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University of Zagreb

**Faculty of Forestry  
and Wood Technology**

# CONTRIBUTION OF FOREST-BASED INDUSTRY IN LOW CARBON CIRCULAR BIOECONOMY: LIFE CYCLE ASSESSMENT OF SELECTED WOOD-BASED PRODUCTS USING SIMAPRO SOFTWARE

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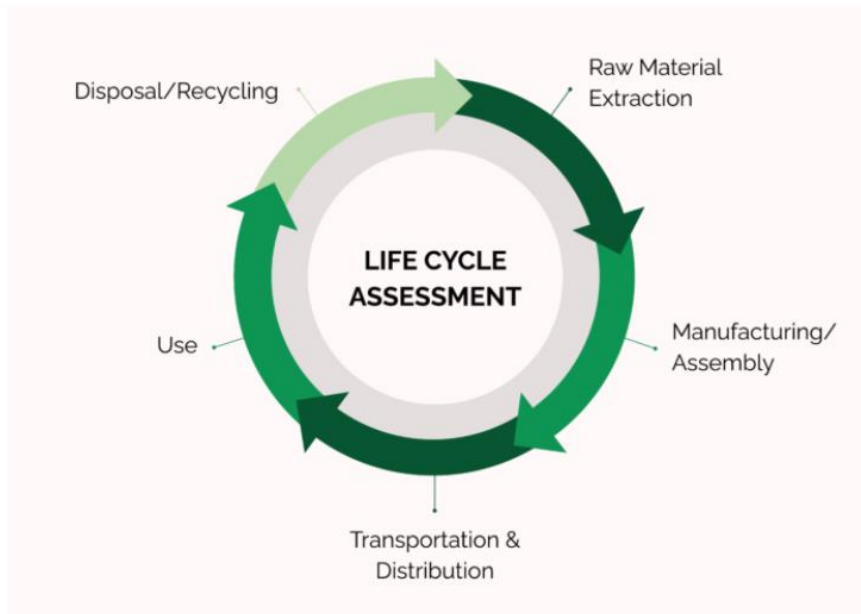
Acknowledgements

# 1. INTRODUCTION

- **European forest-based industries** → important role → European low-carbon circular bioeconomy
- **Wood industry** → essential for the global environment (sustainable development)
- **Life Cycle Assessment (LCA)** → method used to provide a scientific measure of a **product sustainability** and **environmental performance**
- the purpose of an LCA is to measure the **environmental impacts** of a **product system** throughout its life cycle

Product system: Collection of unit processes with elementary and product flows, performing one or more defined functions that models the life cycle of a product (ISO 14040).

# 1. INTRODUCTION



*Life Cycle Assessment*

*Source: Sustainability tools in Cultural heritage*

LCA - Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (ISO 14040).

- LCA is frequently used **environmental assessment tool** → assesses significant environmental aspects and their impact from **extraction to production, use and end-of-use phase**
- LCA can be used in situations ranging from **quick LCA** using generic data from different databases to a **complex LCA** with a high level of imported data

- The main current LCA software tools are: **SimaPro**, **GaBi**, **Umberto** and **openLCA**
- **SimaPro** → generic data → wood products → **Ecoinvent database**

## 2. MATERIALS AND METHODS

**SimaPro**



- **SimaPro** is one of the leading sustainability and life cycle assessment software for the last **30 years** → used by companies, consultancies and universities
- This software provides solution for **collecting, analysing** and **monitoring of sustainability performance data of products and services**
- Developed by **PRé Sustainability** (company)
- The software is available as a desktop version or with option to use cloud-based modules
- **SimaPro** can be used for **various applications** → such as sustainability reporting, carbon and water foot printing, product design, generating environmental product declarations and determining key performance indicators

## 2. MATERIALS AND METHODS



- For the purpose of this study ***SimaPro*** version 9.3.0.3 (**Expert user package**) was used.
- Data were taken from the ***Ecoinvent v3 database*** → that covers more than 10000 processes
- The *Ecoinvent* database → developed by different Swiss institutions → offers one of the most consistent and transparent life cycle inventory databases (that provides support for environmental assessment of products and processes worldwide)
- Database contains **18000 reliable life cycle inventory datasets**, covering a range of sectors → for each dataset available, Life Cycle Impact Assessment (LCIA) provides relevant impact assessment methods, and compatible impact categories
- The **Functional unit** used for this overview was **m<sup>3</sup> wood product**
- Method → the **ReCiPe 2016 Midpoint (E)**

