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Introduction

Buildings notably contribute to global environmental negative impacts due to the consumption of both embodied energy and natural resources, as well as various emissions during their whole life cycle. In this context, the **Life Cycle in Practice (LCiP)** project helps SMEs to reduce the environmental impacts of their products and services across the entire life cycle. Within the frame of this project, **IsoHemp hemp blocks** [1] impact is evaluated in a **cradle-to-gate life cycle assessment (LCA)**. Evaluation of environmental performance is needed to support both the design and the production of waste based insulation solutions.

IsoHemp hemp blocks are made of lime and hemp shives. With one insulating material, it offers a personal comfort thanks to three technical properties: thermal regulation (warmth and cold insulation, with the ability to distribute accumulated heat progressively and help to keep a constant temperature inside the house), soundproofing, and humidity regulation. It is also considered to be human friendly since it does not contain any artificial substances or additives that would be harmful.

Materials and Methods

Goal definition

The aim of this study is to assess environmental impacts of hemp blocks.

Scope

– The functional unit (FU) is 1 pallet of IsoHemp hemp blocks, ready for shipping.

Methods

- This study is done in accordance with the ISO standards 14040 and 14044 [2].
- CML IA Baseline v3.03 [2] method.
- SimaPro 8.1.0.60 software (PRé-Consultant); Ecoinvent 3.1 database [4].

Inventory and Borders

- 1 pallet = 1.296 m³ (390 kg dry).
- Composition: 9% slaked lime (Ca(OH)₂), 11% natural hydraulic lime (Ca(OH)₂ + clay), 80% hemp shives.
- Process tree is schematized in Figure 1.
- Hemp shives are mixed with slaked and hydraulic lime. The mortar is pressed before a 24 hours cure in a naturally ventilated chamber. After that, the blocks are palletized before a 2 months storage during which carbonation of lime occurs (attributed to "storage" step). Then, pallets are ready for shipping.
- All the block waste is recycled in the process.
- Inventory data comes directly from IsoHemp, except for hemp shives (VIBE study in Grow2Build project, literature). Hemp comes from France, hydrated lime is from local – and very close - provider (Carmeuse).
- Lifetime is 100 years (→ CO₂ sequestration in hemp is included). Reference year is 2014/2015. Cradle to gate assessment ⇒ no end of life.

