BeGlobal

Presentation & Methodology

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ABBREVIATIONS

ACV: Life Cycle Analysis [LCA]

ART: **A**groscope de **R**eckenholz-**T**änikon – Research Station

a.s.b.l: Non-Profit Association

DHW: **D**omestic **H**ot **W**ater

EMPA: Federal laboratory for materials testing and research

EPD: **E**nvironmental **P**roduct **D**eclaration

EPFL: **E**cole **P**olytechnique **F**édérale de **L**ausanne *(Lausanne Federal Technical Institute of Higher Education)*

ETHZ: **E**cole **P**olytechnique **F**édérale de **Z**urich *(Zurich Federal Technical Institute of Higher Education)*

GWP: **G**lobal **W**arming **P**otential

KBOB: **K**oordinationskonferenz der **B**au- und Liegenschaftsorgane der **ö**ffentlichen **B**auherren
(Public Constructors construction and building services co-ordinating conference)

IBO: **Ö**sterreichisches **I**nstitut für **B**aubiologie und -ökologie *(Austrian institute for eco-construction)*

IPB: **I**nteressengemeinschaft **p**rivater professioneller **B**auherren
(Private professional constructors interest group)

IPCC: **I**ntergovernmental **P**anel on **C**limate **C**hange

PHI: **P**assiv**ha**us **I**nstitut

PHP: **P**assief**h**uis **P**latform v.z.w.

PHPP: **P**assiv**h**aus **P**rojectierungs **P**akket

PMP: **P**lateforme **M**aison **P**assive a.s.b.l.

PSI: **P**aul **S**cherrer **I**nstitute

CONTENTS

1 INTRODUCTION

The concept of the "passive house" is not a new one; the term was first coined in the early 1990s by Professor Wolfgang Feist. In the 1980s, low-energy houses were already the standard for new building in Sweden and Denmark.

According to the Passivhaus Institut (PHI), a passive house is a building that achieves a comfortable ambient temperature without the use of conventional heating in Winter and without air-conditioning in Summer (GROBE, 2008).

In Belgium, 3 criteria have to be respected for passive residential construction: the annual energy requirements for heating must be less than or equal to 15 kWh/(m².y), the air renewal rate at a pressure of 50 Pa must be less than or equal to 0.6 h^{-1}, and the percentage of excess heating (over 25°C) must be less than or equal to 5%. A fourth criterion will shortly be added to the 3 current ones: this is going to set a limit for primary energy requirements.

The trend towards passive building is constantly growing. Belgium presently has over 130 certified passive buildings. Moreover, a great many passive projects are underway: residential and tertiary sector buildings, currently being built or renovated.

Through the granting of various subsidies, the Belgian authorities are currently operating a policy of encouraging passive, very low- and low-energy, or even "zero-energy" construction and renovation. In this context, the PMP (Plateforme Maison Passive a.s.b.l.) and the PHP (Passiefhuis Platform v.z.w.) are playing an important role, since it is they who issue the "Passive Building" certificates.

Against a background of growing developments in energy requirements in Belgium and in Europe, PMP a.s.b.l. sought to develop a tool for calculating a building's energy and greenhouse gas emissions profiles.

This new tool, intended particularly for architects and consulting engineers, makes it possible to offer users new information concerning two environmental impact indicators: the overall energy profile of a building and its greenhouse gas emissions. Here we are producing an environmental report on the building, which corresponds to the first two steps in the life cycle analysis: defining the objectives and the scope of the study, and analysing the inventory.

Why "BeGlobal"? "Be" because it is a Belgian project and "global" because it performs a calculation of the building as a whole.

Here is the detailed methodology for the BeGlobal project. It is presented in several sections. After setting out the objectives of the project and briefly defining the PHPP software, we shall be describing the scope of the study. We shall then review the elements taking into consideration in the study, where we shall be defining 'grey energy' in particular. We shall present our expectations in terms of the databases and the databases selected for the module. We shall then detail the method used to calculate the result, we shall see which data need to be entered for a project, and lastly, we shall see how the result are presented.

2 OBJECTIVES OF THE BEGLOBAL PROJECT

The "BeGlobal" project falls within the policy of optimizing the energy efficiency of buildings under pressure from the Belgian authorities in the Brussels-Capital region, in Flanders, and in Wallonia.

The project has several objectives. Initially, it is a question of offering a simple but not simplistic tool for calculating a building's overall energy profile.

Following on from this initial objective, it is necessary to make maximum use of the data already available in the PHPP, thereby offering users a minimum of additional data entry. In point of fact, the BeGlobal tool is an add-in to the existing PHPP software, which is why we are seeking to extract the information users will have already entered into the PHPP for use within this module.

The tool is also intended to give additional information about a building's overall energy profile. This is what makes it really useful. By re-working the data from the PHPP, previously entered by the user, using the selected database(s), the BeGlobal tool will give results for the building's energy profile (grey energy and energy consumed during the lifetime of the building: heating, domestic hot water (DHW), domestic electricity, and cooling) and will also offer a report on the building's greenhouse gas emissions.

And lastly, this tool is being developed with a long-term objective: to make it possible, by means of this module, to offer "passive +" certification which will incorporate the environmental aspect (grey energy and greenhouse gas emissions) in addition to the energy data taken into account up to now. This comes within the framework of the financial grants and tax concessions offered by the Regions in order to encourage passive, very low- and low-energy as well as "zero energy" building and renovation.

Let us note here that it will also be possible to use the BeGlobal software without the PHPP. This will entail entering additional data. However, using the PHPP software will make it easier for the user to enter data and obtain results.

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3 THE PHPP

The Passivhaus Projectierungs Pakket (PHPP) is a tool to aid in the design of passive buildings, developed by the PHI and translated into French by the PMP a.s.b.l. In Belgium, it is the only recognized tool for ensuring that the criteria for the passive standard are met. After the data have been entered and checked, the "Passive Building" certificate may be issued.

The PHPP is not confined to the residential sector. Increasing numbers of tertiary sector buildings, particularly schools and offices, are moving towards a passive policy. Furthermore, a large number of building are undergoing very low- or low-energy renovation.

Concerning the actual tool itself, it is in essence a collection of Excel spreadsheets that make it possible to calculate the energy profile (heating, DHW, domestic electricity, and cooling) and the heating power, to determine the appropriate ventilation flow rates, to assess comfort in Summer, and so on. In all, entering data into around thirty spreadsheets makes it possible to calculate the annual heating energy requirements and to find out if the passive standard criteria are met or not.

The PHPP is currently available in its 2007 version, as well as in its 1.5 BE beta version; the BeGlobal software however will only be using the PHPP2007, saved in the .xls format.

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4 DEFINING THE SCOPE OF THE STUDY

It is imperative at the outset to define the scope of the study and in this way set the limits for the elements taken into consideration or excluded from the scope of the study.

