

Guidelines for the use of existing Life Cycle Assessment data on building materials as generic data for a national context

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Abstract

This paper focuses on a methodology to determine generic Life Cycle Assessment (LCA) data for building materials for a national context based on existing and currently available data at the European and country-specific levels. It describes the different existing data types that can now be used in practice and focuses on their quality according to CEN/TR 15941. Two options are proposed: the first one proposes to average the existing EPD provided by the building industry. The second one relies on the use of existing generic LCA data at the European or country-specific scale. Data quality assessments are proposed to qualify each data assumed to be a generic data for a national context. Comparisons of Life Cycle Impact Assessment indicators are also suggested to identify both differences and variability of the collected data. Results from a preliminary case study for the French context showed that the French average EPD for glass wool can well replace the generic Ecoinvent data mainly because of its more appropriate geographical, temporal and technological representativeness. Furthermore it reflects the actual realistic situation of glass wool sold on the French market, in comparison with Ecoinvent data, which is calculated for the Swiss context. However, some meta data commonly used to describe LCA generic datasets are currently missing in the French average EPD as some of the information are kept confidential by the industry.

Keywords: generic data, LCA, building material, meta data, indicator, Environmental Product Declaration (EPD), Ecoinvent

1. INTRODUCTION

Environmental aspects are usually quantified by means of environmental indicators using a consistent methodology to assess the impacts of a building assembly or structure. The new European standard EN 15978 defines the cores rules for assessing the environmental performance of a building [1]. However, few aspects are described concerning the use of LCA data depending on the stage of a building project: either early design or more detailed design. The available LCA data in Europe ranges from European average LCA data to national

generic or EPD data (IBO [2], Ecoinvent [3], INIES [4], ICE [5], Ökobau.dat [6], IBU [7] etc.). Some EPD can also be developed at the European scale by trade unions (e.g. cement or plastics industries). Each of these databases is unique in some way, mostly in data types, methodology and origin, and the results from these data can differ significantly (see figure 1). In some national contexts, generic or EPD data may be missing. However, it is generally accepted within the LCA community that it is better to have one data than no data. Thus, these national contexts can use e.g. generic data coming from existing databases. Under these special circumstances, it is very important to choose the best available data and check for completeness, representativeness and reliability, while using them under specific conditions e.g. for a national context.

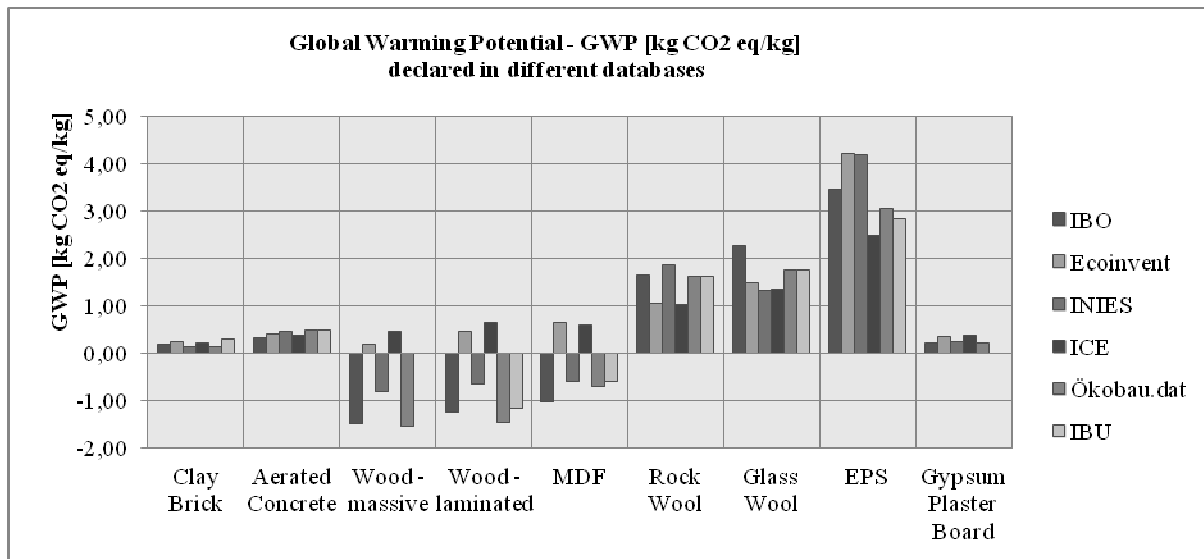


Figure 1: Differences in GWP values of building materials in different LCA databases [8]

