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Review

Welfare effects from eco-labeled crude oil preserving wood-polymer composites: A comprehensive literature review and case study

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ABSTRACT

Bio-based plastics, such as Wood-Plastics Composites (WPC), represent a new generation of sustainable building materials. They contain up to 80% of renewable resources and comparatively less fossil-based plastics. Reportedly, WPC products preserve crude oil for upcoming generations. However, WPC suffers from a moderate consumer acceptance due to its plastics-like appearance and a lack of differentiation to low-price plastics. Obviously, WPC hardly takes advantage of its environmental opportunity. This paper examines to what extend WPC could benefit from an eco-label as a means of self-regulation and how internalization acts in favor of society. An economic impact analysis is carried out using basic knowledge from a comprehensive literature research about eco-labeling effects on market allocation and welfare. The current WPC-market was subject of further investigations to find out whether a WPC eco-label has a welfare-increasing potential. The analysis revealed that labels are currently in use for differentiation among WPC products which yields higher profits and thus reduces consumer surplus. From social perspective it would be more beneficial to employ such labels for better distinguishing between pure plastics and WPC. In such a case a WPC eco-label would perfectly reduce externalities from crude oil plastics production and this goes along with a growing demand for green-plastics and higher willingness-to-pay of eco-aware consumers which is beneficial for the development of a green building market. Finally, social welfare is most likely to be higher than without labeling even if producer profit increased as well. Nevertheless, total welfare is expected to be maximal only if a public regulator prevents the industry from profit maximization which, however, is not recommendable for the investment-intensive WPC-branch.

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1. Introduction

In 2011, the EU-Regulation No.305/2011, known as Construction Products Regulation (CPR), entered into force. Since then, manufacturers are more than ever obliged to use environmentally compatible raw and secondary materials in their construction products. This regulation was transferred into national law in each EU member country which thus provides enough power to force the building industry supplying environmentally friendly products and also to push deciders, like architects and engineers, specifying "green" products in their planning process. However, environmental efficiency depends on products and services which are competitive in price and utility (Hsieh et al., 2012). On the other hand, applying production technologies which are less harmful to the environment mostly demands high investments and increases production costs (Crespi and Marette, 2005). Further, implementing renewable raw materials in building products often degrades weather resistance or structural fitness which limits their application (Friedrich, 2016a). Products would become more expensive and less useful. At the first glance it appears that being eco-friendly has only a positive effect on the environment but is counterproductive for the supplier and consumer. A lot of research has been conducted to show that the production of sustainable building products can even maximize a firm's profit. Ar (2012) demonstrates that the development of green products has more potential to increase a firm's prosperity than many other corporate activities. Vatalis et al. (2013) performed a survey which pointed out that renewable energy and healthy materials range at the top when choosing a product in the building scope. However, being green is not only a question of strategic behavior. Iwaro and Mwasha (2013) see in sustainability even a philosophy with strong orientation on the welfare of future generations.

One example for building materials with high environmental efficiency is bio-based plastics. This innovative compound increasingly gains in market share and is well known as Wood-Plastic Composites (WPC). The most important WPC sector is the construction industry with decking, wall panels and fencing and automotive with interiors (Carus et al., 2008). In 2012, the share of WPC from total volume of reinforced plastics-composites in Europe was 10% and it is expected that WPC will rise by 175%–450′000 to in 2020 (Carus et al., 2014). WPC consists of petrochemical plastics, like polyethylene (PE), polypropylene (PP) or polyvinylchloride (PVC) in which 60%–80% wood fibers are encapsulated (Fig. 1). Given a façade cladding panel made from neat PVC plastics. It usually consumes crude oil which was refined by high energy input into thermoplastics. If made from WPC, a considerable amount of crude oil can be retained. Reportedly, WPC is a promising substitute to petrochemical plastics (Teuber et al., 2016). Further, wood fibers in plastics act like a reinforcement and they increase the material's mechanical properties (Monteiro et al., 2012). On the other hand, the wood fibers are hydrophilic and susceptible to mold growth and frost-thaw cycling (Ashori and Nourbakhsh, 2009; Schirp and Wolcott, 2005; Naumann et al., 2012; Adhikary et al., 2010; Pilarski and Matuana, 2005; Wang et al., 2007). This significantly reduces WPC's durability in outdoor applications (Friedrich, 2016a). However, greenness is only one aspect when comparing products with each other (Schwarzkopf and Burnard, 2016). In the special case of WPC its overall utility is most precisely quantified if assessed against pure plastics because then only wood-fibers make the difference. Friedrich (2016b) tested PVC cladding against WPC and found that wind load resistance of such products depends on profile geometry and fixation mechanism rather than on the material itself. This highlights that there are multiple approaches how to value WPC's utility where besides the material itself costs also play a key role. Implementing plant fibers in plastics is a new and complex abatement technology for the preservation of oil reserves. It demands know-how and investment mainly in extrusion technology (Carus et al., 2015). This makes the costs of a WPC cladding panel up to 2.5 times higher than similar products made from conventional neat petrochemical plastics. Finally, one of the major obstacles for WPC to become a valued green material for which a consumer is ready to pay more is its plastics-like appearance which hardly differentiates it from low cost neat plastics (Osburg et al., 2016).

Obviously, WPC is faced some challenges. Although building norms support the use of WPC due to its sustainability, the industry and consumers have few incentives to invest in this technology. Currently, WPC experts see a lag of product innovations (Ornetzeder et al., 2008). Even more, new products like WPC cladding are currently far behind any sales expectations. Although most papers in the field of WPC report about its environmental attractiveness the current market situation paints a different picture. This raises the question if crude oil preservation as sales argument has potential to facilitate WPC's market entry and if particular mechanisms are needed to much better recognize WPC among pure plastics products.

This study examines the state of research on eco-labeling for

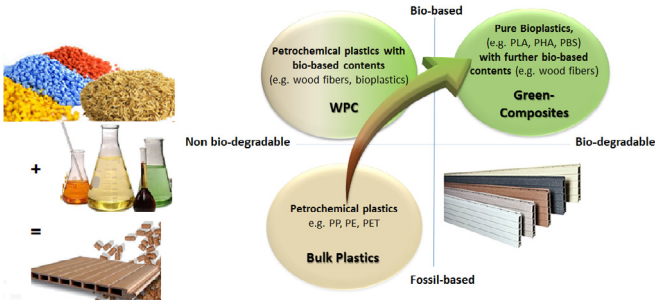

Fig. 1. Petrochemical polymers + wood fibers + additives = Wood-Plastic Composite (WPC) (lhs) Transfer of petrochemical plastics into bio-composites (rhs).