4.1 Overall building energy profile

A building's overall energy profile is defined as the sum of the consumption associated with the 'grey energy' for all the materials required to build the building (see 5.1) and the primary energy consumed during the life of the building, i.e. for heating, DHW, domestic electricity, and cooling. This profile will be expressed in kWh.

Three other interpretations of this overall energy profile will be offered. It may be related to the energy reference area and/or the number of occupants.

4.2 Overall building greenhouse gas emissions profile

A building's overall greenhouse gas emissions profile is defined as the sum of the greenhouse gas emissions from each of the following items:

- Extraction of the raw materials and transportation to the production site
- Processing of the raw materials and manufacture of the product
- Implementation of the product
- Emissions arising from the use of the building (consumption)
- End of product life: incineration / recycling / dumping
- Transport to the site where the materials are used
- Transport at the end of the materials' life

This profile will be expressed in kg $EqCO_2$.

Three other interpretations of this overall greenhouse gas emissions profile will be offered. It may be related to the energy reference area and/or the number of occupants.

4.3 Constructional elements taken into consideration in the study

A certain number of constructional elements were taken into consideration in the study. These are detailed in this section.

The next section will detail which constructional elements have been excluded from the study.

4.3.1 External walls

We consider the building's external shell, which will be detailed wall by wall. This section includes only vertical external walls.

4.3.2 Internal walls

Only vertical internal walls will be considered in this section. Users are offered a choice of default internal walls. They will be able to select both default internal walls and detailed internal walls, data for which they have entered themselves.

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4.3.3 Roofs

Roof data will be entered under the 'Roofs' tab. It will be possible to enter several types of roof.

4.3.4 Doors and windows

On the assumption that they represent a not inconsiderable part of a building's energy profile, doors and windows (glazing, frames, opaque panels) will be included in the calculation.

4.3.5 Structure

We include the structure of the building in the calculation. We shall set nominal values for the various types of structure (timber framing, concrete, metal, etc.). (see Appendix 4)

4.3.6 Foundations

In terms of foundations, we shall be considering 3 types:

- Foundations over a ventilated underfloor void
- Foundations directly on the ground
- Foundations involving a cellar

4.3.7 Miscellaneous elements

One section will be left for users to enter data not falling into any of the above categories.

4.4 Elements excluded from the study

4.4.1 Systems / Ventilation

The elements of the various systems (DHW, ventilation, heating, etc.) will not be considered in the BeGlobal tool. However, the consumption of these will be counted in section 7.1.2 'Overall energy in use'

Let us note here that users will be able to manually enter data for these systems as miscellaneous elements. In this case, it will be necessary to refer to the paragraphs concerning miscellaneous elements under point 7 'Calculation method'

4.4.2 Wiring and piping

Wiring and piping will be excluded from the scope of the study.

4.4.3 Finishes

Finishes will not be included in the calculation either, since the tool needs to be kept simple and little data is available.

4.4.4 Other elements

Any other elements not mentioned amongst those considered in the study are excluded from the study.

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4.5   Renovation

The BeGlobal module will allow data to be entered for renovation projects. Two pieces of information will be requested for each material: is it being re-used, and is it re-usable? Thus if one or both of these options are ticked, the calculations will be performed accordingly, avoiding accounting twice for the production or disposal phases, along with the transport.

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5 INDICATORS, TRANSPORT, AND LIFESPAN CONSIDERED

In the first instance, we shall be considering those environmental impact indicators whose effect is the most significant for the construction sector on a global level: grey energy and greenhouse gas emissions.

We shall also be taking into account transport, building life, and the life of the materials – in the absence of such data, the result would be inaccurate and incomplete.

5.1 Grey energy

The grey energy for a product is defined as the total of all the energy inputs required throughout all the stages in the life of this product.

The BeGlobal tool will take into account the energy required for:

- extracting and transporting the raw materials
- processing the raw materials and manufacturing the product
- implementing the product
- end of product life: incineration / recycling / dumping

Grey energy is calculated in kilowatt-hours (kWh) per measurement unit: for example, kWh/m³, kWh/tonne, kWh/m²; or in megajoules (MJ), depending on the data table used (see 6 – 'Databases').

For information, let us note the following conversions:

- 1 kWh = 3.6 MJ
- 10 kWh $\cong$ 1 l of fuel oil or 1m³ of gas.

The grey energy data we shall be using here are those provided by the database(s) selected (see 6 – 'Databases')

5.2 Greenhouse gas emissions

Greenhouse gas emissions are a very significant item in a building's environmental profile. The construction of a building produces a relatively large quantity of greenhouse gases, particularly carbon dioxide (CO_2). Thus it is imperative to measure these emissions and to take them into account in order to give an indication of this environmental impact.

Greenhouse gas emissions will be expressed in kg equivalent CO_2 (kg $EqCO_2$).

In terms of the emissions due to the materials and transport, we shall be using the database(s) selected by the user (see 6 – 'Databases').

5.3 Overall primary energy

The overall primary energy is the raw energy that has not been subject to conversion or transformation. This is the sum of the renewable proportion (wind, solar, water, or biomass-derived power) and the non-renewable proportion (nuclear, fossil fuels, timber from cutting primary forests) of primary energy.

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This result will be expressed in kWh.

The data used in the BeGlobal tool will be drawn from the databases selected (see 6 – 'Databases').

5.4 Transport

Transport is the point on which expert opinion is most divided. It is clear that the transport has a very significant impact, particularly on greenhouse gas emissions and grey energy. However, it is difficult to find transport data suitable for each product and calculated in the same way. For some of the materials from the databases, the transport data are already included within the results provided. For those where this is not the case, the PMP suggests two options: using the default value established by the PMP, or entering the transport data manually if the composition is known.

The method for calculating the default values is presented below. Data to be entered manually can also be based on this.

5.4.1 Geographical zoning

The first aspect to be taken into account for transport calculation is the geographical zone. Four zones are defined:

[1] Belgium
[2] Countries adjoining Belgium (Germany, France, Great Britain, Luxembourg, and the Netherlands)
[3] European countries other than those already included in [2]
[4] Rest of world excluding [1], [2], and [3]

The transport calculation is based on averages.

In order to calculate the average number of kilometres within Belgium, we looked at where the various construction materials factories are located in Belgium. Following this, we established that the maximum distance between a factory and a typical delivery point was around 90 km. When selecting transport for the zone "Belgium", the BeGlobal software will use 90 km as the average distance.

For the adjoining countries, we considered five: Germany, France, Great Britain, Luxembourg, and the Netherlands. We plotted a concentric circle round these five countries, then measured the radius and divided this value by 2. This gives us an average value of 550 km. We used the same method for Europe (excluding the countries already considered in zone [2]) and for the world (excluding Europe), and we obtain the values of 1,055 km for zone [3] and 10,000 km for zone [4].

In the case where the default values are used, a survey was carried out among construction material suppliers in order to find out where their supplies come from. Following this, we were able to establish statistics per type of product. Thus x% of a material β comes from zone [1], x% from zone [2], x% from zone [3], and x% from zone [4]. The calculations are performed automatically and incorporated into the software's transport tab.