Based on environmental indicators differences like in figure 1, previous works have focused on a more detailed understanding of LCA data differences that are used in current LCA software for buildings. For instance, [9] developed a data analysis tool for the French context. In the study, generic Ecoinvent and French EPD building materials and products data were grouped in a database using harmonized Life Cycle Inventory (LCI) and Life Cycle Impact Assessment (LCIA) parameters. Preliminary comparisons of LCA data showed the variability of Environmental Product Declaration (EPD) from the French EPD database (INIES) when compared to the generic data (from the largest available database Ecoinvent). Although the data values should not be compared because of their different methodology (according to ISO 14025 [10]), the applicability of either Ecoinvent or French EPD as generic data for a national context (France in that case) should be found out to fulfill the need of a consistent and representative generic database.

The German Ökobau.dat already provides some generic data for the German context. Some of these generic data are partly based on EPD provided by the IBU database. The Ecoinvent also provides practitioners with generic data that can be used as European or Swiss average. These available data can be modified to better describe the technological processes in every

national context. The other possibility is to use either these foreign generic databases or a national average EPD based on industry data.

Different ways actually exist to determine a generic LCA data. The probably most accurate way would be to conduct a new LCA study for every building material for each national context. A recent example in the case of the generic LCA of reinforcing steel sold on the French market shows the feasibility of this approach [11]. However, it is not always possible to conduct such a detailed study regarding the number of building materials and products implemented in a building and in a given time and cost constraint framework. As a result, in this paper, alternative approaches are studied to determine generic LCA data for a national context. They are based on the analysis of the existing LCA or EPD data from the existing European databases and on the development of data quality indicators. A case study covering both French EPD and Ecoinvent data of glass wool products will be used to illustrate the feasibility of the approach.

2. METHODOLOGY

To determine the most appropriate generic data based on existing LCA or EPD data in the national context – several steps have to be done. After the data collection (section 2.1), EPD can be averaged if they correspond to the same type of materials. Then, a comparison with an existing generic data can be made to check for plausibility and identify any differences.

2.1 Identification of LCA and EPD data in available European databases

The different LCA or EPD data from existing country-specific or European databases should be collected. They are based on different sampling levels. They can be either specific to a manufacturer, represent an average or a generic data. According to the technical report CEN/TR 15941, specific and generic data can be used in environmental assessments of building materials, products and assemblies [12]. Specific data represent data coming from one plant of one manufacturer. Average data are either data measured in several plants of one manufacturer or data coming from several manufacturers.

Each national EPD programs (e.g. both German and French) allow for two types of data: single manufacturer and group of manufacturers. These data are provided by the manufacturers that sold products on national markets. Depending on the size and the number of manufacturers, the EPD can be more or less specific. On the other hand, a generic data should be representative of the total production of one material (e.g. concrete, rock wool) for the chosen geographical area, technology and time scale.

Regarding the building design process stages, specific data of one manufacturer should normally be used mainly during the detailed design stage (when the types of products are known), while generic or average data should be kept for the first conceptual stages. The specific data are currently covered by a growing number of EPD in different countries. For example, in France, both single and group of manufacturers EPD are available. As a result, it is now possible to determine generic data based on EPD averaging to be used in early design stages.

2.2 Use of average country-specific or European EPD of building materials (option 1)

A first option is to use the EPD provided by the building industry. An EPD is developed according to a product category rules (PCR) methodology according to ISO 14025 [10], which ensure unified and comparable results in an EPD database. The EPD are

representatives of the building materials and products that are actually sold on a national market. Figure 2 presents the different types of EPD that can be considered as generic data for each building material. The two first types of data are based on the French EPD program according to the NF P01-010 standard [13] but are also valid other European EPD programs e.g. the German EPD program. The single manufacturer's EPD represents only one product from one manufacturer (with possible average of production sites). The group of manufacturers' EPD represents a mean product for which process data are averaged based on production volumes or market shares for at least two manufacturers. The two last ones (average and generic EPD) are defined for the purpose of this study. The average EPD can be calculated as arithmetic or weighted mean (based on production volumes or market shares covered by each EPD) of the existing EPD. The generic data could be based on individual, joint or average EPD. It should be representative of all the products that is available at the market. However, in practice, the average EPD for a given building product may most probably not cover 100% of the market share to date. As a result, the circles are not confused to illustrate the fact that the generic data has to be extrapolated from single, group of manufacturer's or average EPD. In some cases, some families of products may be covered only by a few country-specific EPD (or even no EPD at all), so that the representativeness of the average EPD assumed to represent a generic data may be poor. An alternative option is to use other generic LCA data taken from European databases.