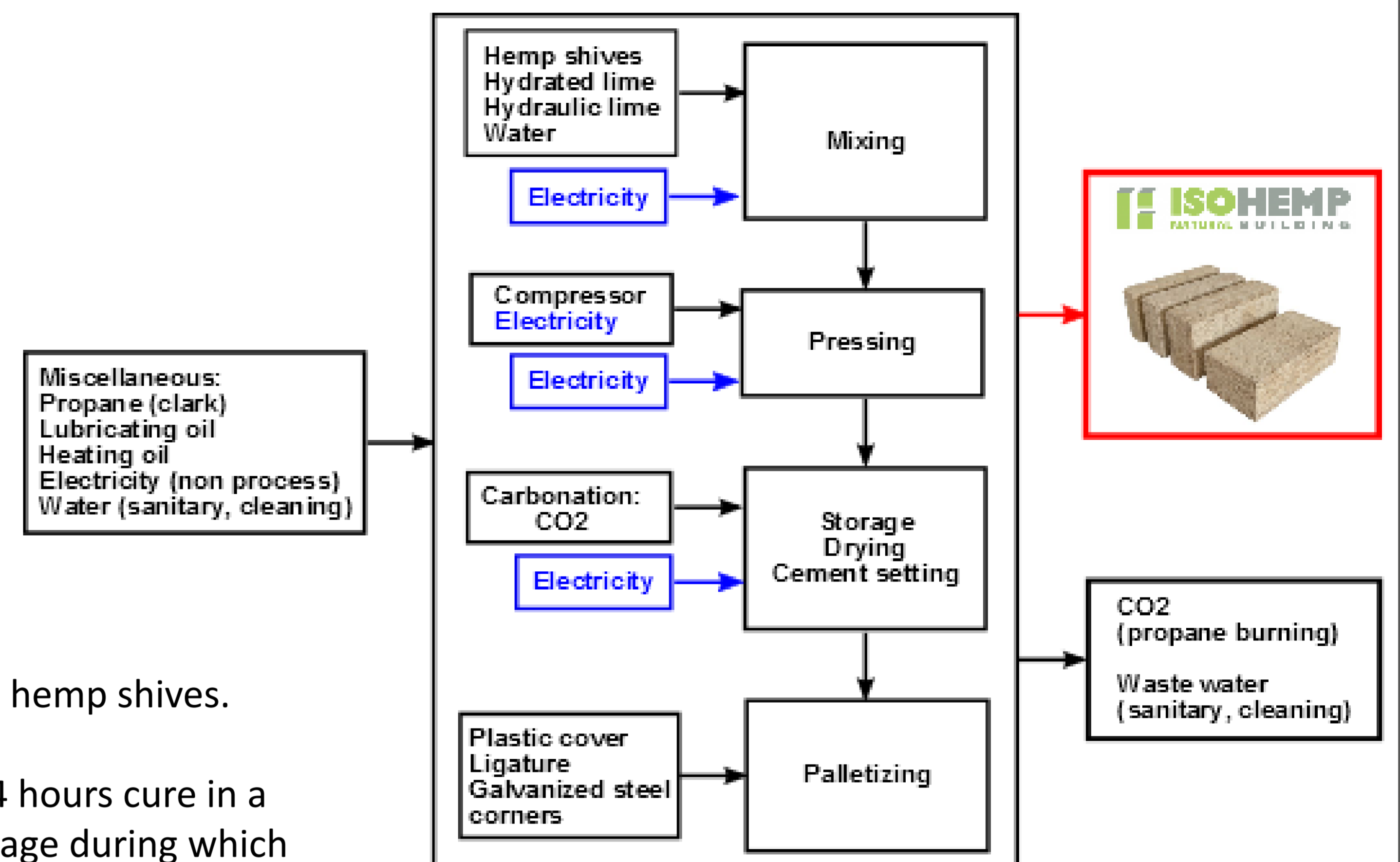


Figure 1. IsoHemp blocks process tree

Results and Discussion

Main results of this study are presented in Figure 2 (characterisation) and 3 (normalisation) for 1 FU.

