Life Cycle Thinking as an Integral Part of Entering a New Business Field

Nathanael Ko[1*], *Tilman* Bässler[2], and *Benjamin* Bässler[2]

[1]Öko-Ko environmental assessment, oeko-ko.de, Germany
[2]Bässler Holz- und Fensterbau GmbH, Steinstraße 25, 73037 Göppingen, Germany

Abstract. This paper tells of a transition driven by life cycle thinking. The traditional business of producing plastic-based windows in southern Germany has reached its limits. Therefore, a new business field has been entered: wooden houses. In this transitional process, which was the biggest investment in the last 30 years, with new machines and new products, the life cycle thinking has been integrated early on in the decision making. First, literature was studied to get a general idea of environmental footprints of wooden houses versus conventional houses. Secondly, drafts of different wall design options were assessed for their environmental footprint, using data from the Ökobau.dat. The idea of modularity and re-usability of different structural components was considered in the design of the house as means to increase its lifespan and to prolong the use-phase within the life cycle. In conclusion, this case study within this small company shows, that it is possible to integrate life cycle thinking in companies even in times of drastic changes.

1 Introduction

This paper tells of a transition driven by life cycle thinking. The traditional business of producing plastic-based windows in southern Germany has reached its limits. The business of plastic-based windows is prize-driven, which is a difficult business landscape to navigate in as a small to medium-sized enterprise (SME). Therefore, a new business field has been entered: wooden houses. In this transitional process, which was the biggest investment in the last 30 years, with new machines and new products, the life cycle thinking has been integrated early in the decision making.

The company in question is the Bässler Holz- und Fensterbau GmbH [1], which was founded 1945 in Göppingen, Germany. Currently the main products are PVC windows and doors, sun protection and carpentry work. With an annual turnover of 3 million Euros and a staff of 30 full time equivalents, it can be considered a small-sized enterprise [2].

The business transformation was driven by two factors. First, it was personality driven – a change of generations within the management (from father to sons). The new generation brought with them a sense of responsibility as a business for local environment and an urge to contribute to global sustainable development as envisioned in the sustainable development

* Corresponding author: oeko-ko@posteo.de

goals of the UN. Second, this transformation sat within a larger context of change from the business perspective, i.e. on its own the traditional building and construction business model does not positively contribute to the environment in the long run. Considering the current societal trend towards sustainability, the transformation would enable the business to set an example within its field.

To get a better understanding for the scale of possible results, a short literature study was performed. Three studies in German were identified as suitable [3, 4, 5]. All three sources discussed wooden houses or the value chain of wood for building within a German system boundary. From these three sources, one source [3] was examined more thoroughly and the life cycle comparison of different construction types of houses is shown in Figure 1.