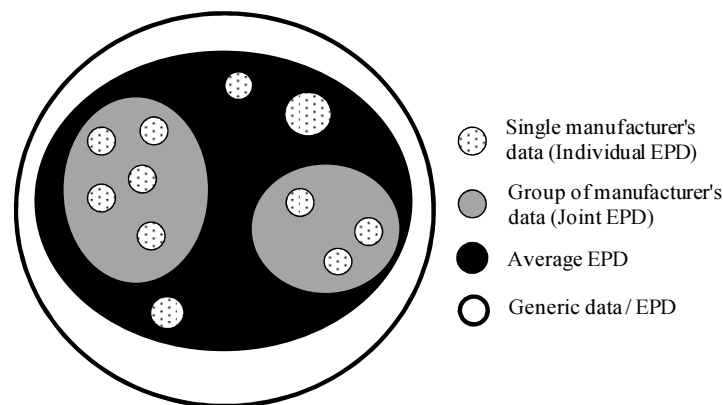


Figure 2: Relation between the different types of EPD data for each building material

2.3 Use of country-specific or European generic data of building materials (option 2)

The use of existing generic LCA data is the second option of the guidelines. For instance, the Ecoinvent database is sometimes used to assess the environmental impacts of buildings due to the lack of national generic LCA data. This database contains generic data from different sources adjusted using the same methodology to create a unified database. This can happen e.g. when no EPD are available for a given building material or if the plausibility of the average EPD previously calculated needs to be checked.

The main advantage with unit process generic databases (e.g. Ecoinvent) is to be able to modify the key parameters for the national context e.g. energy mix, technological parameters, transportation distances, waste treatment processes [14]. However, some of the information may require additional expert knowledge e.g. share of imported and locally produced building materials. In most cases, the generic data may be used as it is. It is then very important to be

able to qualify both existing generic LCA data and average EPD depending on each national context.

2.4 Data quality assessment (representativeness and consistency)

All LCA data need to be described by means of meta data which includes all the relevant information that can help the practitioner to select appropriate and good quality data for a given context. The key requirements stated in [12] should be used to qualify the data that is used as generic data for a national context: completeness, reliability, temporal, geographical and technological representativeness. The completeness check ensures that the data covers sufficient production volumes or market shares. Other aspects refer to the consistency criteria (quality of the methodology). For example, if a data does not comply in terms of system boundaries or allocation rules, this aspect will be taken into account in the consistency check. These representativeness and consistency assessments are proposed to be finally aggregated into a data quality indicator (DQI), adapted from the criteria given e.g. in [12] or in [15]. The DQI is used to inform the practitioner that the generic LCA or EPD data may not comply with all the criteria fulfilling a generic LCA data for a national context.

2.5 Comparison of LCI and LCIA indicators and variability assessment

In addition, comparative analyses of LCI and LCIA indicators in the case where more than one data can be used are proposed based on a previous work [8]. In the case of EPD, the average EPD may display a standard deviation showing the industry variability that can reflect the different uses of the material but also the different processes used by the producers.

3. CASE STUDY FOR THE GLASS WOOL IN THE FRENCH CONTEXT

3.1 Datasets under study

In France, the EPD database INIES [4] contains already around 700 single or group of manufacturer's EPD which already cover 5000 commercial references of building products available in the French market. Some families of products are well documented. This can now lead to the determination of an average EPD. The following case study aims at showing the practical implementation of the methodology presented in section 2. It covers the existing LCA data of glass wool products available in the French LCA tools for buildings. The LCI and LCIA values of glass wool were taken from the data analysis tool developed by [8][16]. Four different datasets for glass wool were determined for the purpose of the case study (see table 1). The average EPD was calculated at the basis of 80 single manufacturer EPDs of glass wool products for the production stage ("cradle-to-gate"). In addition, the Ecoinvent data, used in one of the French LCA software for buildings, was included to make a comparison between the two kinds of data.

3.2 Analysis of both the generic LCA and the different EPD for glass wool

This sub-section is an application of sub-sections 2.2 to 2.5 of the methodology. The main issue was to determine whether the different average EPDs or Ecoinvent data approach more levels of representativeness of a generic data for the French context. This issue depends very much on the percentage of market shares covered by the EPD of the different producers. Unfortunately, the EPD provides publicly neither this value nor production volumes. This parameter is generally kept confidential and is not publicly available in the French EPD

database. In this study, the following assumptions were made: 80 single manufacturer’s EPD of glass wool products taken from four major producers in France were used; each EPD is assumed to have the same market share (leading to an arithmetical mean); more thermal insulation than acoustical insulation products are covered by an EPD. Figure 3 plots the different datasets according to their type.