If users manually enter transport data for their product, they will be required to select the zone the construction products come from from a drop-down menu, and will have to add a line for each mode of transport used with the associated distance.

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5.4.2 Mode of transport

It is likewise necessary to consider the mode of transport. In point of fact, over a short distance, using a 3.5–28 t lorry or an ocean-going ship would not generate the same costs, the same energy consumption, or the same greenhouse gas emissions. Here are the assumptions made in calculating the default values:

For zone [1], we shall consider that the transport takes place[1]:
- 86 % by lorries over 28 t
- 8 % by inland waterway
- 5 % by lorries 3.5–28 t
- 1 % by rail

For zone [2], we shall consider that the transport takes place[2]:
- 91 % by lorries 3.5–28 t
- 8 % by inland waterway
- 1 % by rail

For zone [3], we shall consider that the transport takes place[2]:
- 69 % by lorries over 28 t
- 22 % by lorries 3.5–28 t
- 8 % by inland waterway
- 1 % by rail

For zone [4], we shall consider that the transport takes place[2]:
- 85 % by ocean-going ship
- 6 % by lorries 3.5–28 t
- 6 % by lorries over 28 t
- 2 % by inland waterway
- 1 % by rail

As explained in the previous section, if users wish to manually enter data for the transport element, they will need to select the zone their product comes from, then the type of transport required, along with the number of kilometres travelled. Users will be able to add as many types of transport as they wish.

Concerning disposal transport, two cases will be presented. If the materials are re-used on site, it will be necessary to check the relevant box (see 8.2.4) and enter "0" for the number of kilometres travelled; in this way, the disposal transport will not be taken into account twice.

Otherwise, we shall consider that the whole of the disposal transport takes place in Belgium using 3.5–15 t vehicles. We shall consider that the average transport between the site where the end-of-life waste originates and the waste disposal location is 30 km. There are in fact 213 authorized centres in Belgium for sorting and recycling inert waste from construction and demolition (1).

Users will be able to modify the number of kilometres for the disposal transport if they wish to be more accurate than the default value proposed by the PMP.

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[1] Source of values used: www.plan.be – Values taken into account: Modal distribution of national goods transport, distribution for the category 'Raw or manufactured minerals and construction materials' 2000–2006 in thousands of tonnes

[2] Extrapolation from values for zone [1].

5.5 Building life

A building's overall energy profile can be calculated over the whole life of the building, insofar as this is known. This element is essential if one seeks to find out the building's impact per year. A drop-down menu will offer the type of use for the building, to which a lifespan will be automatically attributed.

However, the life of a building is not a fixed element, it depends, among other things, on the building system, the location in which it is built, the materials used, the way it is built, and what it is used for. This is why we adopt a simplifying assumption:

- Residential: 80 years
- Tertiary sector: 80 years

This value of 80 years is based on a New Zealand/Swiss study (ALTHAUS H.-J., KELLENBERGER D., 2008) on the usefulness of simplifying the way construction elements are accounted for in lifecycle analysis (LCA).

The life of a building, expressed in years, will make it possible to provide consumption figures (grey energy and greenhouse gas emissions) per year of the building's life.

5.6 Material life

It is vital to know and take account of the life of the materials. There is currently no standard or law that imposes a method for calculating the life of each material; the figures we have are those published by the manufacturers.

This "material life" information will be incorporated into the BeGlobal module. We shall give an average value for each group of materials. It will be possible for users to modify this in the event of specific data issued by a producer. A single value is suggested in the databases, however if you want to be more accurate, you can modify these values material by material in order to take into account the use of each material by means of the table below, proposed by the PMP.

Life of each group of materials suggested by the PMP (in years):

	Structure	External skin	Internal skin	Other
Concretes	80	60	40/20	/
Timber	80	50	20/10	30
Insulating materials	/	/	/	40
Bricks / Terracotta	80	60	40/20	/
Metals	80	50	– /10	/
Plasters / Coatings	/	30	20/5	/
Glazing / Frames	/	40	20/10	/
Stone	150	150	40/20	/
Slates / Tiles	/	80	/	/
Waterproofing membranes / Vapour retarder / Vapour barrier	/	30	40	40

Residential buildings
Tertiary sector buildings

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Table 1 – Life of materials depending on their use

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6 DATABASES

When selecting a database to use, it is imperative to lay down the expectations one has of it.

In the context of this BeGlobal project, our expectations concern five points:

- transparency
- reliability of the information
- the geographical factor
- the choice of indicator / terminology
- updating

6.1 Criteria in choosing a database

6.1.1 Transparency

Our aim is to create a transparent tool, while employing a database that is not our own. So for the sake of consistency, the databases implemented in the BeGlobal module will also be required to demonstrate transparency.

This transparency involves several points:

- the source of the data
- the calculation method(s)
- the limits of the life cycle analysis system for the product being studied

6.1.2 Reliability of the information

The reliability of the information available in the databases must be proven. To this end, the PMP a.s.b.l. will be offering a description of each database, along with a brief presentation of its authors.

6.1.3 The geographical factor

The databases implemented in the BeGlobal tool will be selected according to the geographical nature of the data provided. In point of fact, there are numerous tables, but the data do not always correspond to the actual situation for Belgium. There are at present no Belgian databases covering construction materials. This is why we are initially going to have to use other databases. However, we shall be selecting those that are as consistent as possible with the situation in Belgium.

6.1.4 Choice of indicators / Terminology

We are seeking to give indications about grey energy and greenhouse gas emissions connected with the entire life of a building, it seems obvious that the tables used should contain this information.

The database terminology must be the same as that of the project. So we have to find databases that meet our criteria.

6.1.5   Updating

Future developments may be associated with the databases (adding a new database, updating of the current database), modifications to the PHPP, or the addition of new environmental impact indicators to the results.

Users will be informed of any new updates.

6.2   'KBOB' database

The database offered by KBOB uses the data specific to the construction materials in the Ecoinvent database. The latter is a life cycle inventory database for more than 4,000 products in several fields (energy, transport, construction materials, etc.) This arose out of an initiative by the Centre Ecoinvent - *Swiss Centre for Life Cycle Inventories*, a skill centre that brings together several bodies such as:

- Agroscope Reckenholz-Tänikon (Research Station) (ART)
- *Ecole Polytechnique Fédérale de Zurich* (Zurich Federal Technical Institute of Higher Education) (ETHZ)
- *Ecole Polytechnique Fédérale de Lausanne* (Lausanne Federal Technical Institute of Higher Education) (EPFL)
- Paul Scherrer Institute (PSI)
- Federal laboratory for materials testing and research (EMPA)

All the following points refer to the Ecoinvent database, since KBOB is simply an extract of this specifically for construction materials.