# 3. RESULTS

## 3.1. Inventory and impact assessment result

- To demonstrate basic functionalities of the *SimaPro* software, regarding the analysis of the environmental profile of a product, the **Laminated timber element** was chosen

- Different **units** of each category are shown on a **percentage scale**
- The **colours** indicate the relative contribution of different parts of the product
- Analysis (Figure 1.) of the laminated timber element (transversally prestressed) shows that the highest impact on the environment in the process is accounted to **steel** (coloured light blue)

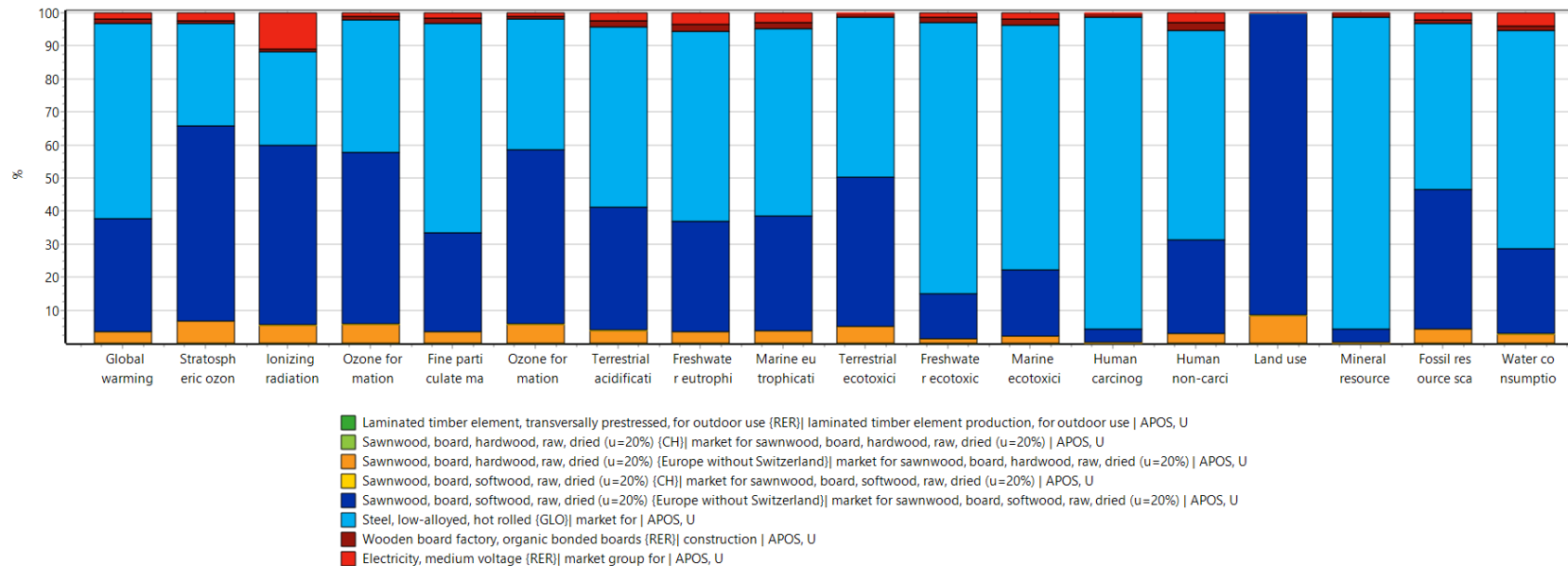


Figure 1. Characterization results - Inventory and impact assessment result - Laminated timber element, transversally prestressed (Source: SimaPro version 9.3.0.3)

# 3. RESULTS

## 3.1. Inventory and impact assessment result

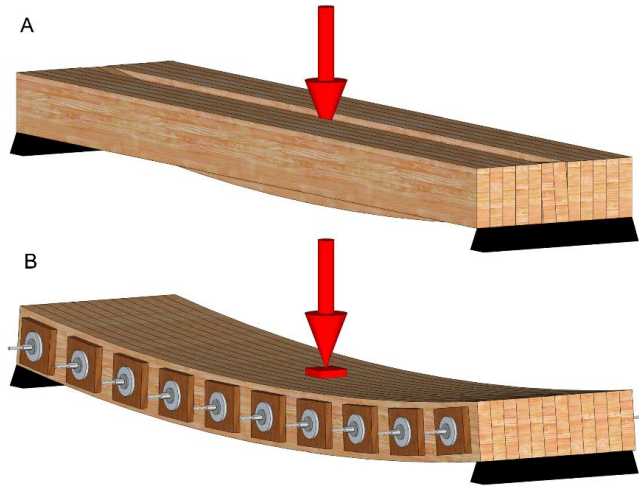


Figure 2. Source: Performance of Stress-Laminated-Timber Bridge Decks

- Represented example of laminated timber element is transversally prestressed with steel, which is used for improving the strength of the element that is used in construction
- Detailed information regarding the product were not available through the *SimaPro* software