Table 1: Datasets under study

Datasets under study	Data sources and assumptions
Average EPD by producer	80 EPDs were divided into 4 groups according to their producers. Arithmetic mean of LCI and LCIA from all EPDs from each group was then made.
Average EPD by use	80 EPDs were divided into 2 groups according to their use in a building – thermal or acoustical insulation. Arithmetic mean of LCI and LCIA from all EPDs from each group was then made.
Average EPD (global)	Arithmetic mean of LCI and LCIA from all 80 individual French EPDs for glass wool was made.
Generic LCA data	Generic dataset for glass wool from a generic database available in Europe (Ecoinvent version 2.0)

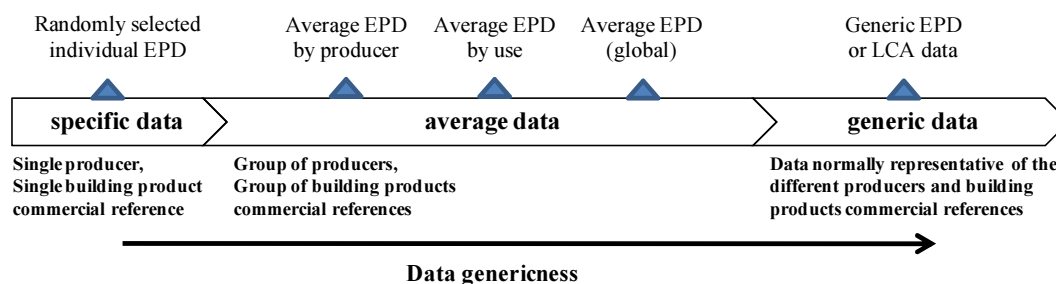


Figure 3: Levels of aggregation of the different types of EPD under study

The information in figure 3 shows that a randomly selected individual EPD that represents a single producer and a single commercial reference is the least level of data genericness. Then, the averaging of EPD leads to increasing the genericness of the data. Average per producer (between 9 and 25 products), per application (between 25 and 55 products) or a global average (for all the glass wool products) can be calculated. The last data in the right shows a generic EPD or a LCA data. It can be approximate by the average EPD or by the generic Ecoinvent data. However, the Ecoinvent is found to be calculated using data from only one production site and one manufacturer. Thus, the Ecoinvent is assumed to be first a specific data that was extrapolated to a generic data. Reasons for this extrapolation are probably the size of the producer and the size of the plant.

The meta data comparison of generic Ecoinvent dataset and average EPD by producer was then deepen to find out their representativeness for the French context. Findings from the meta data comparison revealed that the data from the average French EPD is much better to

use under French conditions than the Ecoinvent data (regarding the data quality requirements of CEN/TR 15941 [12]). The main results of the data quality criteria are: assumed good completeness for the French EPD (four producers to be compared to only one in Ecoinvent); high reliability based on industry data including the major producers that sold on the French market (to be compared to only one producer in the Ecoinvent data); appropriate time-related coverage (not older than 6 years to be compared to the reference year 1993 in Ecoinvent); appropriate geographical coverage (French technology mix to compared to a Swiss coverage for Ecoinvent); appropriate technology coverage (technology representative of the products sold in France to be compared to Swiss technology including a Swiss grid mix). More than 75% of the EPD were critically third-party reviewed whereas in Ecoinvent, an internal critical review is done for the glass wool dataset.

The values of several environmental indicators (primary energy, water consumption, abiotic depletion, global warming potential, waste, etc.) were compared for all the datasets, which could possibly represent the generic data for the production of glass wool. For instance, the total primary energy indicator is presented in figure 4. As the average data are based on single manufacturer's EPD, the dispersion of these EPD is also part of the figure 4 to show their variability. The declared unit of 1 kg was chosen to represent the data. Differences in the average EPDs are observed among the different producers and uses. The results of figure 4 may lead to have not only one generic data for this type of material, but for instance two generic data – one for thermal insulation and one for acoustical insulation. It would be also possible to have a generic data for each producer. But this option remains a tricky issue mainly because during the conceptual stage the producers of materials are not known.