6.2.1   Transparency

There is a maximum of transparency in the Ecoinvent database. Each set of data in the Ecoinvent database is covered by documentation containing a maximum of details. For reasons of confidentiality, however, there are a number of sets of data (less than ten out of the over 4,000 datasets) that are not accessible on this detail level.

A second point concerning transparency: the documentation (the reports describing all these datasets) is accessible free to everyone; all you have to do is log in as a "Guest" to the Ecoinvent website and all the reports are available in .pdf format.

6.2.2   Reliability of the information

The data source is documented in the respective report for each dataset. The data is collected in accordance with the Ecoinvent quality guide (see Ecoinvent Report 1). Validation is performed by another institution of Ecoinvent (see Ecoinvent Report 1). The Ecoinvent data are all calculated in the same manner.

The Ecoinvent centre has been in existence since 1997. The bodies belonging to this skill centre are reliable bodies, recognized in Switzerland. Furthermore, an international consultative council has been set up, bringing together organizations like WWF, PRé Consultants B.V., Sylvatica, and Life Cycle Strategies.

The Ecoinvent database can be, and is, used with a number of life cycle analysis programs, including SimaPro, Umberto, and Emis.

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6.2.3 The geographical factor

This international database provides data for Europe, for Switzerland, and for other zones. While awaiting a purely Belgian database, we shall be making maximum use of Ecoinvent's 'Europe' data.

The list of the geographical zones covered is available in the 'Overview and Methodology' Report (Frischknecht R. *et al.*, 2007)

6.2.4 Choice of indicators / Terminology

The Ecoinvent database offers are very large number of environmental impact indicators. However, we shall initially only be concerned with those indicators set out in point 5 – 'Indicators, transport, and lifespan considered', i.e. grey energy and greenhouse gas emissions.

Ecoinvent's definition of grey energy is based on Technical File SIA 2032 "Grey energy in buildings" According to this document, grey energy is defined as the quantity of non-renewable primary energy needed for the stages from extraction of the raw materials to the manufacturing and production processes and for disposal. This corresponds to the sum of the consumption of energy from fossil fuel, nuclear, and wood from cutting primary forests.

The overall primary energy will be the sum of the renewable primary energy part and the non-renewable primary energy part, this sum being expressed in MJ.

The greenhouse gas emissions calculated in Ecoinvent correspond to the "GWP 100a" indicator (Global Warming Potential over 100 years) according to the IPCC 2007 method (Intergovernmental Panel on Climate Change).

6.2.5 Updating

When the Ecoinvent database is updated, the data will be adapted to the modification in the BeGlobal module, and users will be notified of the modifications, developments, and additions to the database.

6.3 *'Ecobilan de parois'* database

The *Ecobilan de parois* database has been produced by Sophie Trachte and André De Herde (Architecture et Climat) with support from the Wallonia Region.

This database is taken from the book *Choix des Matériaux – Ecobilan de parois [Choice of materials – Environmental profile of walls]* (De Herde A., Trachte S.) The book can be consulted on the Wallonia Region's Energy website (3). "This book is in line with this approach, since it offers designers the practical means to enable them to design high-performance, energy-saving, and environmentally-friendly walls. To assist readers in their designs, the book bring together both quantitative (grey energy, greenhouse effect, acidification, ozone) and qualitative (resources used, waste produced, recycling potential) approaches, taking the life of each material into account."

The database adopts the quantitative approach per construction material.

Transparency

The book details the methodology for evaluating the various environmental impacts, along with the working assumptions and the data taking into account.

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6.3.1 Reliability of the information

This database is a compilation of 3 databases: Ecoinvent, KBOB, and Eco-soft. The first two have been mentioned in the previous section devoted to them. Eco-soft is an Austrian database based on the construction materials database from the IBO, which currently includes over 500 construction materials. The construction materials are evaluated step by step.

6.3.2 The geographical factor

This database is not a Belgian database, as the authors have not succeeded in obtaining the necessary information from the manufacturers. So it involves a compilation of 3 databases. However, the 3 databases propose data for a number of European countries.

6.3.3 Choice of indicators / Terminology

We are interested in the indicators set out in point 5 – 'Indicators, transport, and lifespan considered', i.e. grey energy and greenhouse gas emissions. Both these indicators are covered in this database.

6.3.4 Updating

When the *Ecobilan de parois* database is updated, the data will be adapted to the modification in the BeGlobal module, and users will be notified of the modifications, developments, and additions to the database.

6.4 "Producers" database

Each material in this database is proposed by the producer of this material. The values included come from the EPD (Environmental Product Declaration) specific to each material.

Attention, do not forget that even though the EPDs are required to meet the ISO 14025, 14040, and 14044 standards, they do not necessarily use the same functional units, nor the same boundaries for the system studied. So one must remain vigilant when comparing two materials, and investigate the complete EPDs.

6.4.1 Transparency

Each producer whose data are included in the database provides us with one EPD per product which has already been verified by an expert external to the company. We only make available data that have been validated.

6.4.2 Reliability of the information

This paragraph cross-refers to the previous one. An expert body external to each company has verified the data provided by the producers before validating them.

6.4.3 The geographical factor

The producers who provide their data for the program are based in Belgium, and the majority of the EPDs involved are Belgian. However, certain of them have been produced in other countries, for example France, or are European.

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6.4.4 Choice of indicators / Terminology

We are interested in the indicators set out in point 5 – 'Indicators, transport, and lifespan considered', i.e. grey energy and greenhouse gas emissions. Both these indicators are covered in the producers' EPDs.

6.4.5 **Updating**

When an EPD is updated, the data will be adapted to the modification in the BeGlobal module, and users will be notified of the modifications, developments, and additions to the database.

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7 CALCULATION METHOD

The BeGlobal module is intended for calculating a building's overall energy profile, together with its greenhouse gas emissions profile. The calculation method is detailed in the following pages.

It is based on data extracted from the database selected.

7.1 Overall building energy profile

$$B_{E,G} = E_{I,G} + E_{U,G} + E_{E,G}$$

Where:

$B_{E,G}$: the building's overall primary energy profile [kWh]

$E_{I,G}$: overall initial energy [kWh]

$E_{U,G}$: overall energy in use [kWh]

$E_{E,G}$: overall disposal energy [kWh]

Reminder: (see 4.1 – 'Overall building energy profile') this may be related to the energy reference area and/or the number of occupants.

$$B_{E,G,S} = \frac{B_{E,G}}{S_{Ref}}$$

Where:

$B_{E,G,S}$: overall energy profile by unit area [kWh/m²]

$B_{E,G}$: the building's overall primary energy profile [kWh]

S_{Ref}: energy reference area [m²]

*****

$$B_{E,G,O} = \frac{B_{E,G}}{N_O}$$

Where:

$B_{E,G,O}$: overall energy profile by number of occupants [kWh/person]

$B_{E,G}$: the building's overall primary energy profile [kWh]

N_O : number of occupants [-]

