DEVELOPING NATIONAL DATABASE OF ENVIRONMENTAL IMPACTS OF BUILDING PRODUCTS IN CZECH REPUBLIC

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Summary

Envimat.cz is an online catalogue of environmental profiles of building materials and structures localized for the Czech Republic. It allows users to compare, model and edit elements of buildings and calculate environmental profiles thereof. It helps architects and designers to choose appropriate materials for their building based on their environmental impacts. Initial dataset is derived from generic database but the goal is to continuously replace them with more accurate, localized data from Czech local Environmental Product Declarations. Envimat.cz brings multiple benefits for the sustainable building stakeholders: it gives clear information to the building owners; architects and students can easily choose environment-friendly options for their projects; producers with lower environmental impacts compared to competitors get marketing advantage and Czech construction practice as a whole is being shifted to higher environmental standard.

Keywords: environmental impact, building product, life cycle assessment, national context, environmental product declaration, national database, SBTool, building sustainability assessment

1 Introduction

1.1 Background

Global civilization starts to be challenged by stress on primary materials, fossil fuels and damage of the environment. To face the challenge, it is necessary to have detailed knowledge of the environmental impacts of human activities. In the construction industry tools to figure out the real impacts of built environment are needed.

1.2 Buildings – product level matters

In recent years technical design of buildings has significantly improved. This led to a sound reduction of environmental impact during the operational stage of buildings' life cycle. The most important impacts are represented especially by energy consumption, atmospheric emissions and solid waste, but also by depletion of non-renewable sources of raw materials and water consumption during the production phase of materials.

Impacts of building elements' production and assembly has not been significant so far, but several case studies showed that the ratio between operational impacts and production and construction impacts has approximately quadrupled over the last 80 years. It means the production stage of the building matters and the importance is expected to grow as energy and water consumption standards get tighter.

1.3 Life cycle assessment

The basic methodology for evaluation of environmental impact of buildings is generally Life Cycle Assessment (LCA). The methodology is applicable to any product or process of human activity, including construction materials and works and also operation, refurbishment and demolition or reuse of the building and its components. Most of currently used methods for environmental quality assessment of building are based on LCA. They differ primarily by chosen system boundaries, data resources and time of data acquisition (Hodková et al. 2011).

1.4 System boundaries

This approach uses the system boundaries "Cradle to Grave", which includes all product life cycle stages from extraction of primary raw materials, through production, transport, application, use and final disposal. More recently, even a "Cradle to Cradle" approach appears, which means a closed life cycle of products including their recycling.

On the other hand, most important phase of building life cycle in which extent of building's impacts on the environment, depletion of materials and consumption of primary are decided in design stage.

At the same moment the scenarios of use of all building components are fixed. When assessing a building, we do not need LCA of all components on "Cradle to Cradle" basis, because it would be too complicated to analyze all the scenarios that have been implied when analyzing separate products. It is more practical and transparent to have all data from "Cradle to Gate" (plus transport on site) phases gathered in a standard format and use them as input for building LCA with the scenario of use of the real building.

1.5 Environmental product declarations

Several ways of communication products' impacts on the environment and resource depletion have been developed. For voluntary certification of products in building industry Environmental Product Declaration (EPD) is common.

The EPD is defined as "quantified environmental data for a product with pre-set categories of parameters based on the ISO 14040 series of standards, but not excluding additional environmental information" [2]. It presents energy and water consumption, waste production, impact on climate change, eutrophication, destruction of the ozone layer, etc. throughout the life cycle.

In the EPD method every product is included in a category defined by its character and function and has clearly established the so-called product category rules (PCR), i.e. a set of required parameters with defined system boundaries that has to be evaluated in order to maintain the comparability of the results. The PCR are elaborated by professional organizations and international review process is applied.

The main principles of EPDs are objectivity, credibility, neutrality, comparability and universality. This is achieved by processing the EPD by an independent organization according to prescribed PCR. The EPD document containing this information must be publicly accessible and the data contained therein must be verifiable [3].

It is important to understand that being labelled by EPD does not mean the product is "ecological" or "green". EPD only enables companies to show the environmental performance of their products in a credible and understandable way meaning the manufacturer provided standardized set of data enabling comparability to alternative products according to planned function of the evaluated product.

For end customers and consumers, the EPD represents a credible document that allows them to choose the most suitable product. EPDs are elaborated according to unified international methodology, the parameters of the products of the same type from different parts of the world are comparable which can be an advantage for manufacturers, since the declaration of their products are accepted worldwide.

1.6 Existing product databases and development of national database

Most of currently used methods for environmental quality assessment of building are based on LCA. They differ primarily by chosen system boundaries, data resources and time of data acquisition [4]. The LCA data are gathered in several existing databases, for instance: Gabi, Ecoinvent, KBOB, IBO Baustoffdatenbank, INIES, ICE, Ökobau.dat IBU, DGNB Navigator, etc. [5]. Several studies [6] showed that for obtaining relevant information applicable to local construction market, it is not possible to combine data from various databases. Therefore a project called Envimat with objective of founding a free database of environmental impacts of building products for the Czech Republic was initiated in 2010.

