The CAP'EM project: providing scientifically sound information on environmental and health impacts of construction materials, based on a common LCA methodology across 5 European countries

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Abstract Whilst the building industry and the general public understand the importance of energy efficiency, the environmental impacts of the building materials we use remain less well known. The CAP'EM project aims to increase the manufacture, distribution and use of eco-materials in the building industry of North West Europe (NWE), by allowing impartial and comprehensive demonstration of their benefits. A key hurdle is overcoming differences in regional and national approaches to how we define, evaluate and promote eco-materials. This paper describes the Life Cycle Assessment (LCA) method developed by the CAP'EM Partners, the challenges in evaluating 100 building materials manufactured by small businesses, the web-based tool for sharing results and the first results of the assessments.

1 Introduction

Sustainable buildings are the fabric of sustainable lifestyles. Whilst the building industry and the general public understand the importance of energy efficiency, the environmental impacts of the building materials we use remain less well known. For an average home, construction can represent around 30% of the overall greenhouse gas emissions. For an energy efficient home, the embodied energy in the construction can represent more than 75 years of heating in equivalent energy [1]. An answer to reducing this is using appropriate "ecological" building materials.

2 The Project

The €8.5 million CAP'EM project brings together partners across five countries with a wide range of expertise to increase the manufacture, distribution and use of eco-materials in the building industry of North West Europe (NWE). Cd2e, the expert center for eco-enterprise development in Northern France is the lead partner, and VIBE (BE), GreenSpec (UK), Agrôdome (NL), HWK Münster (G) and Globe 21 (FR) have all contributed to the development of a shared Life Cycle Assessment (LCA) methodology for evaluating the environmental impacts of building materials. The project partners have been guided by Dr Andrew Norton of Renuables (UK) to develop the LCA method.

The CAP'EM method uses a transparent spreadsheet format as the calculating system and mixture of bespoke and Ecoinvent secondary data to calculate impacts from "cradle to gate". Results for over 100 building materials will be available on-line, where, via an innovative Graphical User Interface (GUI), end users will be able to calculate and compare the impacts of different materials delivered to their own building site. Throughout 2011, the method will be applied to 100 construction materials, and the results will be freely available on the internet.

In addition to the online database, a network of eight exhibition centers will be established to demonstrate the use of eco-materials, both in new build and renovation. The majority of these centers are being developed within the context of a significant new build or renovation project using eco-construction techniques. This is intended to raise awareness among building professionals and increase demand for eco-materials.

3 The CAP'EM Method

Although all are specialists in eco-materials, the six partner organizations that developed the method have very different skill sets. It was therefore essential to develop a method that all could use without having extensive experience with LCA software. A balance was also required to create a credible method that follows established methodology and captures all major impacts, but that could be applied 100 materials without it being too costly or time consuming.

The ISO 14040 series of standards were followed in regards to “LCA thinking”. The whole project was considered as one large comparative study with its own requirements for setting system boundaries and comparative ruling. It was also essential to develop simple and complete instructions to ensure that results generated by different practitioners are truly comparable.

To develop the product category rules, system boundaries and other assumptions to ensure that all products assessed using the CAP’EM approach are comparable, we have reviewed:

- the draft product category rules released from the CEN TC 350 working group, and
- the assessment method developed by IBO (ATDE), used in the Naturep Plus assessment.

Whilst we have endeavored to be consistent with both approaches, they are both insufficient in themselves to achieve CAP’EM’s objectives. The CEN TC 350 product rules are too incomplete to apply in the short term, and the Nature Plus methodology is not sufficiently transparent and accessible for a project of this scale with so many assessing partners, and requires bespoke software.

A method was thus developed that was based on the familiar platform of Microsoft Excel whereby all aspects of a material’s assessment are captured in one workbook file. This includes; guidance notes for the practitioner, all general and technical data regarding the material and its performance, a flow chart of production, the raw questionnaire data, a summary of this data in a descriptive unit format (usually per kg), the emission factors used and the final results of the calculations. All this is presented in a way that allows the GUI to access the data required by an end user, as well as providing the manufacturer with a marginal analysis breakdown of where their impacts originate.

Separating the technical emission factor calculations (i.e. SimaPro based work) from the more straight forward data collection and final calculations means that all the information is presented transparently in a file format that does not require access to bespoke software.
This facilitates:

- active participation from partners less familiar with SimaPro,
- critical review by the project partners, and
- presentation of complete results to the manufacturers, including a marginal analysis breakdown of where their impacts originate,

Many of the products assessed use the same country specific energy sources and even raw materials. Calculations for later products were thus speeded up by creating a database of the emission factors for these inputs.