*****

$$B_{E,G,S,O} = \frac{\dfrac{B_{E,G}}{S_{Ref}}}{N_O}$$

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Where:

$B_{E,G,S,O}$: overall energy profile per unit area and per number of occupants [kWh/m²/person]

$B_{E,G}$: the building's overall primary energy profile [kWh]

S_{Ref}: energy reference area [m²]

N_O: number of occupants [-]

7.1.1 Overall initial energy[3]

$$E_{I,G} = E_{F,mat} + E_{T,mat}$$

Where:

$E_{I,G}$: overall initial energy [kWh]

$E_{F,mat}$: materials manufacturing energy [kWh]

$E_{T,mat}$: materials transport energy [kWh]

With:

$$E_{F,mat} = E_{F,PE} + E_{F,PI} + E_{F,PL} + E_{F,FE} + E_{F,ST} + E_{F,FO} + E_{F,DI}$$

Where:

$E_{F,mat}$: materials manufacturing energy [kWh]

$E_{F,PE}$: manufacturing energy for external walls [kWh]

$E_{F,PI}$: manufacturing energy for internal walls [kWh]

$E_{F,PL}$: manufacturing energy for floors [kWh]

$E_{F,FE}$: manufacturing energy for doors and windows [kWh]

$E_{F,ST}$: manufacturing energy for structure [kWh]

$E_{F,FO}$: manufacturing energy for foundations [kWh]

$E_{F,DI}$: manufacturing energy for miscellaneous elements [kWh]

7.1.1.1 *Manufacturing energy for external walls*

$$E_{F,PE} = \sum_{x=1}^{n} E_{F,PE,x}$$

Where:

$E_{F,PE}$: manufacturing energy for external walls [kWh]

n : number of different walls [-]

$E_{F,PE,x}$: manufacturing energy for external wall x [kWh]

*****

---

[3] The overall initial energy, expressed in kWh, is the overall energy consumption required, from extraction to implementation of a product.

pmp

$$E_{F,PE,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \left\{ \frac{a_{m1,y} \cdot E_{F,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y}}{3,6} + \frac{a_{m2,y} \cdot E_{F,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}}{3,6} \right.$$
$$\left. + \frac{a_{m3,y} \cdot E_{F,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}}{3,6} \right\}$$

Where:

$E_{F,PE,x}$: manufacturing energy for external wall x [kWh]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$E_{F,mi,y}$: manufacturing energy for the material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

3.6 : conversion factor from MJ to kWh

$$*****$$

$$N_{C,mi,y} = ENT\left(\frac{D_{V,B}}{D_{V,mi}}\right) + b$$

With:

$$b = 0 \; si \; \left(\frac{D_{V,B}}{D_{V,mi}}\right) - ENT\left(\frac{D_{V,B}}{D_{V,mi}}\right) = 0$$

$$b = 1 \; si \; \left(\frac{D_{V,B}}{D_{V,mi}}\right) - ENT\left(\frac{D_{V,B}}{D_{V,mi}}\right) \neq 0$$

Where:

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

ENT : integer

$D_{V,B}$: building life [years] – see 5.4 – 'Building life'

$D_{V,mi}$: life of material mi [years] – see 5.5 – 'Material life'

7.1.1.2 *Manufacturing energy for internal walls*

In detail, the manufacturing energy for internal walls will be calculated as follows:

$$E_{F,PI} = \sum_{x=1}^{n} E_{F,PI,x}$$

Where:

$E_{F,PI}$: manufacturing energy for internal walls [kWh]

n : number of different walls [-]

pmp

$E_{F,PI,x}$: manufacturing energy for internal wall x [kWh]

*****

$$E_{F,PI,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \left\{ \frac{a_{m1,y} \cdot E_{F,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y}}{3,6} + \frac{a_{m2,y} \cdot E_{F,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}}{3,6} \right.$$
$$\left. + \frac{a_{m3,y} \cdot E_{F,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}}{3,6} \right\}$$

With:

$E_{F,PI,x}$: manufacturing energy for internal wall x [kWh]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$E_{F,mi,y}$: manufacturing energy for the material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

3.6 : conversion factor from MJ to kWh

*****

It will be possible to enter data for internal walls per m² of standard wall, i.e.

$$E_{F,PI,x} = S_x \cdot E_{F,PI,x}^{*}$$

Where:

$E_{F,PI,x}$: manufacturing energy for internal wall x [kWh]

S_x: nett area of wall x [m²]

$E_{F,PI,x}^{*}$: approximate manufacturing energy for internal wall x [kWh/m²] – see 'Appendix 1'

7.1.1.3 *Manufacturing energy for floors*[4]

In detail, the manufacturing energy for floors will be calculated as follows:

$$E_{F,PL} = \sum_{x=1}^{r} E_{F,PL,x}$$

Where:

$E_{F,PL}$: manufacturing energy for floors [kWh]

r : number of floors [-]

---

[4] Reminder: this point only concerns floors between levels (see 4.3.1 'External walls').

pmp

$E_{F,PL,x}$: manufacturing energy for floor x [kWh]

<div align="center">*****</div>

$$E_{F,PL,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \left\{ \frac{a_{m1,y} \cdot E_{F,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y}}{3,6} + \frac{a_{m2,y} \cdot E_{F,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}}{3,6} + \frac{a_{m3,y} \cdot E_{F,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}}{3,6} \right\}$$

With:

$E_{F,PL,x}$: manufacturing energy for floor x [kWh]

S_x: nett area of wall x [m²]

q : number of layers per element [-]

e_y: thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$E_{F,mi,y}$: manufacturing energy for the material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

3.6 : conversion factor from MJ to kWh

Rather more approximately, it may be calculated as follows:

- <u>In the case where there is only a single composition for internal floors:</u>

$$E_{F,PL} = S_{PL,AP} \cdot E_{F,PL}^*$$

With:

$E_{F,P}$: manufacturing energy for floors [kWh]

$S_{PL,AP}$: approximate area of internal floor [m²]

$E_{F,PL}^*$: approximate manufacturing energy for internal floor [kWh/m²] – see 'Appendix 2'

With:

$$S_{PL,AP} = A_{ch} - S_{Sol} - \sum_{g=1}^{t} P_g \cdot e_{Ext} - \frac{e_{Ext}}{2} \cdot l_{mit,g}$$

Where:

$S_{PL,AP}$: approximate floor area [m²]

A_{ch}: gross area of heated floor [m²]

S_{Sol}: area of ground floor [m²]

P_g: perimeter of floor g , including party wall(s) if any [m]

t : number of floors [-]

e_{Ext} average thickness of external walls [m]

$l_{mit,g}$: length of party wall for floor g [m]

- <u>In the case where there are various compositions for internal floors:</u>

pmp

$$E_{F,PL} = \sum_r S_{PL,r} \cdot E_{F,PL,r}^*$$

Where:

$E_{F,PL}$: manufacturing energy for floors [kWh]

r : number of floors [-]