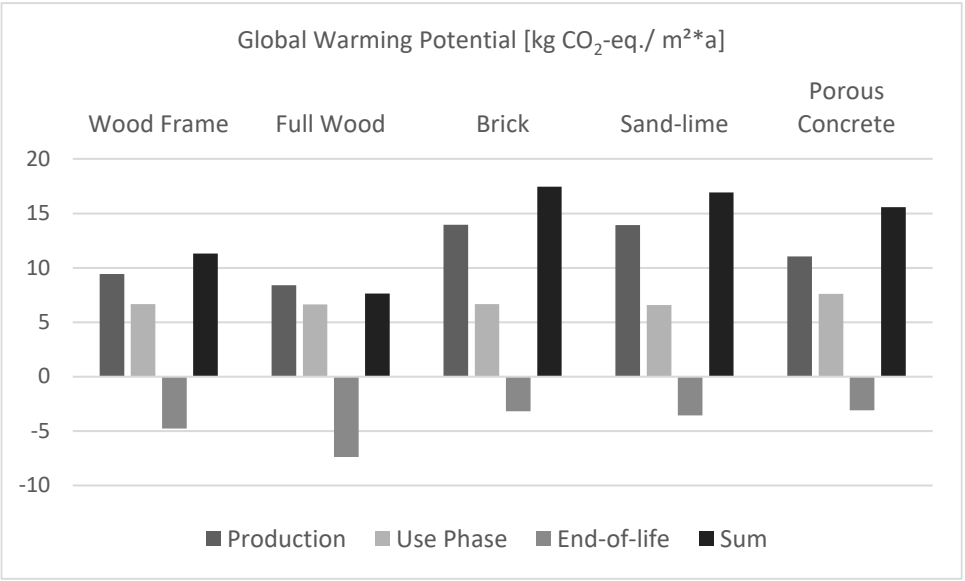

Fig. 1. GWP results for different construction types (graph based on [4])

Figure 1 shows the global warming potential (GWP) in kg carbon-dioxide equivalents (kg CO_2-eq.) per m² of usable space and year. All results refer to the same standard energy consumption, which was set to be EnEV 2016 [6] and therefore the results of the use-phase are almost the same for all types of construction. The greatest differences occur in the production phase and the end-of-life cycle. In this impact category, the house built entirely of wood performs best in these two life cycle phases.

The lesson learned from this literature is, that going into wooden constructions has some potential to create an overall benefit for the environment. Also, the end-of-life phase seems to be a significant area for adjustments.

2 Company and Transformation

The vision for the business itself was to implement a sustainable business model within a running system through an organic transformation. At the end of this transformation, a new market would be established with a benchmark being set for all products in terms of a positive overall life cycle impact for the environment. This new market would provide sustainable wooden houses for the local building sector. Whereas “local” was defined twofold, first as the area with a radius of 30 km, where the wood comes from and secondly as the area of the

market with a radius of 60 km, where the houses are built. The centre for calculating the radius is the headquarter in Göppingen, Germany.
The vision for the products themselves was that it conforms to these criteria:

- Free from plastics
- Free from harmful substances
- Recyclability
- Longevity
- Replaceability

From the criteria, that were set for the products these questions were posed:

- Which substances are included in the building materials?
- How can building materials containing harmful substances or plastics be substituted?
- How to design the house to achieve longevity and replaceability of parts?

Both the transformation of the business and the vision for this transformation needed real world tools to be implemented successfully. The main tool for the assessment is the life cycle assessment (LCA) [7]. Based on the life cycle thinking, integral to LCA, the following questions arose concerning the product:

- Where does the wood come from?
- What environmental impact is accumulated over the life cycle?
- Where can the environmental performance of the product be improved within the life cycle?

The question concerning the sourcing of the wood raised another set of – currently still unanswered – questions, such as whether sources other than cutting trees i.e., old furniture, old wooden structures, or fences, could be used.

3 Case Study

In a first step to integrate life cycle thinking into the transformation process, different wall panel designs for a prototype small wooden house, with around 50 m² of use-space, were assessed based on the publicly available German database OEKOBAUDAT [8]. The energy consumption for all wall panel designs was defined as KfW 40+ [9], so the impact during the use phase was assumed to be the same and therefore left out of the assessment.

The three wall panel designs were defined as such:

(1) Wood frame: wooden frame with wooden boards
(2) Traditional Oriented Strand Board (OSB): OSB within a wooden frame
(3) Full wood: a solid wall of wood

The functional unit is 1 m² of a wall panel with insulation qualities according to the KfW 40+ standard. Since the use phase was left out of this assessment, the results are expressed for the impact category GWP in kg CO_2-eq. per m² wall without a time dimension. The results are summarized in Figure 2.