A standard data sheet with LCA data displayed alongside other technical and sustainability data will be produced, providing data for EPDs or possibly becoming an EPD format itself. The most ambitious component of the method however, is the GUI, where the impacts of the products are presented in a way that is particular to the user, based on address and final delivery transport mode. The GUI will also allow their own functional unit to be used to allow a fair comparison of materials, which has not been defined or influenced by others.

It was felt important the project not to influence this comparison, e.g. by presenting data in set functional units or by normalizing or ranking the results. Instead the project provides guidance as to what the impact categories and data means so that the user can chose the correct material for their own building project. By selecting the impact categories, technical performances, or sustainability indicators that matter to them, the GUI in effect allows the end-user to define their own eco material.

A summary of the CAP'EM method and its interaction with the manufacturer of the material through to the end user of the CAP'EM data is shown in Figure 1.

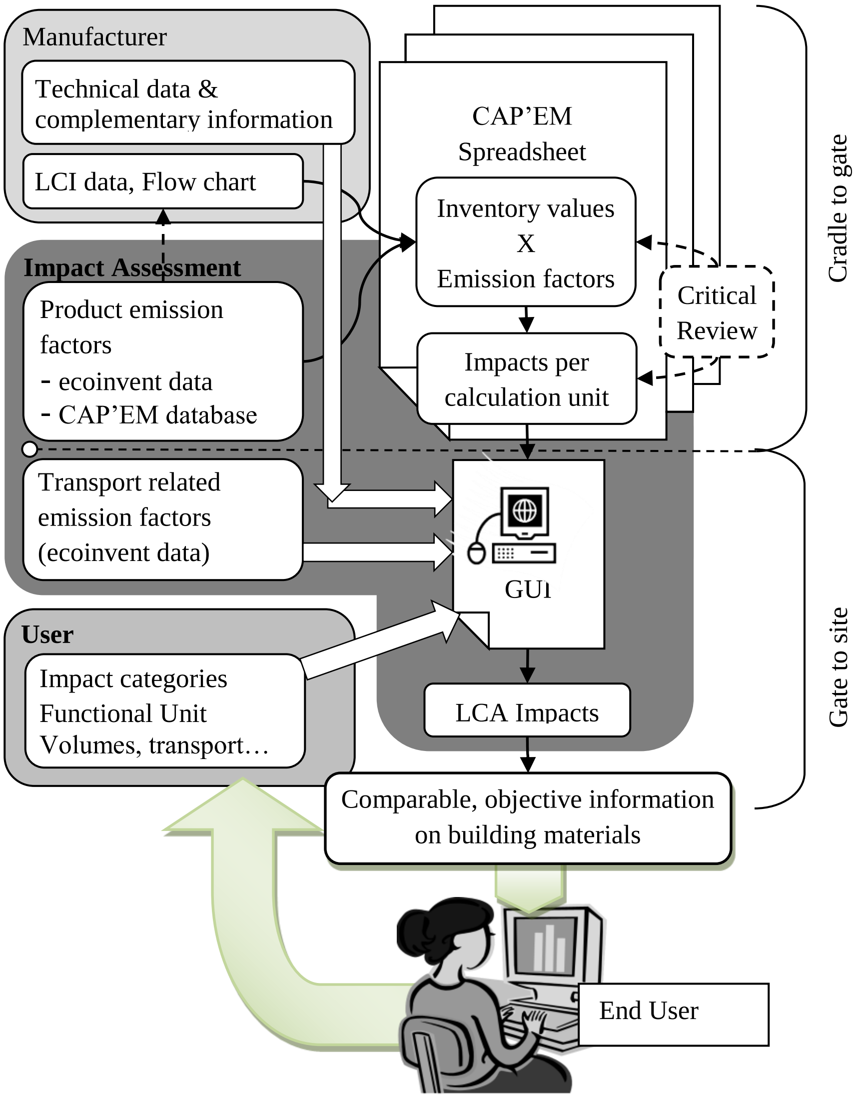

Fig.1: Summary of the CAP'EM Method

4 Project Progress

In the first work package of the CAP’EM project a general method was tested with 30 materials in order to develop the method template, system boundaries, data usage, and general rules so it can be used in the testing of the final 70+ products.
The transparent nature of the workbooks means that the CAP’EM evaluations have been easy to review and to learn from. It also means the calculations can easily be used as part of other assessments (such as natureplus) at a reduced cost to the manufacturer.

An essential element of the analyses is the factory visits, which are translated into flowcharts of the manufacturing process. This helps the practitioner to develop a thorough questionnaire based on a robust understanding of the production, hence reducing overall assessment time due to less corrections and confirmation correspondences.