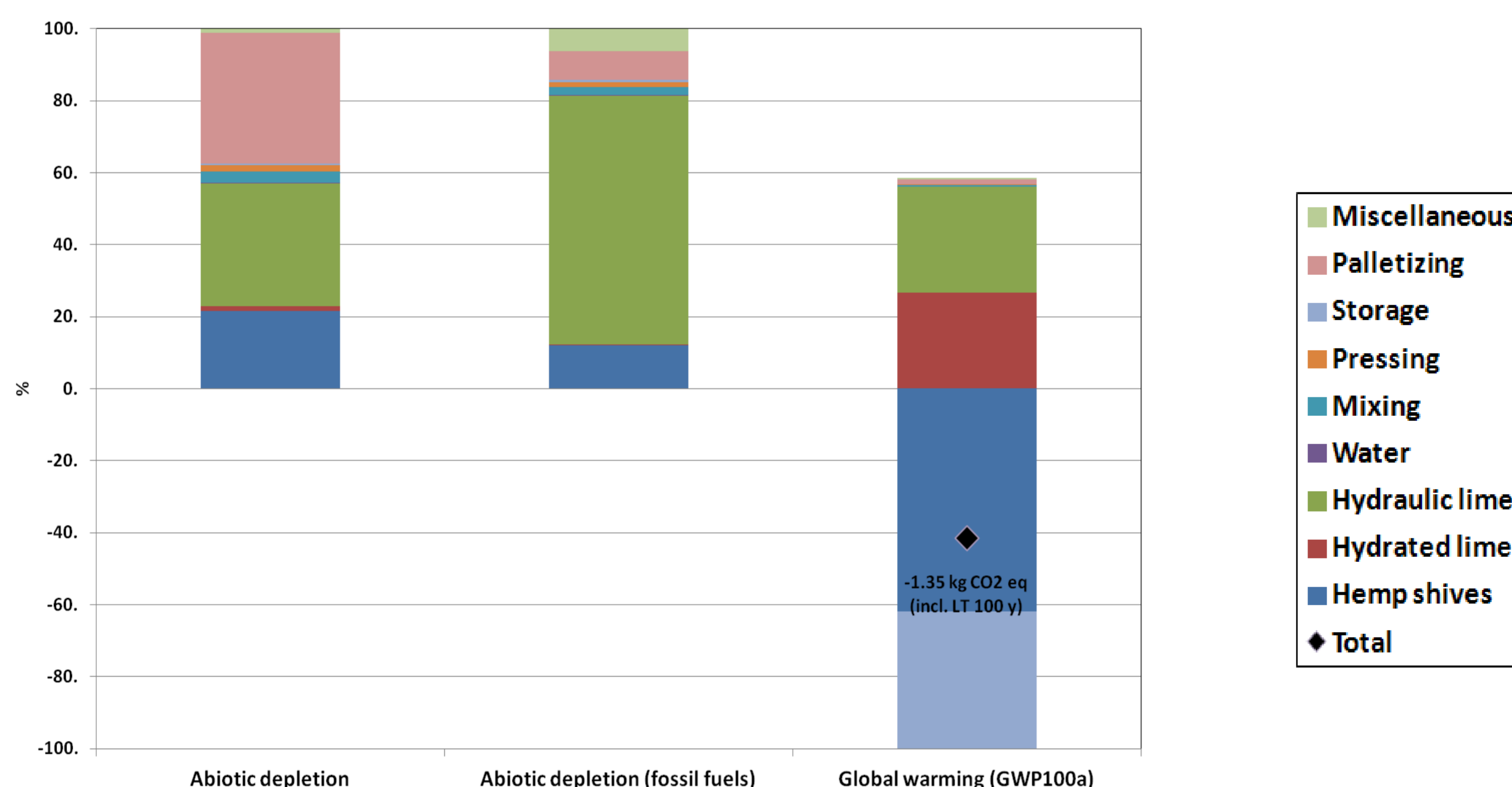


Figure 2: Environmental impacts of 1 FU of IsoHemp hemp blocks

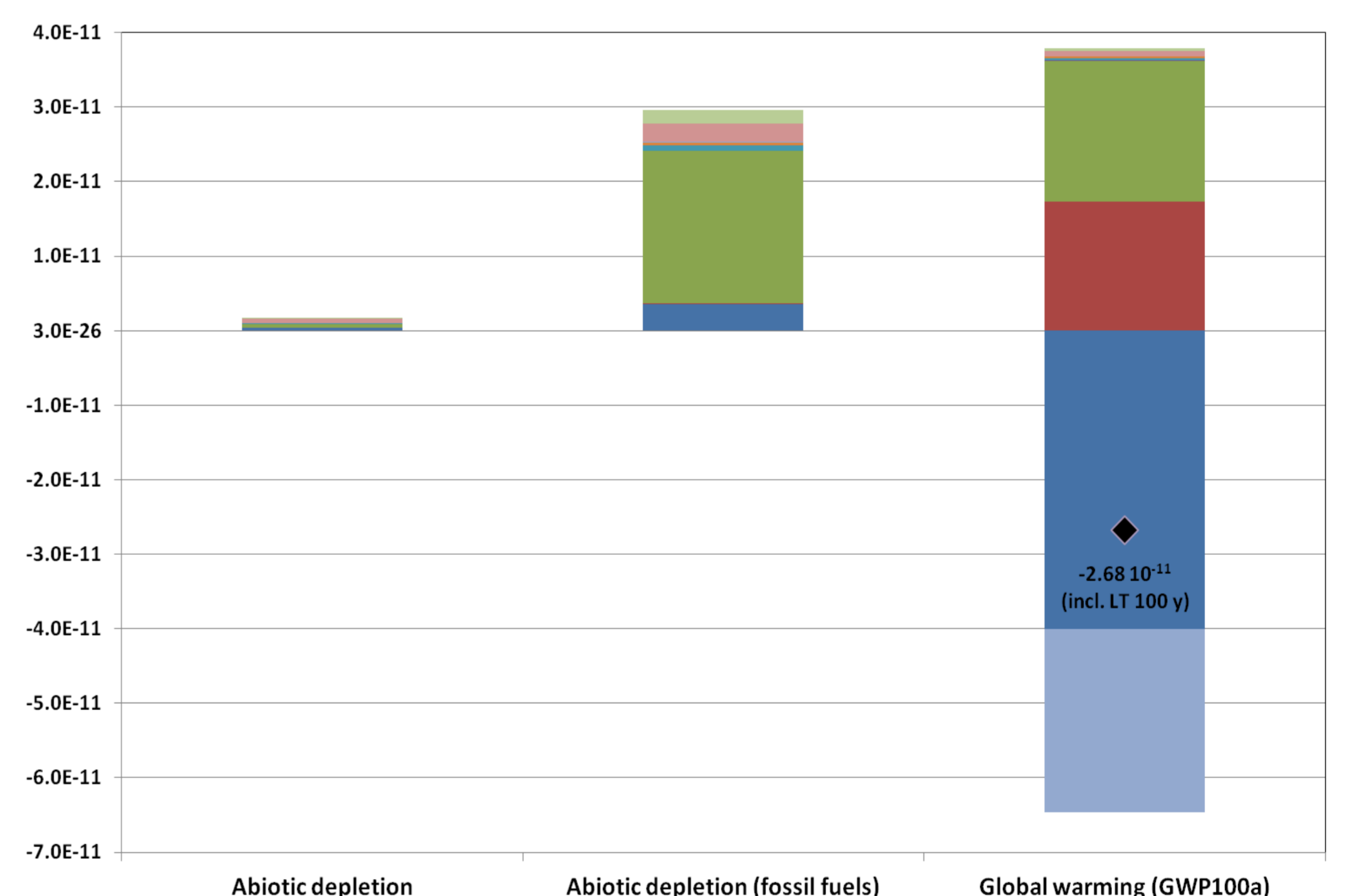


Figure 3: Normalisation of 1 FU of IsoHemp hemp blocks

◆ Most impacting elements:

- **Hydraulic lime**, slaked lime, and hemp shives
- **Environmental benefit:** CO₂ sequestration in hemp shives and lime [Ca(OH)₂ + CO₂ → CaCO₃ + H₂O] ⇒ -1.04 kg CO₂ eq / 1 m³ of IsoHemp blocks (inc. 100 years life time)

◆ Most impacted categories:

- **Global warming**
- Abiotic depletion (fossil fuels)
- (Abiotic depletion)



◆ Ways to improve:

- Palletizing: cardboard protective corners or reused (with deposit) and thinner galvanized steel corners
- Thinner or biobased plastic cover
- NB: Natural hydraulic lime has specific properties and is impossible to substitute

Conclusions

Cradle-to-gate life cycle assessment of IsoHemp hemp concrete blocks points up the most impacting element of the process, which are raw material (hemp shives and lime). The most impacted categories are Global warming (GWP100a), in both positive and negative way, and Abiotic depletion (fossil fuel). Effect on GWP100a is directly linked to the characteristics of the raw materials. Hemp shives store carbon by photosynthesis, a "negative impact" corresponding to an environmental benefit. Even if hydraulic and slaked lime burden is high because of their method of making (energy use and carbon dioxide emission), this aspect is offset by carbonation during storage. The entire process of hemp shive production has a negative carbon footprint, including the energy needed to grow and process the plant itself. IsoHemp blocks were already the result of an ecodesign thinking, but this study has highlighted some improvements that can easily be made at the packaging level in order to lower the global environmental impact and to increase the sustainability of this insulation material.

References

- [1] <http://www.iso hemp.be/en/construire-avec-iso hemp/>
- [2] ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework; ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines
- [3] <http://cml.leiden.edu/software/data-cmlia.htm>
- [4] Ecoinvent Centre, The life cycle inventory data version 3.01, 2014. Swiss Centre for Life Cycle Inventories. <http://ecoinvent.ch/>