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Contribution to the development of product category rules for ceramic bricks

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ABSTRACT

An Environmental Product Declaration (EPD) provides information on a product's environmental performance along its life cycle. This paper aims to contribute to the development of Product Category Rules (PCR) specific for ceramic bricks in order to support the establishment of a "cradle to grave" EPD. The methodology for developing the PCR takes into account ISO 14025, ISO 21930 and EN 15804, and the environmental profile is based on the Life Cycle Assessment (LCA) methodology. In this context, some core issues like product category definition, impact categories, indicators, cut-off criteria and allocation criteria are addressed. The selected impact categories for this study were: global warming, ozone layer depletion, photochemical oxidation, acidification, eutrophication, depletion of abiotic resources and respiratory inorganics. Indicators of energy and water consumption were also considered, as well as particle emissions to air. The results obtained from an LCA study on ceramic bricks produced in Portugal, to support the development of the PCR, show that the use of different fuels in the brick manufacturing stage has a significant effect in some impact categories. The use of petroleum coke generates higher impacts than natural gas or biomass. In general, the major environmental impacts occur in the brick manufacturing stage, mainly due to fuel usage in the firing operation. Particle emissions to air should be considered as an additional parameter in the EPD, being especially important when solid fuels are used. A sensitivity analysis of the cut-off criteria options was also conducted, which concluded that a 0.5% decrease in mass proved to be adequate for adoption, with a significant reduction in the effort required for data collection.

1. Introduction

Several European and international instruments and policies (e.g. EC (2001), EC (2011a, 2011b), ISO (1999a, 1999b, 2006a, 2006b, 2008)) have been pointing out the importance of Environmental Product Declarations (EPDs) as relevant communication tools for the environmental aspects and impacts associated with products throughout their life cycle, and that they can also act as tools for the improvement of sustainability. EPDs (type III environmental declarations according to ISO 14025 (ISO, 2006b)) provide quantified environmental data for a product using predetermined parameters based on life cycle assessment (LCA) in accordance with the ISO 14040 series of standards (ISO, 2006c, d). They are designed to communicate verifiable and accurate information to different stakeholders regarding the environmental aspects and impacts of products and services. They also encourage the improvement of the environmental performance, and provide information for assessing the environmental impacts over the life cycle of products. The use of EPDs can stimulate competition between material manufacturers and therefore promote more eco-efficient products (Ingwersen and Stevenson, 2011). EPDs are also an important tool for market communication and a basis for eco-design, although the amount of work and competence required to perform a full EPD based on LCA has been identified as a major obstacle for small and medium sized enterprises (SMEs) (Zackrisson et al., 2008).

EPDs must be conducted under specific agreed guidelines for each product category, known as Product Category Rules (PCRs). The PCRs include, among others, the description of the product

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category, the functional unit (or declared unit), system boundaries, cut-off criteria, allocation rules, information on the use phase, units, calculation procedures, requirements for data quality and parameters to declare in the EDP, materials and chemicals, and other relevant environmental information. From the perspective of buyers and end consumers, the EPDs for products fulfilling the same function need to be comparable, so efforts need to be done in aligning existing PCRs and developing new PCRs that can permit consistent comparison of products (Hunsager et al., 2014; Ingwersen and Stevenson, 2011; Subramanian et al., 2012).

Therefore PCR should be very specific in terms of content, both in general requirements (e.g. product category definition, reporting format), and also in LCA methodology (e.g. system boundaries, inventory analysis, allocation rules, indicators, methods) (Ingwersen and Subramanian, 2013; Subramanian et al., 2012). Rules for the use of specific and generic data, and foreground and background processes should also be specified (Modahl et al., 2013).

The construction sector has played a very active role in the development and harmonization of EPDs. This sector consumes more raw materials than any other industrial sector and it also involves high energy consumption (Koroneos and Dompros, 2007; Misiga, 2012; Ronning and Lyng, 2011). In Europe, the building sector consumes 40% of the total energy and raw materials, emits 36% of the total greenhouse gas (GHG) emissions and produces 15% of the total industrial waste (Misiga, 2012). Among the most commonly used construction materials, Brilián et al. (2011) have highlighted that steel, cement and ceramic materials are the most energy intensive construction materials. Ceramic products are one of the oldest building materials and generate a series of environmental impacts over their life cycle (Almeida et al., 2011; Bovea et al., 2007; Bribián et al., 2011; Center for Clean Products, 2009; Ibáñez-Forés et al., 2013; Koroneos and Dompros, 2007; Rouwette, 2010).