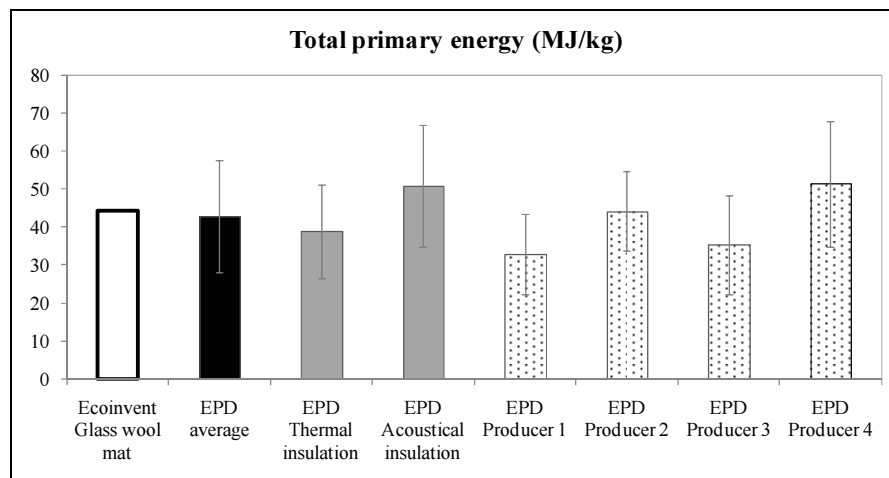


Figure 4: Comparison of primary energy indicator for the different datasets of glass wool

The deviations of the environmental indicators of the averaged EPD are then rather an advantage, because the generic data will cover the variability of the single manufacturer's processes that sold their building materials on the French market. These variabilities may be explained by different technologies used for the production of glass wool depending of the producer but also on the application. The Ecoinvent data was then found pretty similar for the total primary energy and global warming potential, even if, according to the meta data, its representativeness is weak for the French context. Biggest differences were reported for the

dangerous waste and water consumption indicators. However, a deeper investigation of the sources of these differences was not a part of this study.

4. DISCUSSION

4.1 Discussion of the methodology applied to glass wool products

The meta data comparison has shown that even if the EPD are assumed to be more representatives of a national context, some key parameters such as the percentage of market shares or the included processes are missing because this information is not mandatory to be publicly available in the Product Category Rules (PCR) of the French EPD. They should be made available in the future especially if a generic data on the glass wool product is to be released for the French context. As the global average EPD covers around 80 glass wool products sold on the French market, the assumption can be made, that it represents a large part of total production volume in France, even if is not precisely known. Concerning the dispersion of the average and specific data per producer and use, it was concluded that in this way the variability of the products is covered. It is strength of the average EPD when compared to a single generic data from Ecoinvent. Indeed, the generic data from Ecoinvent represent only one production plant from one producer thus the robustness of the generic data may be less than for the calculated average EPD.

4.2 Recommendations when determining a generic data for a national context

The results of the case study also question the type of generic data: does it have to represent a building product according to its use in a building? Whatever the type of generic data, they are useful to cover the needs of practitioners in e.g. simplified building assessments or in early design stages. When both Ecoinvent and several EPD data exist for a same building material in a national context (e.g. in France), the average EPD is better to use for an early design assessment, because it is consistent with more detailed assessment that will be done later by means of single manufacturer's EPD. However, more case studies should be done regarding different situations where for instance only a few or only one EPD exist for one material. In some cases, where no EPD exists, the use of existing generic data will be the only option. Data quality indicators are thus needed for each generic data to inform the practitioner that it is a proxy data (e.g. consistency and representativeness may not be fulfilled at each time). As a result, future works such now qualify the different data to determine the ones that are the more convenient for a generic LCA database for a national context (e.g. in France). It will ensure the determination of robust generic data on building materials and products being both consistent from a LCA point of view and representative from a technological, temporal, geographical and completeness point of view. The variability of average EPD should also be analyzed into more details to explain this new feature when comparing it to the generic data from Ecoinvent (that do not include such an industrial variability).

5. CONCLUSION

The study has provided some guidelines to the practitioners in a view of adapting existing data (generic or EPD) to determine generic data for a national context and for different objectives (simplified LCA, early design assessment). The importance of meta data analysis was highlighted in the case study of glass wool products. Average EPD for glass wool can

very well represent the generic data for the French context, instead of the Swiss Ecoinvent proxy data. However, more analyses will be needed to find out how to select and determine the most appropriate generic data for other building materials by ensuring both consistency and representativeness of the generic database. New LCA studies to determine generic data are in parallel highly needed for each national context to improve the representativeness of the LCA studies of buildings.

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