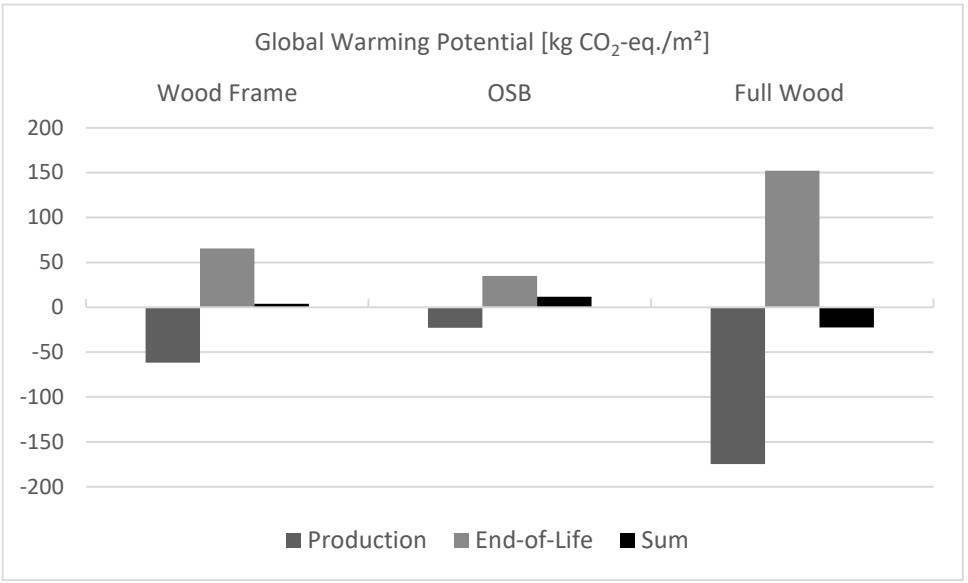

Fig. 2. Comparison of different wall panels

Interestingly, these results show a different direction than the one from literature. Here the end-of-life has an impact, resulting from the emissions of incineration. The production phase – which also includes the impact from harvesting the wood – gains credit from the incorporated carbon during the growth of the trees. With the current level of assessment, design (3) full wood wall would benefit the environment in this impact category.

The conclusion for the prototype drawn from these results would be to keep the carbon in the wood as long as possible. Therefore, the design must be modular to enable a re-use of the different wall elements and to achieve a longer life for the house itself. A lifespan of decades for the elements and of centuries for the house is aimed for. Also, as much wood as possible should be used.

During the production phase, the choice of wood plays an important role. The wood should come from a forest with sustainable management. No competing usage should occur, so the wood processing technology should be able to process bark beetle timer, which currently has no long-term usage.

4 Conclusion

The conclusions drawn from the above-mentioned exercises are, to keep the value chain short, as depicted in Figure 3, and extend the life cycle as long as possible. Furthermore, an example of a SME was given that incorporates life cycle thinking as integral element in changing a business field. Since the incorporation of life cycle thinking started early within the transformation of the business, many technologies and processes can be chosen according to sustainability standards.

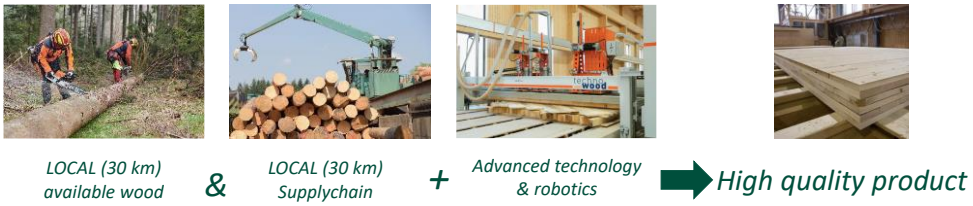

Fig. 3. A short and local value chain for the wooden house catering to a local market with a radius of 60 km

Of course, the journey does not end here. More assessments need to be done to better understand the newly established value chain and the product itself and to improve even more. The next step is to validate more elements of the prototype building: internal walls, roofing, insulation material and utilities. In a broader outlook not only the materials of the prototype need to be assessed but more thought needs to be put into methods of joining the elements and their re-usability. The small wooden house should have a maximum use phase with a flexible layout in order to enable multi-purpose usage. All in all, there are plenty of ideas guided by the life cycle perspective.

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