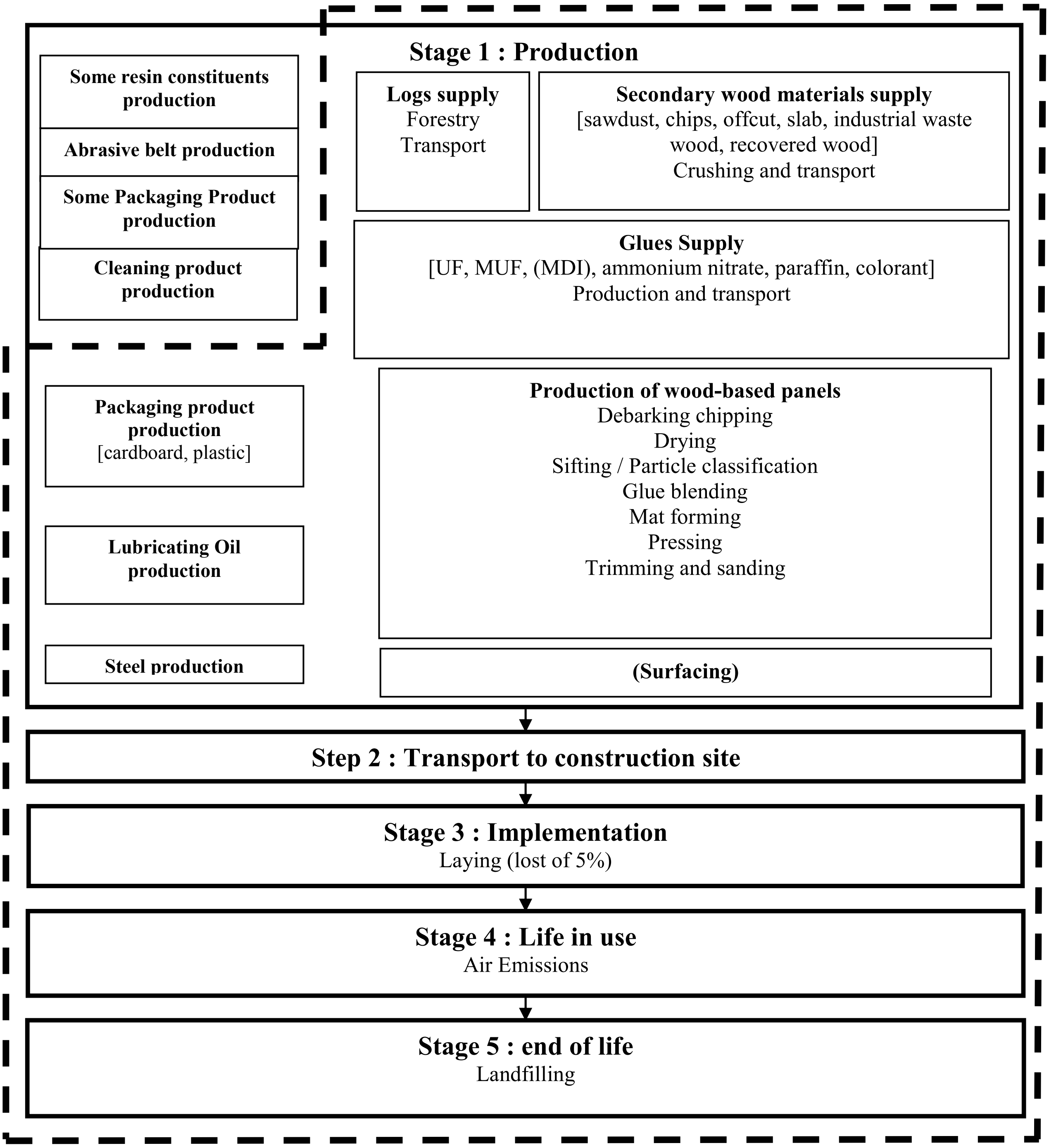


Figure 4: Life cycle and system boundaries [▬ ▬ System boundarie, () Option step according to the studied panel]

In order to insure a good representativeness of the EPDs, most of the French plants were involved in the data collection. Data for the panel production step were collected from eight plants and for the surfacing step from three plants. Data were also collected for the wood supplying step from the main panel producers. The data collected correspond to the production of year 2005. Data collection was based on a specific questionnaire, site visits, phoning and mailing.
Thanks to the wood supply data collection, the different wood supply types and their proportions have been established for all the French wood-based panels production (table 2).