- In the results window, there are several possible uses, such as **Life Cycle Inventory results** (the list of emissions and results), following the different **impact assessment steps** (through Characterization, Damage assessment, Normalization and Weighting), and **process contribution analysis** (that shows relative contribution of each individual process to an impact category or to another indicator).



# 3. RESULTS

## 3.2. Overview of the life cycle presented as a network

- In order to generate the **process network**, it is necessary to choose the **Network option**
- As a result, there will be generated a **network flow chart** (Figure 3), that is not completely visible
- Due to this the *SimaPro* software calculates the influence of processes, but by default it determines “**cut of value**”, so that only **12 processes** are shown
- To display all processes, it is necessary to set “cut-of-value” to **zero**

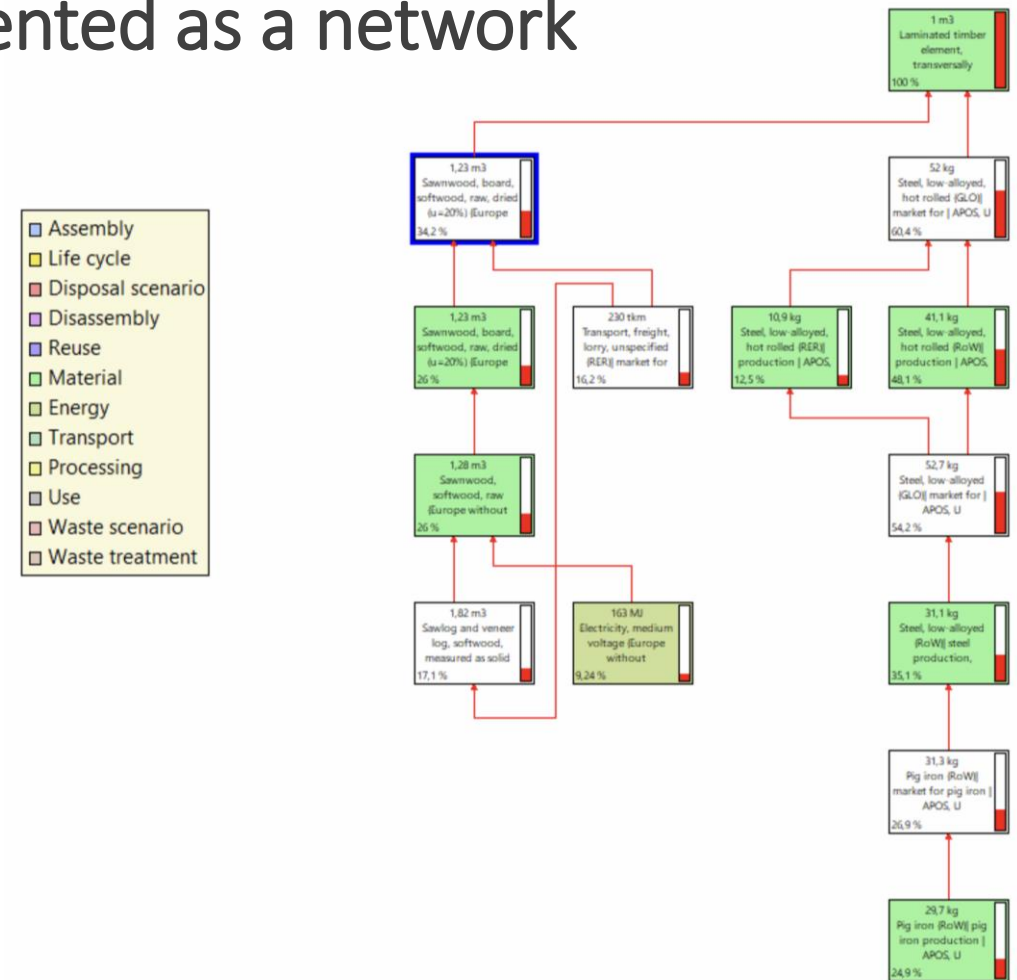


Figure 3. Overview of the life cycle presented as a network (cut-off value = 8,8 %) (Source: SimaPro version 9.3.0.3)