Marginal analyses have been well received by manufacturers and reviewers to prioritize efforts in reducing impacts and checking calculations respectively.

As many of the materials where bio-derived the issue of carbon sequestration had to be considered and is likely to be displayed as both quantity of CO2 “stored” along with the overall impact of the material.

5 Initial Results

As the method is still being refined, it is not yet possible to communicate finalized results with product names. We are, however, able to start comparing different materials and understanding what the key issues are in regard to their impacts.

One such example is a comparison between two blocks considered as ecological alternatives to traditional concrete: lightweight concrete blocks and pumice blocks, shown in Figure 2.

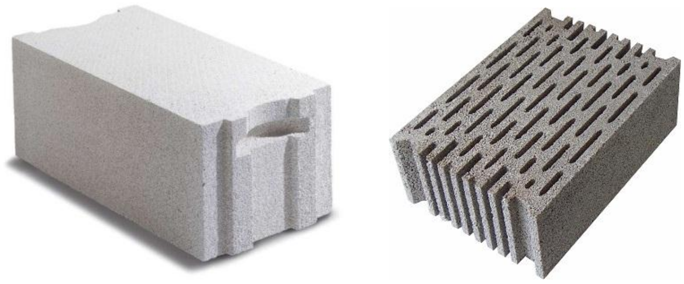

Fig.2: **Which block is best? Lightweight concrete (left) or pumice (right)**

These products are used in both internal and external walls or as infill blocks in beam and block flooring. Their main advantage over traditional concrete blocks comes from a combination of higher insulating properties and a lighter unit weight. The lighter block enables time and material cost savings through easier handling and larger units [2]. The pumice stone block has an additional advantage in that its production requires far less energy.

The cradle to gate results, shown in Figure 3, show that the pumice block has less environmental impact than the lightweight aggregate in most impact categories. The functional unit chosen to compare the results here is a thermal resistance (R value) of 2.63; that is that both blocks have the same level of insulation. When the data is available in the GUI, the end user will be able to define their own functional unit, for example the thickness of the wall.

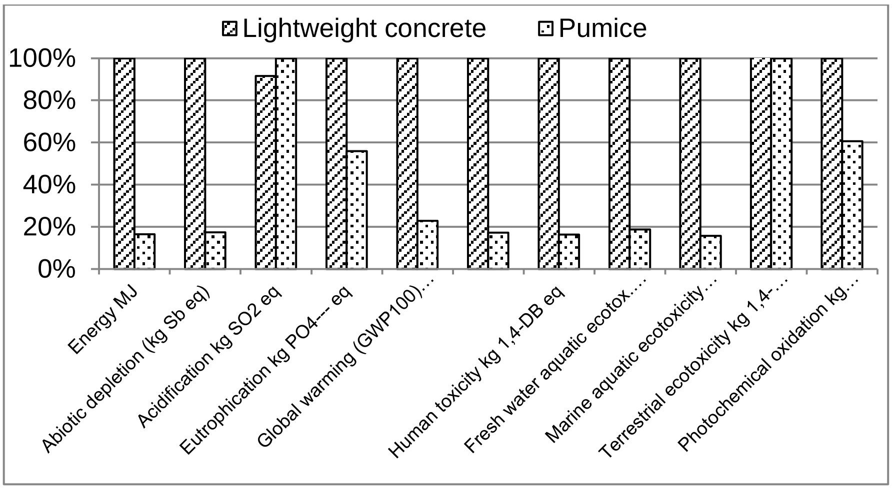

Fig.3: **Cradle to Gate analysis, R=2.63, CML 2002**

When we take transport to the work site into account, the impacts change considerably, as shown in Figures 4 and 5, below.

In Scenario 1 (Figure 4), the building site is 40 km from the pumice factory and 100km from the lightweight concrete factory. As expected, the pumice block still has less impact than the lightweight concrete, but for indicators such as Energy, the difference is less pronounced as the transport phase (rather than the production phase) dominates the impact.