Table 2: Results of wood supply data collection

Supply	**PP**	**OSB**	**MDF/HDF**
Hardwood timber	8%	12%	27%
Softwood timber	19%	87%	51%
Logs (total)	**26%**	**99%**	**78%**
Sawdust, chips, offcut, slab	52%	1%	22%
Industrial waste wood	6%	/	/
Recovered wood	16%	/	/
Waste wood (total)	**74%**	**1%**	**22%**

Concerning the panel production, eight plants were involved in the data collection: three for PP, two for OSB and three for MDF and HDF. Data about material consumption, energy and water consumption, emissions and waste have been collected. The representativeness of these data has been assessed. Table 3 shows that the representativeness is very good for OSB and MDF/HDF, and average for PP.

Table 3: Representativeness of the production data collection according to the production volume

Production site	**PP**	**OSB**	**MDF/HDF**
Producers studied	3	2	3
Producers in France	10	2	4
Representativeness according to volume production	24%	100%	77%

To improve PP data collection representativeness, one plant was chosen for each volume production class of plant to reflect the different sizes of plants:

- the small one, smaller than 120 000 m^3/year,
- the medium one, between 120 000 and 500 000 m^3/year,
- the big one, bigger than 500 000 m^3/year.

Table 4 shows that the 3 producers chosen are well representative of PP French producers according to the size of plants.

Table 4: Representativeness of PP production data collection according to the size of plants

Volume %	**Small**	**Medium**	**Big**	**Total**
French producers : Total	7%	34%	59%	100%
Producers studied	7%	42%	51%	100%

Three producers of wood-based panels and laminated were involved to collect data on the laminating process. Concerning forestry, data are coming from the FCBA LCI (Life Cycle Inventory) database according to tree species and specific mechanization rates. Concerning UF resin production, data have been collected from two major producers. Generic data used in this study are coming from global databases such as Ecoinvent and DEAM^{tm}.

Finally the LCAs have been verified by a third party according to AFNOR verification program.

RESULTS AND DISCUSSION

Many results have been obtained in this study. In this paper, the most important results are presented about energy, climate change and abiotic depletion potential.

Energy indicators

Regarding energy aspects in LCA, there are two types of energy:

- Consumed energy (burned) by the process (processing, transport, heating, ...) called *fuel energy*,
- Energy contained in the material called *feedstock energy*, which corresponds to a mobilization of a raw material with a calorific value.

These energies, whether feedstock or fuel may either come from renewable or from non renewable sources (Figure 5):

- Renewable energy (RE) comes from renewable resources like wind or biomass,
- Non renewable energy (nRE) comes from fossil resources such as oil, uranium, coal or natural gas.