# 3. RESULTS

## 3.2. Overview of the life cycle presented as a network

- The Network option allows a display of **all processes** together.
- Each **box** represents a **process**, and the **arrows** represent the **flows** between the processes
- The **red bars**, located on the right side of the boxes, indicate the **environmental load** generated by each process and its upstream processes
- Choosing the **indicator selector**, it is possible to specify which indicator or LCI (Life Cycle Inventory) result is going to be represented by the red bars
- There is also an option to select any single impact category or inventory result

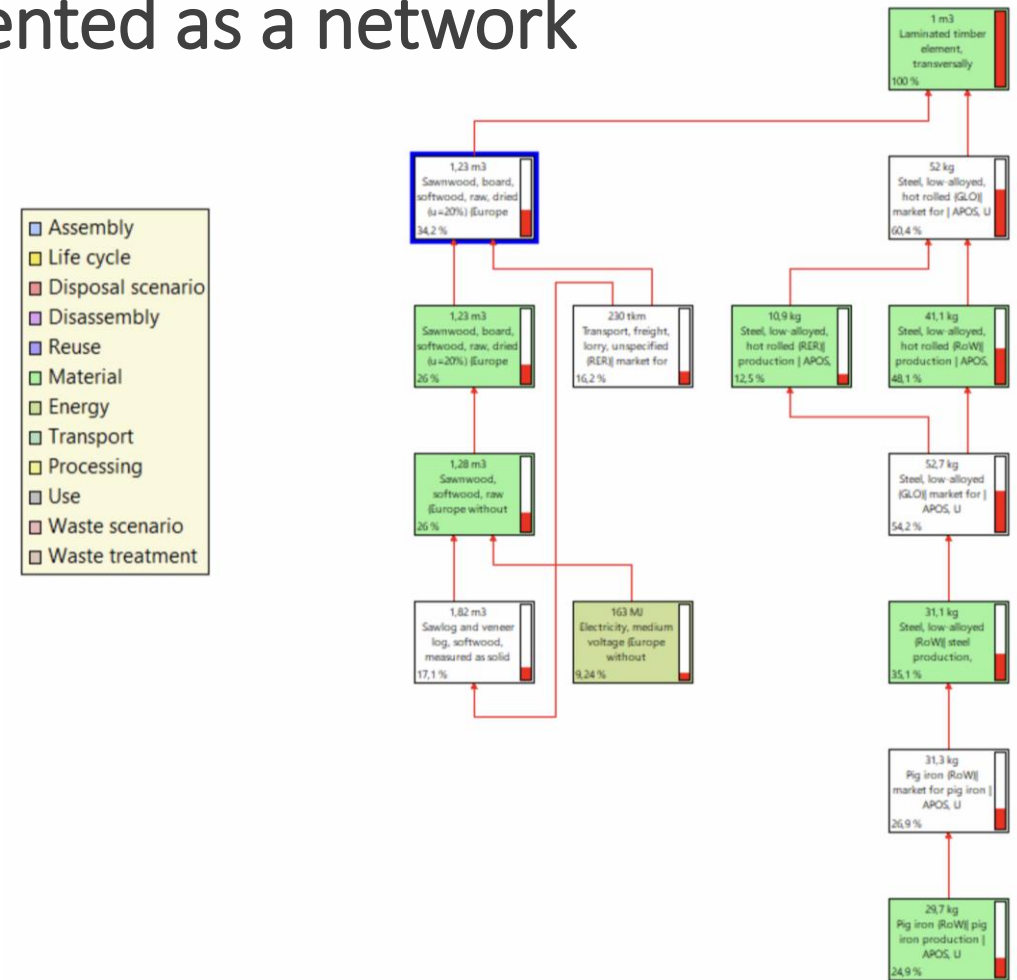


Figure 3. Overview of the life cycle presented as a network (cut-off value = 8,8 %) (Source: SimaPro version 9.3.0.3)