$S_{PL,r}$: area of internal floor r [m²][5]

$E_{F,PL,r}^*$: approximate manufacturing energy for internal floor r [kWh/m²] – see 'Appendix 2'

7.1.1.4 *Manufacturing energy for doors and windows*

$$E_{F,FE} = E_{F,FE,V} + E_{F,FE,Ch} + E_{F,FE,Esp}$$

Where:

$E_{F,FE}$: manufacturing energy for doors and windows [kWh]

$E_{F,FE,V}$: manufacturing energy for glazing and opaque panels for doors and windows [kWh]

$E_{F,FE,Ch}$: manufacturing energy for frames for doors and windows [kWh]

$E_{F,FE,Esp}$: manufacturing energy for window spacers [kWh]

7.1.1.4.1 *Manufacturing energy for glazing and opaque panels for doors and windows*

$$E_{F,FE,V} = \sum_i \left\{ (S_{THC,i} - S_{PO,i}) \cdot \frac{E_{F,V,i}}{3,6} \cdot N_{C,V,i} + S_{PO,i} \cdot \frac{E_{F,PO,i}}{3,6} \cdot N_{C,PO,i} \right\}$$

Where:

$E_{F,FE,V}$: manufacturing energy for glazing and opaque panels for doors and windows [kWh]

i : number of doors and windows [-]

$S_{THC,i}$: total area of door or window i excluding frame [m²]

$S_{PO,i}$: area of opaque panel for door or window i [m²]

$E_{F,V,i}$: manufacturing energy for glazing of door or window i [kWh/m²]

$E_{F,PO,i}$: manufacturing energy for opaque panel of door or window i [kWh/m²]

3.6 : conversion factor from MJ to kWh

$N_{C,V,i}$: number of cycles in glazing V [-]

$N_{C,PO,i}$: number of cycles in opaque panel PO [-]

Let us note that:

$$S_{THC,i} = S_{Tot,i} - S_{Ch,i}$$

---

[5] In this instance, the internal floor area will have to be calculated by the user, depending on the project.

pmp

With:

$S_{THC,i}$: total area of door or window i excluding frame [m²]

$S_{Tot,i}$: total area of door or window i [m²]

$S_{Ch,i}$: area of frame for door or window i [m²]

The area of the frame is either given by the PHPP, or calculated as follows:

$$S_{Ch,i} = 2(h_i + l_i).e_{Ch,i} - 4(e_{Ch,i})^2$$

With:

$S_{Ch,i}$: area of frame for door or window i [m²]

h_i : height of door or window i [m]

l_i : width of door or window i [m]

$e_{Ch,i}$: thickness of frame of door or window i [m]

7.1.1.4.2   *Manufacturing energy for door and window frames*

$$E_{F,FE,Ch} = \sum_i S_{Ch,i}.\frac{E_{F,Ch,i}}{3,6}.N_{C,Ch,i}$$

Where:

$E_{F,FE,Ch}$: manufacturing energy for frames for doors and windows [kWh]

i : number of doors and windows [-]

$S_{Ch,i}$: area of frame for door or window i [m²]

$E_{F,Ch,i}$: manufacturing energy for frame of door or window i [kWh/m²]

3.6 : conversion factor from MJ to kWh

$N_{C,Ch,i}$: number of cycles of the frame Ch [-]

7.1.1.4.3   *Manufacturing energy for window spacers*

$$E_{F,FE,Esp} = \sum_i (e_{v,i} + 2.d_{Esp,i}).0,001.\big[2(h_i - 2.e_{Ch,i}) + 2(l_i - 2.e_{Ch,i})\big].\left(\frac{F_{Esp,i}}{3,6}.\rho_{Esp,i}.N_{C,Esp,i}\right)$$

Where:

$E_{F,FE,Esp}$: manufacturing energy for window spacers [kWh]

$e_{v,i}$: total spacing between panes for window i [m]

$d_{Esp,i}$: thickness of spacers for window i [m][6]

0.001 : default profile length proposed [m]

h_i: height of door or window i [m]

---

[6] We shall adopt a default value of 0.004 m.

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$e_{Ch,i}$: thickness of frame of door or window i [m]

l_i : width of door or window i [m]

$F_{Esp,i}$: manufacturing energy for spacers for window i [kWh/kg]

3.6 : conversion factor from MJ to kWh

$\rho_{Esp,i}$: density of spacers for window i [kg/m³]

$N_{C,Esp,i}$: number of cycles of spacer Esp [-]

In the case of triple glazing: $e_{v,i} = \sum Esp_i . 2$

In the case of quadruple glazing: $e_{v,i} = \sum Esp_i . 3$

7.1.1.5 *Manufacturing energy for the structure*

$$E_{F,ST} = \frac{F_{ST}^*}{3,6} . m_{ST}$$

Where:

$E_{F,ST}$: manufacturing energy for the structure [kWh]

F_{ST}^*: approximate manufacturing energy for the structure [MJ/kg] – see 'Appendix 3'
3.6 : conversion factor from MJ to kWh

m_{ST} : mass of the structure [kg]

7.1.1.6 *Manufacturing energy for foundations*

$$E_{F,FO} = E_{F,FO,RA} + E_{F,FO,SE} + E_{F,FO,PIE} + E_{F,FO,MU} + E_{F,FO,PL}$$

Where:

$E_{F,FO}$: manufacturing energy for foundations [kWh]

$E_{F,FO,RA}$: manufacturing energy for rafts [kWh]

$E_{F,FO,SE}$: manufacturing energy for footings [kWh]

$E_{F,FO,PIE}$: manufacturing energy for piles [kWh]

$E_{F,FO,MU}$: manufacturing energy for foundation walls [kWh]

$E_{F,FO,PL}$: manufacturing energy for floors [kWh]

7.1.1.6.1 *Manufacturing energy for slabs*

$$E_{F,FO,RA} = 0$$

Where:

$E_{F,FO,RA}$: manufacturing energy for rafts [kWh]

The data for the rafts has already be entered under the external walls.