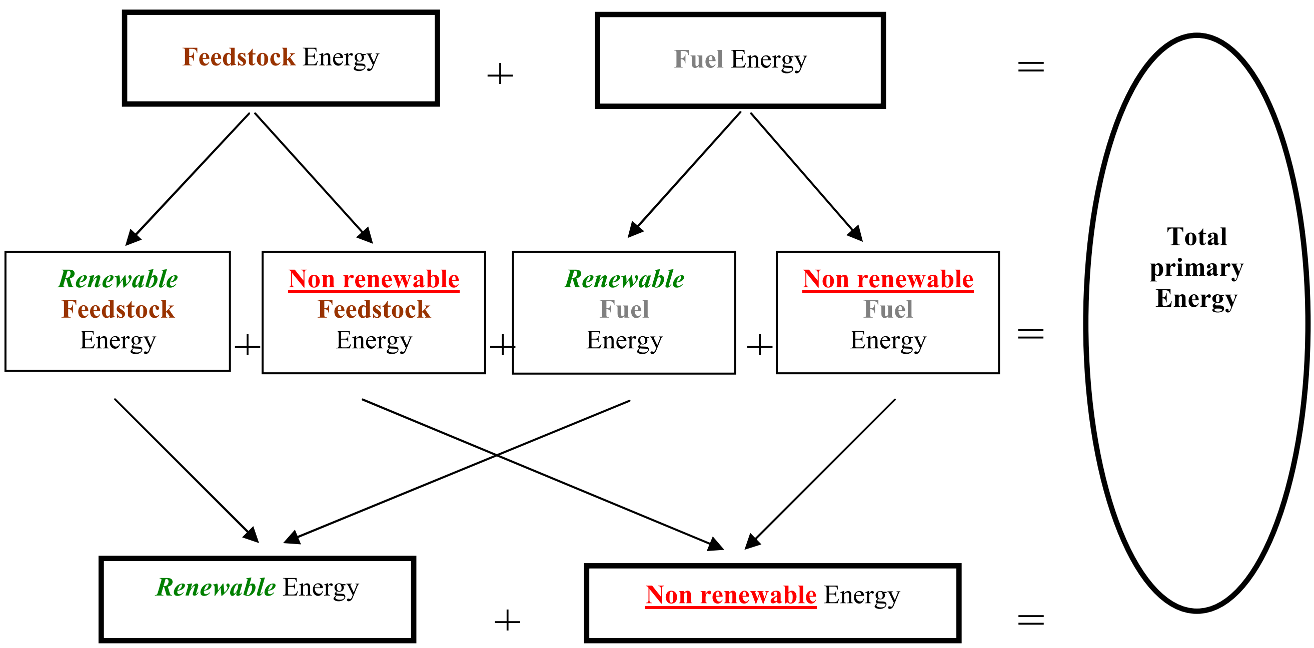
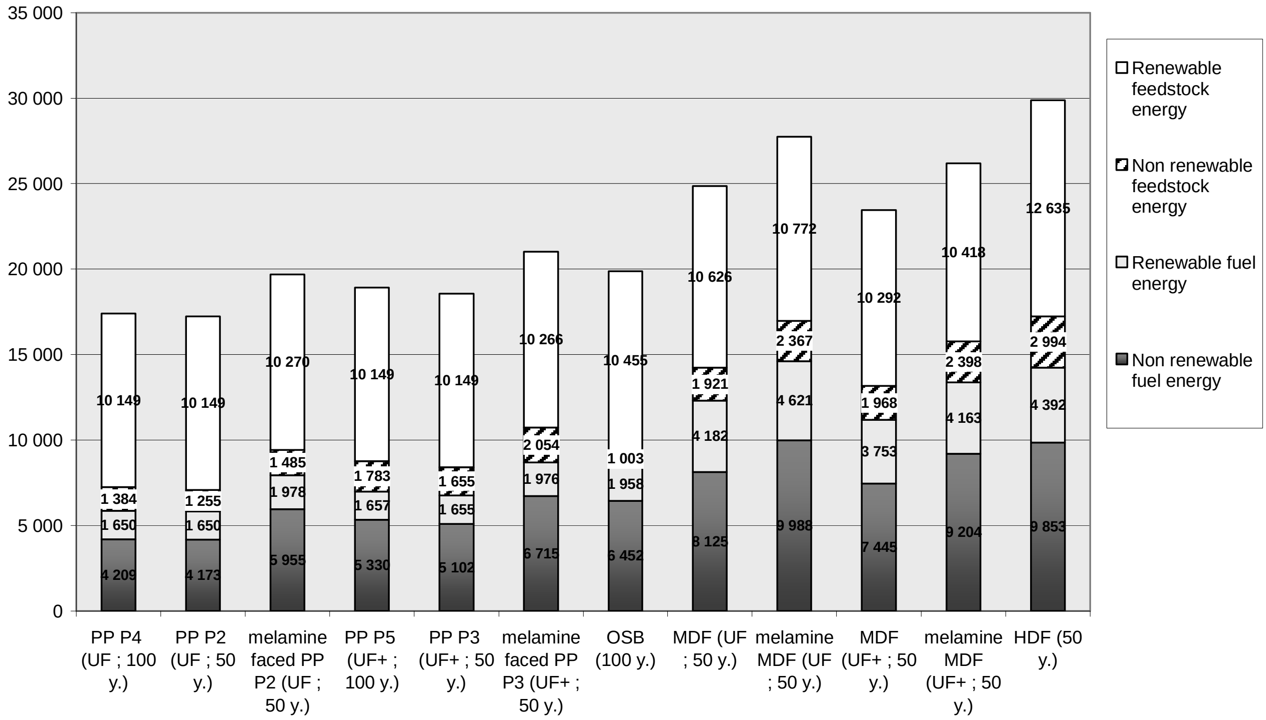


Figure 5: Energy indicators in LCA

Figure 6 shows the energy indicators of French wood-based panels.