With the publishing of European standard EN 15804:2012, “Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products” (CEN, 2012), the existing European EPD programmes have had to adjust their core PCRs for construction products to be consistent with this standard. Despite the fact that the EN 15804 standard provides core PCRs, specific rules for subcategories of construction products will still be necessary and efforts to harmonize them at an international level have to be made in order to guarantee their comparability. The ECO Platform was created for EPD Programme Operators in Europe to agree on common rules based on EN 15804 principles and procedures (PCR harmonization), which will lead to mutual recognition of EPDs (Eco-platform, 2014).

There are more than 30 EPDs in Europe for ceramic bricks, but they differ in several aspects such as the type of brick, function, usage of ancillary materials and additives, environmental impact categories, sources of data, system boundaries and EPD format. Although there are some EPDs for bricks, no PCR for this product category could be found, which compromises the comparability of the existing EPDs.

Some LCA studies have also been conducted on a number of ceramic brick products (Almeida et al., 2011; Bribián et al., 2011; Koroneos and Dompros, 2007; Rouwette, 2010), but comparison is difficult because they have different system boundaries, sources of data, impact indicators and impact assessment methodologies, and none of these studies have evaluated the effect of using different rules in the LCA calculation, such as cut-off criteria or allocation procedures.

This study aims to contribute to the development of a specific PCR, that allows for a comparison of the environmental performance of ceramic bricks, establishing some rules that can support a coherent PCR, namely through a sensitivity analysis in order to evaluate the effect of using different cut-off criteria and allocation rules. For this purpose, a “cradle to grave” LCA of ceramic bricks produced in Portugal is considered as well as previous LCA studies of ceramic materials. On the other hand, the use of different fuel sources (natural gas, biomass and petroleum coke) for the firing unit operations and a comparison of the derived environmental impacts based on the LCA have never been performed. This LCA study also intends to establish reference values for the environmental burdens when different fuels are used in the brick production factory.

2. Methodology

The methodology used in this study followed the ISO 14025 (ISO, 2006b), ISO 21930 (ISO, 2007) and EN 15804 (CEN, 2012) specifications for the development of the PCR to support the development of the EPD for ceramic bricks.

Previous LCA studies on ceramic materials (Almeida et al., 2011; Bovea et al., 2007; Bribián et al., 2011; Center for Clean Products, 2009; Ibáñez-Forés et al., 2013; Koroneos and Dompros, 2007; Rouwette, 2010) were also considered as background information for the development of specific PCR to ceramic bricks, namely relevant indicators and impact categories for this construction material.

Fig. 1 schematically presents the methodology followed in this work. This methodology began with the product category definition, followed by the development of the PCR, which defines the criteria, requirements and guidelines for the specific product category and defines the parameters for preparing and developing the EDP. The LCA methodology was applied to quantify the environmental impacts associated with the brick life cycle from a “cradle to grave” perspective, taking into account the ISO 14040 and ISO 14044 standards (ISO, 2006c, d). This study also includes a sensitivity analysis in order to evaluate the effect of using different cut-off criteria and allocation rules on the magnitude of the impacts.

2.1. Definition of the product category

The product category is ceramic bricks according to NP EN 771-part 1 (CEN, 2011), consisting of clay masonry units made from clay or other argillaceous materials fired at a sufficiently high temperature to achieve a ceramic bond. These bricks have a gross dry density less than or equal to 1000 kg/m^3.

These bricks are characterized by different sizes, void percentages and material densities.

2.2. Development of the LCA study

For the development of an LCA study to quantify the environmental impacts of an EPD, it is necessary to follow precise methodological rules as defined in PCRs in order to guarantee the comparability of different EPDs to products with the same function.

Since brick factories use different fuel sources, three scenarios were developed considering the fuel type used in the brick production phase:

- Scenario NG – Natural gas (average data from three representative factories);
- Scenario BIO – Biomass (average data from three representative factories) using woodchips, pine bark, sawdust and cork dust;
- Scenario PC – Petroleum coke (average data from two representative factories).