2 Methods

2.1 Setting objectives

Several schemes of operation of the existing tools and databases have been taken into account. Based on analysis, the following list of objectives has been composed:

- To create a localized database of building materials and products listing the main sustainability indicators based on environmental product declarations (EPDs);
- To provide transparent and reliable system that helps to analyze differences among products and helps with decision-making process;
- To motivate architects and designers to care about LCA profiles of materials;
- To give advantage to products having lower environmental impacts than others.
- To motivate the producers to provide data sets of their products;
- To provide data needed for LCA of buildings and LCA-based certification schemes like SBToolCZ and others;
- To give supporting information for LCA of students’ projects;
- To increase public awareness of externalities resulting from production of building materials and components.

2.2 Target groups

The main target groups of Envimat.cz have been identified: architects and designers; sustainable building certification schemes users and auditors; developers; producers of building materials and components; consultants and sustainability experts; and students.

The intention was not only to give raw data to the users, but also provide them with sufficient information and background knowledge needed to better understand life cycle analysis, meaning of the data obtained from the application and show methods of using it in a proper way.

3 Results

3.1 Database

Envimat.cz allows users to easily compare, model and edit elements of buildings and calculate environmental profiles thereof. The system is fully compatible with SBToolCZ, the Czech national sustainable building certification system [7]. The structure of provided information is in the Table 2 and Table 3.

Tab. 1 *Parameters of materials in Envimat.cz*

Parameter	Unit
Primary energy input	MJ/kg
Global warming potential	kg CO_2,eq./kg
Acidification potential	g SO_2,eq./kg
Eutrophication potential	g NO_x,eq./kg
Ozone depletion potential	g CFC-11eq./kg
Photochemical ozone creation potential	C_2H_4,eq./kg
Specific weight	kg/m^3
Thermal conductivity	W/mK

Tab. 2 *Parameters of structures in Envimat.cz*

Parameter	Unit
Primary energy input	MJ/m^2
Global warming potential	kg CO_2,eq./m^2
Acidification potential	g SO_2,eq./m^2
Eutrophication potential	g NO_x,eq./m^2
Ozone depletion potential	g CFC-11eq./m^2
Photochemical ozone creation potential	g C_2H_4,eq./m^2
Specific weight	kg/m^3
Thermal conductivity	W/mK
Thickness	mm
Specific weight	kg/m^3
Surface mass density	kg/m^2
Price*	CZK/m^2
Sound reduction index Rw*	dB
Heat transfer coefficient	W/m^{2}K

* Included when available

When starting the database in the Czech Republic, sufficient data to cover all the main categories of building products was not available. Therefore the project was divided into the three phases: Start-up phase; transitional phase; and regular operation.

Start-up phase was the initial one when any data from Czech EPDs were not available. Data for the most common materials and constructions from international databases were used instead; generic datasets were calculated for cradle-to-gate phases.

In the transitional phase generic datasets are presented together with local EPDs from manufacturers. The two types of items are in the application graphically distinguished according to the data sources to eliminate any possible confusion.

Czech local data for the main product categories will continually replace the generic data. Once there are local data for all of the main product categories, generic items will be completely removed from the database. Only local data will be presented to the users and the transition process will enter the final phase of regular operation.

3.2 Integration with SBToolCZ

SBToolCZ is a sustainable building certification system developed from generic SBTool provided by the International Initiative for a Sustainable Built Environment (iiSBE). The certification scheme for residential buildings was introduced in 2010 and certification for offices followed in 2011. SBToolCZ provides a localized tool in full harmonization with Czech national and also European standards. Assessment criteria and their weights have been set by the national panel of experts consisting from experts of different fields of expertise. The certification methodology is being developed at the Czech Technical University in Prague, Faculty of Civil Engineering that also provides courses for auditors and wide public [8].

The certification process is operated by the National Platform SBToolCZ, which has been founded in December 2011 by Technical and Test Institute for Construction Prague (member of SB Alliance), Czech Building Research Institute and Sustainable Building Centre at the Faculty of Civil Engineering, Czech Technical University in Prague.

SBToolCZ for residential buildings [3] has 33 criteria (12 environmental, 11 social, 4 economical and 6 related to site location). Assessment of the environmental criteria is LCA-based and data input from databases of building materials and components is needed. It is used in the six criteria:

- Global warming potential;
- Acidification potential;
- Photochemical ozone creation potential;
- Primary energy consumption;
- Ozone depletion potential;
- Eutrophication potential.

Summarized values for embodied impacts of all building components are combined with the operational values calculated at the building level. Implementation into assessment methodology for office buildings works similarly.

3.3 Curricula implementation

Czech Technical University in Prague provides two master’s degree study programs related to sustainable building:

- *Intelligent Buildings*, provided in cooperation of Faculties of Civil Engineering, Mechanical Engineering and Electrical Engineering;
- *Buildings and Environment* at the Faculty of Civil Engineering.

Curricula of both listed study programs include lessons in LCA and hands-on exercise with Envimat.cz. Students are qualified for special discounted fees in Envimat.cz training courses for professionals.

4 Conclusions

Envimat.cz provides a hub for producers of building materials and components who care about environ-mental impacts of their activities and are bold enough to share their data with wide public and construction professionals.

Architects, designers and consultants have comfortable interface that enables them to select appropriate products for their projects. They can model their own structures from materials and other elements included in the database and see impacts of their choices on the environment. Auditors of sustainable building certification schemes have a new source of information and database of Czech EPDs of building products. Students and sustainability experts obtain data that can be used for optimization of their projects incorporating life cycle analysis.

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