UF+ = UF adhesives doped with melamine

Figure 6: Energy indicators of French wood-based panels [MJ/m^3 of laid panel]

Concerning feedstock energy (renewable and non renewable), it is relatively stable across the panels, with an average value of 12 400 MJ/m^3 of laid panel, representing approximately 50% of total primary energy. It includes a stable renewable part around 10 500 MJ/m^3 of laid panel, representing between 81 and 91% of the total feedstock energy. This energy corresponds to the wood content in the product. The higher value of the HDF, equal to 12 635 MJ/m^3 of laid panel, is due to a much greater density. The non renewable feedstock energy varies, however, from 1 000 to 3 000 MJ/m^3 of laid panel, representing between 9 and 19% of the feedstock energy, with an average value of 1 850 MJ. This energy corresponds to feedstock energy contained in the adhesives.

In contrast, fuel energy is highly variable with values ranging from 5 800 to 14 200 MJ/m^3 of laid panel with an average of 9 700 MJ/m^3 of laid panel. The total fuel energy also includes a renewable part ranging between 23 and 34%, with an overall average around 28% and an average for each type of panel:

- MDF, laminated MDF and HDF, around 32%, reflecting a lower wood yield than other types of panels and an important rate of internal energy recovery,
- PP and laminated PP, around 25%, reflecting a better wood yield and an important rate of internal energy recovery,
- OSB, around 23%, reflecting a low rate of internal energy recovery.

Concerning the surfacing, it causes an increase of fuel energy consumption between 2 000 and 2 300 MJ/m^3 of laid panel, representing an increase between 18 and 36% of the total.

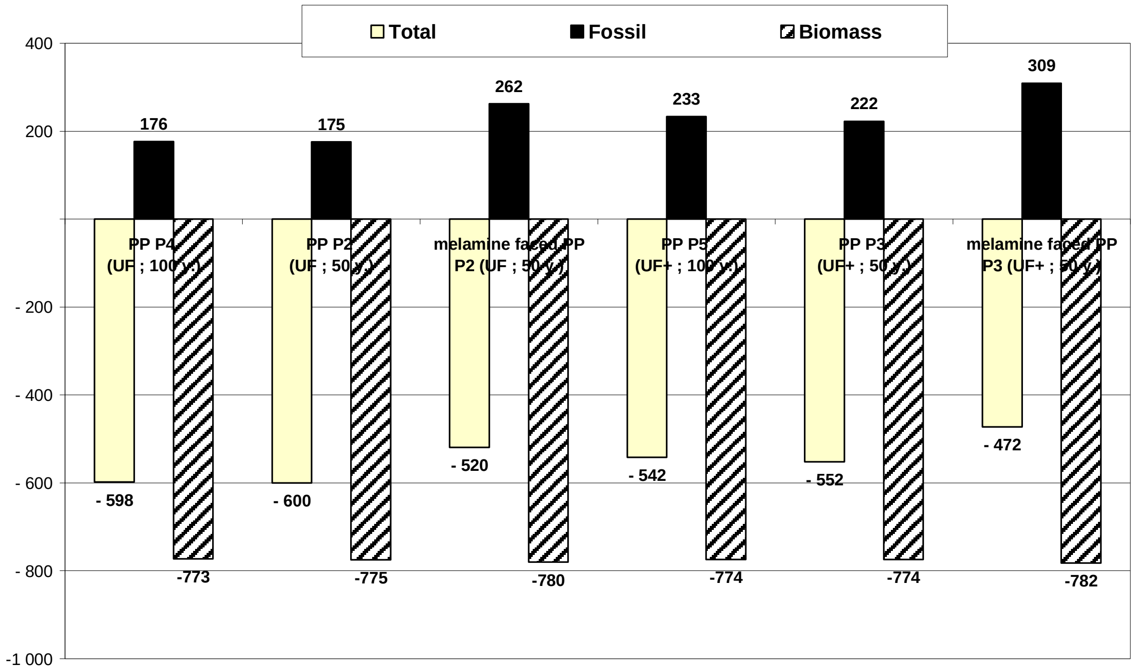
The analysis step by step of the life cycle shows that, whatever the type of panel, the production stage is the most impacting (over than 90%) for the non renewable energy indicator. The detailed analysis of the production stage has highlighted the importance of the glue components production which represents from 40% up to 68% of the impact of the production stage. The raw panel manufacturing contributes also from 27% up to 51% to the production impact.