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7.1.1.6.2 *Manufacturing energy for footings*

$$E_{F,FO,SE} = 0,5 . 0,5 \left(P_b - l_{mit,g} + l_{mp,i}\right).\frac{F_{FO,SE}}{3,6}.\rho_{FO,SE}$$

Where:

$E_{F,FO,SE}$: manufacturing energy for footings [kWh]

0,5 : depth of footing [m]

0,5 : width of footing [m]

P_b : perimeter of building [m]

$l_{mit,g}$: length of party wall for floor g [m]

$l_{mp,i}$: length of internal load-bearing walls [m]

$F_{FO,SE}$: manufacturing energy for footing material [MJ/kg]

3.6 : conversion factor from MJ to kWh

$\rho_{FO,SE}$: density of footing material [kg/m³]

7.1.1.6.3 *Manufacturing energy for piles*

$$E_{F,FO,PIE} = V_{PIE}.\frac{F_{FO,PIE,mat}}{3,6}.\rho_{FO,PIE}$$

Where:

$E_{F,FO,PIE}$: manufacturing energy for piles [kWh]

V_{PIE} : volume of piles [m³]

$F_{FO,PIE,mat}$: manufacturing energy for pile material [MJ/kg]

3.6 : conversion factor from MJ to kWh

$\rho_{FO,PIE}$: density of piles [kg/m³]

7.1.1.6.4 *Manufacturing energy for foundation walls*

$$E_{F,FO,MU} = S_{Fond}.E_{F,FO,MU}$$

In the case where the construction is directly on the ground, then:
$$E_{F,FO,MU} = 0$$

Where:

$E_{F,FO,MU}$: manufacturing energy for foundation walls [kWh]

S_{Fond} : Nett area of foundation wall [m²]

$E_{F,FO,MU}$: approximate manufacturing energy for foundation walls [kWh/m²]

7.1.1.6.5 *Manufacturing energy for floors*

In the case where the construction is on a raft or over a void, then:
$$E_{F,FO,PL} = 0$$

In the case of a cellar:

$$E_{F,FO,PL} = S_{PL} . E^*_{F,FO,PL}$$

Where:

$E_{F,FO,PL}$: manufacturing energy for floors [kWh]

S_{PL} : area of cellar floor [m²]

$E^*_{F,FO,PL}$: approximate manufacturing energy for floor [kWh/m²] – see 'Appendix 4' if default values are being used

7.1.1.7 *Manufacturing energy for miscellaneous elements*

By default, we shall consider that the manufacturing energy for miscellaneous elements is zero.

However, users will be left the possibility of manually entering data corresponding to their heating or ventilation systems or any other element they might wish to include in the calculation.

7.1.1.8 *Transport energy*

$$E_{T,mat} = \sum_{i=0}^{m} m_{mat,i}. K_{mat,i}. N_{km,i} + \sum_{j=0}^{l} S_{mat,j}. K_{mat,j}. N_{km,j} + \sum_{k=0}^{n} V_{mat,k}. K_{mat,k} . N_{km,k}$$

Where:

$E_{T,mat}$: materials transport energy [kWh]

$m_{mat,i}$: mass of material i [kg]

$K_{mat,i}$: transport energy for material i [kWh/kg/km]

$S_{mat,j}$: area of material j [m²]

$K_{mat,j}$: transport energy for material j [kWh/m²/km]

$V_{mat,k}$: volume of material k [m³]

$K_{mat,k}$: transport energy for material k [kWh/m³/km]

: number of kilometres travelled for materials i , j and k [km]

7.1.2 Overall energy in use

$$E_{U,G} = E_{U,G,r}. S_{Ref}. D_{V,B}$$

Where:

$E_{U,G}$: overall energy in use [kWh]

$E_{U,G,r}$: referenced overall energy in use [kWh/m².year]

S_{Ref} : energy reference area [m²]

$D_{V,B}$: building life [years] – see 5.4 – 'Building life'

pmp

This concerns the primary energy consumption, which is provided by the PHPP and includes heating, DHW, domestic electricity, and cooling.

7.1.3 Overall disposal energy

$$E_{E,G} = E_{E,mat} + E_{TE,mat}$$

Where:

$E_{E,G}$: overall disposal energy [kWh]

$E_{E,mat}$: disposal energy for the materials [kWh]

$E_{TE,mat}$: transport energy for disposal of the materials [kWh]

With:

$$E_{E,mat} = E_{E,PE} + E_{E,PI} + E_{E,PL} + E_{E,FE} + E_{E,ST} + E_{E,FO} + E_{E,DI}$$

Where:

$E_{E,mat}$: disposal energy for the materials [kWh]

$E_{E,PE}$: disposal energy for the external walls [kWh]

$E_{E,PI}$: disposal energy for internal walls [kWh]

$E_{E,PL}$: disposal energy for floors [kWh]

$E_{E,FE}$: disposal energy for doors and windows [kWh]

$E_{E,ST}$: disposal energy for the structure [kWh]

$E_{E,FO}$: disposal energy for the foundations [kWh]

$E_{E,DI}$: disposal energy for miscellaneous elements [kWh]

7.1.3.1 *Disposal energy for the external walls*

$$E_{E,PE} = \sum_{x=1}^{n} E_{E,PE,x}$$

Where:

$E_{E,PE}$: disposal energy for the external walls [kWh]

n : number of different walls [-]

$E_{E,PE,x}$: disposal energy for external wall x [kWh]

$$E_{E,PE,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \left\{ \frac{a_{m1,y} \cdot E_{E,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y}}{3,6} + \frac{a_{m2,y} \cdot E_{E,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}}{3,6} + \frac{a_{m3,y} \cdot E_{E,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}}{3,6} \right\}$$

Where:

$E_{E,PE,x}$: disposal energy for external wall x [kWh]

S_x: nett area of wall x [m²]

pmp

q : number of layers per element [-]

e_y: thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$E_{E,mi,y}$: disposal energy for material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

3.6 : conversion factor from MJ to kWh

7.1.3.2 *Disposal energy for internal walls*

In detail, the disposal energy for internal walls will be calculated as follows:

$$E_{E,PI} = \sum_{x=1}^{n} E_{E,PI,x}$$

Where:

$E_{E,PI}$: disposal energy for internal walls [kWh]

n : number of different walls [-]

$E_{E,PI,x}$: disposal energy for internal wall x [kWh]

*****

$$E_{E,PI,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \left\{ \frac{a_{m1,y} \cdot E_{E,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y}}{3,6} + \frac{a_{m2,y} \cdot E_{E,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}}{3,6} + \frac{a_{m3,y} \cdot E_{E,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}}{3,6} \right\}$$

With:

$E_{E,PI,x}$: disposal energy for internal wall x [kWh]

S_x: nett area of wall x [m²]

q : number of layers per element [-]

e_y: thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$E_{E,mi,y}$: disposal energy for material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

3.6 : conversion factor from MJ to kWh

*****

It will be possible to enter data for internal walls per m² of standard wall, i.e.

$$E_{E,PI,x} = S_x \cdot E_{E,PI,x}^*$$

Where:

pmp

$E_{E,PI,x}$: disposal energy for internal wall x [kWh]

S_x : nett area of wall x [m²]

$E_{E,PI,x}^*$: approximate disposal energy of internal wall x [kWh/m²] – see 'Appendix 1'

We note that the disposal energy for internal doors is considered in section 7.1.3.4 'Manufacturing energy for doors and windows'.