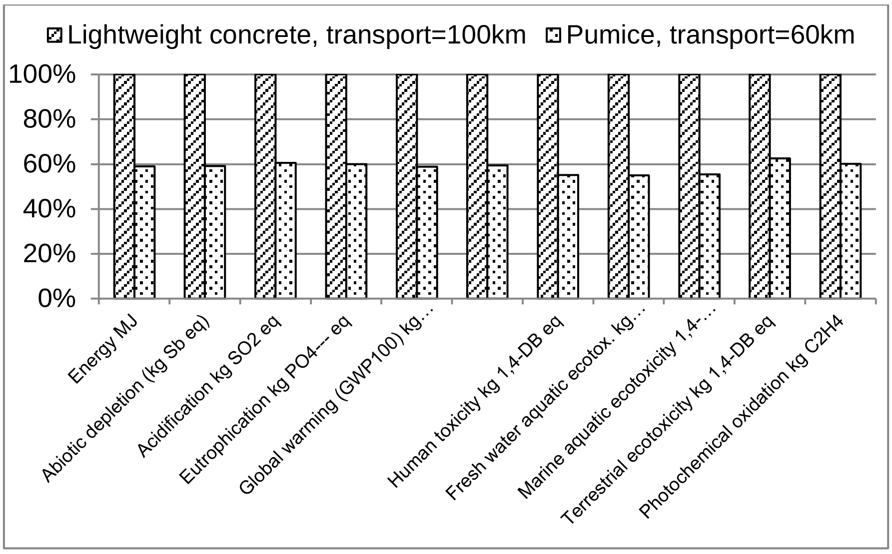

Fig.4: Cradle to Site analysis, scenario 1 (R=2.63, CML 2002)

In Scenario 2 (Figure 5), the transport distances are inversed, so that the building site is 40 km from the lightweight concrete factory and 100 km from the pumice factory. This distance is sufficient to overturn the result, with the pumice stone having a larger environmental impact across all categories.

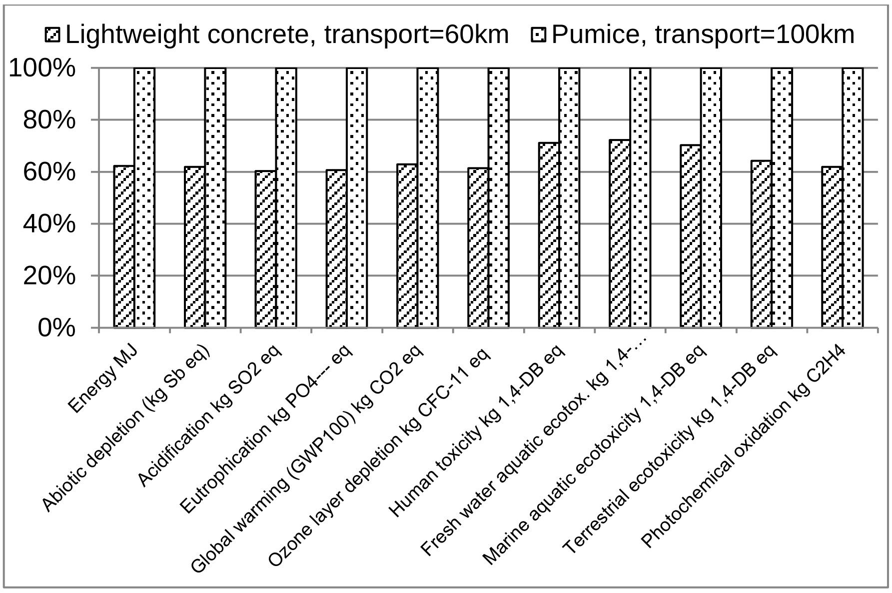

Fig.3: Cradle to Site analysis, scenario 2 (R=2.63, CML 2002)

This demonstrates the importance of the GUI in interpreting the final results. Whilst à priori the pumice stone is the more "ecological" building material, the location of the building site is an extremely important factor in choosing this type of material.

A real definition of an ecological block may simply be the block that is most local. This will not be the case for materials such as paints, for which the chemical constituents will certainly be the main factor for environmental performance.

It is important to note that final results will not be presented to the end user as shown in this paper. The number of indicators will certainly be reduced and at all times the LCA results will be shown alongside complementary information including the technical performance of the material, potential health impacts, social impacts, natural material content and recycling.

6 Conclusions

The ambitions of the project to create a unified data source and data sheet template for technical and sustainability information have been well received by potential end users who do not want to be influenced by others' weighting ideology or ranking system. These have been criticized as promoting "business as usual" rather than innovation, as well as a potential barrier to trade for materials that do not fit into individual assessment groups (e.g. dual purpose materials). As such, it is hoped that this transparent method will increase the market share of genuine eco-materials as well as drive improvements, both technically and sustainably, thus promoting appropriate design and reducing the impact of the building sector.

7 Acknowledgement

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8 References

[1] Extrapolated using data from Lutz, Conrad, Construction, écologie et impact environnemental, Cercle "Politique et Economie", Seedorf, 15 mai 2008.

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