Global warming indicator

Contrary to minerals or fossil fuel based materials, wood molecules are the result of photosynthesis which is the transformation of carbon dioxide molecules into organic matter using solar energy. As a result, the growth of the tree captures carbon dioxide from the air. In the LCA methodology, this carbon uptake can correspond to an input or a negative emission. The uptake and emissions of carbon biomass were accounted for in this study, because the balance between uptake and emissions was not equal to zero. In the NF P01-010 standard, the reference scenario is landfilling. For wood, degradation in anaerobic conditions is incomplete and carbon contained in the product is stored for an indefinite time. A bibliographical review has been performed based on different publications including (Barlaz, 2006) and an average value has been found of 15% degradation rate for wood products.

The global warming indicator includes the greenhouse gases emissions from fossil origin and biomass origin. The biomass part is stable and negative thanks to "definitive" storage of biomass carbon from landfilling panel at the end of life (average -800 kg eq. CO_2/m^3 of laid panel). The fossil part ranges between 175 and 390 kg eq. CO_2/m^3 of laid panel, with an average of 285 kg eq. CO_2/m^3 of laid panel. These results are correlated for the fossil part to the non renewable fuel energy. The result of the total climate change indicator is very favourable, always negative between -400 and -600 kg eq. CO_2/m^3 of laid panel and on average -509 kg.

The analysis step by step of life cycle shows that, whatever the type of panel, the production stage is the most impacting (over than 85%).
Detailed analysis of this production stage has highlighted the importance of the impact of glue components production and raw panel manufacturing. Indeed, while representing a maximum of 12% by mass of raw panel, the glue constituents supply (production and transport) impacts for more than 50% of the production stage for the fossil global warming indicator except for OSB (35%). In general, the impact of the production of the various components of the glue is proportional to their mass ratio in the glue. The production of the raw panels is the second source of the total impact: it represents from 22% to 53% of the fossil global warming indicator. The third source of impact is the wood supply which represents around 10% of the impact. For the melamine faced panels, surfacing significantly increases the global warming indicator and changes the contribution of each different step to the total impact (around 25% for surfacing, 40% for adhesives supplying, 25% for raw panel manufacturing and 10% for wood supplying).



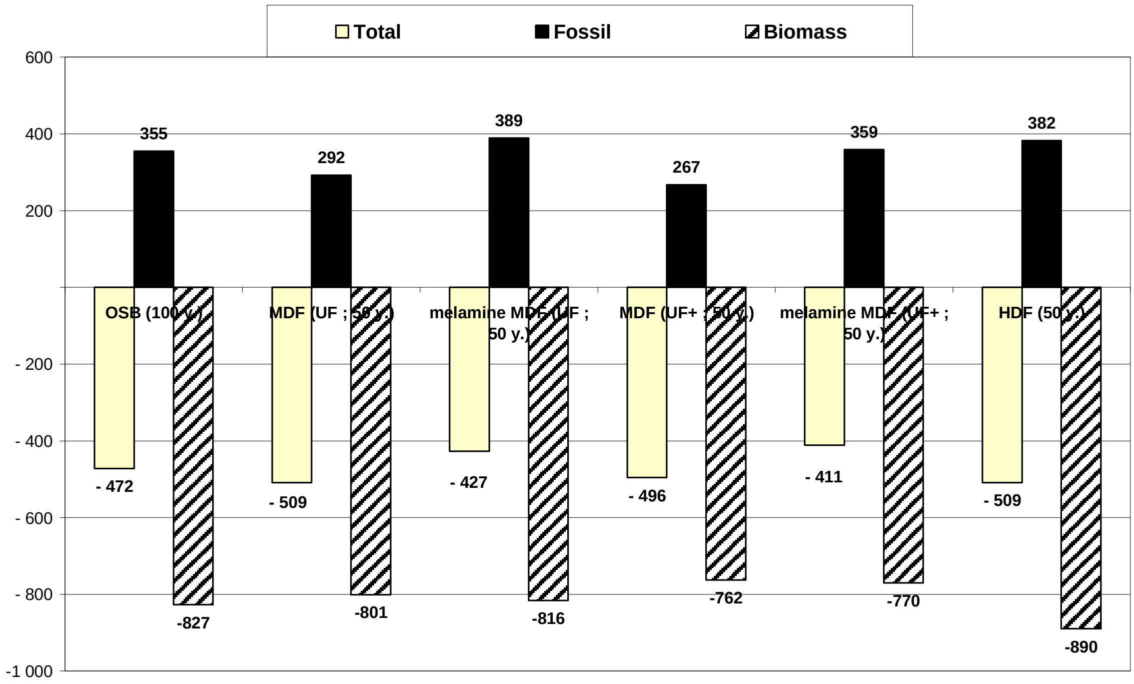


Figure 7: Global warming indicator [kg eq CO_2/m^3 of laid panel]

Abiotic depletion potential indicator

Depletion of abiotic resources indicator concerns depletion of energetic and non energetic resources.