# 3. RESULTS

## 3.3. Comparison of Inventory and impact assessment result of two wooden products

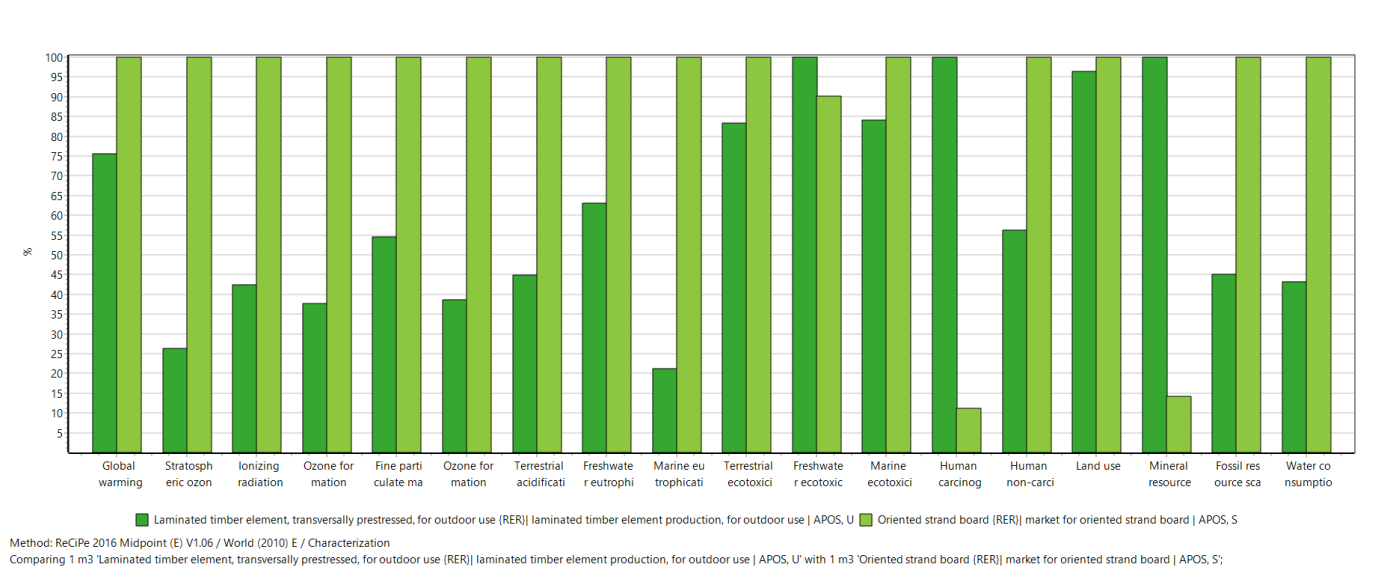


Figure 4. Results of the comparison between two wood products (Source: SimaPro version 9.3.0.3)

- When the life cycles are compared, impact category by impact category in the characterization tab, it appears that the life cycle of Oriented strand board (marked light green) has a higher environmental load for almost all impact categories.

- The SimaPro software offers the possibility of **comparing** the products with a **Compare option**.
- For the purpose of this study, the life cycle of two different wood products were compared: **Laminated timber element** (transversally prestressed) and **Oriented strand board**.
- Calculate option results in displaying the comparison (Figure 4.) of the **environmental impacts** of the life cycle of both products.

# 3. RESULTS

## 3.3. Comparison of Inventory and impact assessment result of two wooden products

- For an example, **Kutnar** and **Hill** noted that **the embodied carbon in OSB** is higher in comparison to Laminated timber elements
- Explaining in more detail, they showed that the **adhesives** used in OSB are responsible for the largest fraction of emissions what is especially significant considering the low total volume they represent in the final products
- In laminated timber, emissions derive mostly from **timber harvest** and **initial lumber production** of the softwood and also from the energy and **adhesives** required to bond the lumber.
- In addition, production process and technology of OSB boards is more **complex** than laminated timber production, because it consists of more specific **sub-processes**, and there are more different input materials used.
- Authors, **Werner** and **Richter** reviewed the results of approximately 20 years of international research on the environmental impact of the life cycle of wood products used in the building sector compared to functionally equivalent products from other materials.
- With regard to greenhouse gas emissions, in comparison to other materials, **wood is shown as a better alternative.**

# 4. CONCLUSION

- **Wood** use as a multifunctional material is expected to increase significantly in **carbon-negative** housing, as well in furnishings
- The results generated in this study are based on relevant **resource extraction, production, and transportation data sources** in tandem with **scientifically grounded assumptions** and **estimates**
- It is essential that a **transparent and standardized approach to LCA is used**
- Unfortunately, the **values can differ significantly between studies**
- The use of **different input data, functional units, allocation methods, reference systems**, and other assumptions, complicates comparisons of the LCA studies – this must be emphasised when using LCA as a tool in the decision-making process
- The methodology of environmental impacts' comparison of products, such as shown in this study, allows engineers and architects to **identify the product with better environmental performance**

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Thank you for your attention!