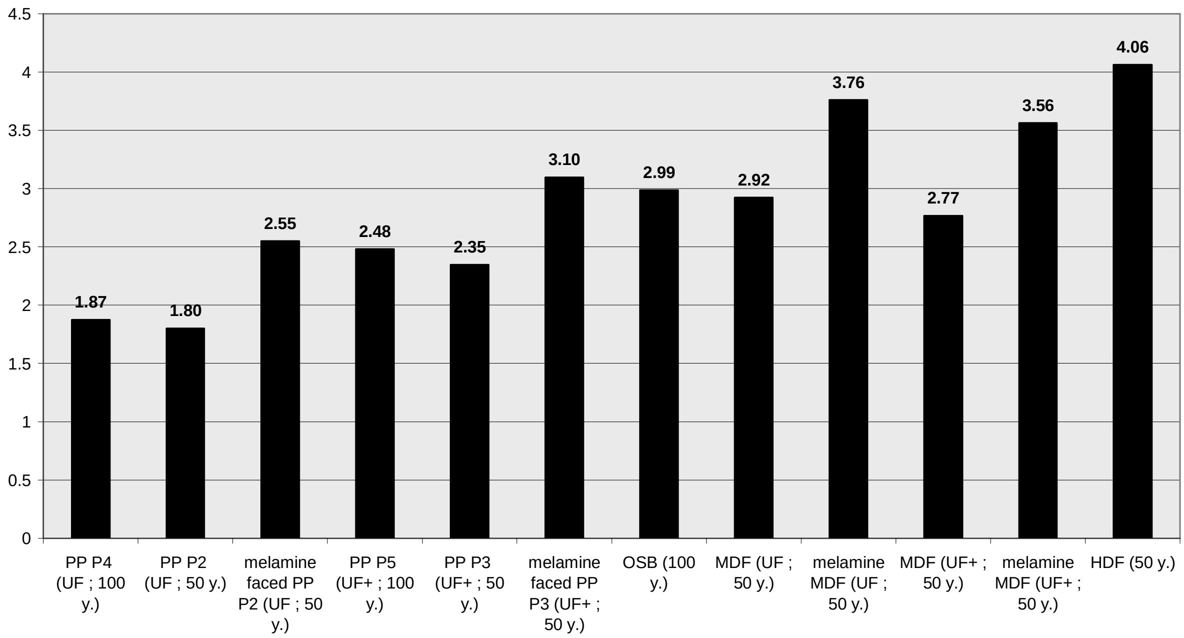


Figure 8: Abiotic Depletion Potential (ADP) Indicator [kg eq Sb/m^3 of laid panel]

The results for the abiotic depletion potential indicator vary between 1.8 and 4 kg eq. Sb with an average value of 2.85. They are correlated to the results of the non renewable fuel energy and the non renewable feedstock energy.

CONCLUSIONS

Thanks to this study, the eco-profile of French wood-based panels was established and twelve EPDs are now available.

The most important and most favourable result is the negative value of the global warming indicator around -500 kg eq. CO_2/m^3 of laid panel, corresponding to the carbon footprint of the panel.

The study also showed important variations concerning fuel energy consumption between the different types of panel (PP, OSB, and MDF).

The analysis step by step of life cycle shows that for most of indicators, and whatever the type of panel, the production stage is the most impacting (over than 90%).

The detailed analysis of this production stage has highlighted the strength of the impact of glue components production and of panel manufacturing. Indeed, while they representing a maximum of 12% by mass of the panel, glue components production impacts up to 50% on the production stage for non renewable energy, ADP and fossil global warming indicator. Generally, the impact of the production of the various components of the glue is proportional to their mass ratio in the glue.

Thus, improvement of the wood-based panel profile studied here should focus on glues production.

This study also showed that surfacing significantly affects the results (around 25%) although it is only 3% by mass of the panel. Surfacing increases the consumption of water and fuel energy but reduces air pollution and photochemical ozone formation indicators by reducing emissions of formaldehyde during the life in use. Impregnating paper step including the glue production is mainly responsible for increase of the fuel energy. Again, to improve the environmental performance of the product, the industry should focus on the environmental impact of glue components production such as UF and MF adhesives.

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