7.1.3.3 *Disposal energy for floors*

In detail, the disposal energy for floors will be calculated as follows:

$$E_{E,PL} = \sum_{x=1}^{r} E_{E,PL,x}$$

Where:

$E_{E,PL}$: disposal energy for floors [kWh]

r : number of different floors [-]

$E_{E,PL,x}$: disposal energy for floor x [kWh]

*****

$$E_{E,PL,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \left\{ \frac{a_{m1,y} \cdot E_{E,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y}}{3,6} + \frac{a_{m2,y} \cdot E_{E,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}}{3,6} \right.$$
$$\left. + \frac{a_{m3,y} \cdot E_{E,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}}{3,6} \right\}$$

With:

$E_{E,PL,x}$: disposal energy for floor x [kWh]

S_x: Nett area of wall x [m²]

q : number of layers per element [-]

e_y: thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$E_{E,mi,y}$: disposal energy for material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

3.6 : conversion factor from MJ to kWh

Rather more approximately, it may be calculated as follows:

- <u>In the case where there is only a single composition for internal floors:</u>

$$E_{E,PL} = S_{PL,AP} \cdot E_{E,PL}^*$$

Where:

$E_{E,PL}$: disposal energy for floors [kWh]

pmp

$S_{PL,AP}$: approximate area of internal floor [m²]

$E_{E,PL}^*$: approximate disposal energy for floors [kWh/m²] – see 'Appendix 2'

- <u>In the case where there are various compositions for internal floors</u>:

$$E_{E,PL} = \sum_r S_{PL,r} . E_{E,PL,r}^*$$

Where:

$E_{E,PL}$: disposal energy for floors [kWh]

$S_{PL,r}$: area of internal floor r [m²][7]

$E_{F,PL,r}^*$: approximate disposal energy for internal floor r [kWh/m²] – see 'Appendix 2'

r : number of floors [-]

7.1.3.4 *Disposal energy for doors and windows*

$$E_{E,FE} = E_{E,FE,V} + E_{E,FE,Ch} + E_{E,FE,Esp}$$

Where:

$E_{E,FE}$: disposal energy for doors and windows [kWh]

$E_{E,FE,V}$: disposal energy for glazing and opaque panels for doors and windows [kWh]

$E_{E,FE,Ch}$: disposal energy for door and window frames [kWh]

$E_{E,FE,Esp}$: disposal energy for window spacers [kWh]

7.1.3.4.1 *Disposal energy for glazing and opaque panels for doors and windows*

$$E_{E,FE,V} = \sum_i \left\{ (S_{THC,i} - S_{PO,i}) . \frac{E_{E,V,i}}{3,6} . N_{C,V,i} + S_{PO,i} . \frac{E_{E,PO,i}}{3,6} . N_{C,PO,i} \right\}$$

Where:

$E_{E,FE,V}$: disposal energy for glazing and opaque panels for doors and windows [kWh]

i : number of doors and windows [-]

$S_{THC,i}$: total area of door or window i excluding frame [m²]

$S_{PO,i}$: area of opaque panel for door or window i [m²]

$E_{E,V,i}$: disposal energy for glazing for door or window i [kWh/m²]

$E_{E,PO,i}$: disposal energy for opaque panel of door or window i [kWh/m²]

3.6 : conversion factor from MJ to kWh

$N_{C,V,i}$: number of cycles in glazing V [-]

$N_{C,PO,i}$: number of cycles in opaque panel PO [-]

---

[7] In this instance, the internal floor area will have to be calculated by the user, depending on the project.

pmp

7.1.3.4.2 Disposal energy for door and window frames

$$E_{E,FE,Ch} = \sum_i S_{Ch,i} \cdot \frac{E_{E,Ch,i}}{3,6} \cdot N_{C,Ch,i}$$

Where:

$E_{E,FE,Ch}$: disposal energy for door and window frames [kWh]

$S_{Ch,i}$: area of frame for door or window i [m²]

$E_{E,Ch,i}$: disposal energy for frame for door or window i [kWh/m²]

3.6 : conversion factor from MJ to kWh

$N_{C,Ch,i}$: number of cycles in frame Ch [-]

7.1.3.4.3 Disposal energy for window spacers

$$E_{E,FE,Esp} = \sum_i (e_{v,i} + 2.d_{Esp,i}).0,001.\left[2(h_i - 2.e_{Ch,i}) + 2(l_i \right.$$
$$\left. - 2.e_{Ch,i})\right].\left(\frac{E_{E,Esp,i}}{3,6} \cdot \rho_{Esp,i}.N_{C,Esp,i}\right)$$

Where:

$E_{E,FE,Esp}$: disposal energy for window spacers [kWh]

$e_{v,i}$: total spacing between panes for window i [m]

$d_{Esp,i}$: thickness of spacers for window i [m][8]

0.001 : default profile length proposed [m]

h_i : height of door or window i [m]

$e_{Ch,i}$: thickness of frame of door or window i [m]

l_i : width of door or window i [m]

$E_{E,Esp,i}$: disposal energy for spacers for window i [kWh/kg]

3.6 : conversion factor from MJ to kWh

$\rho_{Esp,i}$: density of spacers for window i [kg/m³]

$N_{C,Esp,i}$: number of cycles of spacer Esp [-]

In the case of triple glazing: $e_{v,i} = \sum Esp_i.2$

In the case of quadruple glazing: $e_{v,i} = \sum Esp_i.3$

7.1.3.5 Disposal energy for structure

$$E_{E,ST} = \frac{E^*_{ST}}{3,6} \cdot m_{ST}$$

Where:

---

[8] We shall adopt a default value of 0.004 m.

pmp

$E_{E,ST}$: disposal energy for structure [kWh]

E_{ST}^{*}: approximate disposal energy for structure [MJ/kg] – see 'Appendix 3'

3.6 : conversion factor from MJ to kWh

m_{ST} : mass of the structure [kg]

7.1.3.6   *Disposal energy for foundations*

$$E_{E,FO} = E_{E,FO,RA} + E_{E,FO,SE} + E_{E,FO,PIE} + E_{E,FO,MU} + E_{E,FO,PL}$$

Where:

$E_{E,FO}$: disposal energy for foundations [kWh]

$E_{E,FO,RA}$: disposal energy for rafts [kWh]

$E_{E,FO,SE}$: disposal energy for footings [kWh]

$E_{E,FO,PIE}$: disposal energy for piles [kWh]

$E_{E,FO,MU}$: disposal energy for foundation walls [kWh]

$E_{E,FO,PL}$: disposal energy for floors [kWh]

7.1.3.6.1   *Disposal energy for rafts*

$$E_{E,FO,RA} = 0$$

Where:

$E_{E,FO,RA}$: disposal energy for rafts [kWh]

The data for the rafts has already be entered under the external walls.

7.1.3.6.2   *Disposal energy for footings*

$$E_{E,FO,SE} = 0,5 \cdot 0,5 \left(P_b - l_{mit,g} + l_{mp,i}\right) \cdot \frac{E_{FO,SE}}{3,6} \cdot \rho_{FO,SE}$$

Where:

$E_{E,FO,SE}$: disposal energy for footings [kWh]

0,5: depth of footing [m]

0,5: width of footing [m]

P_b: perimeter of building [m]

$l_{mit,g}$: length of party wall for floor g [m]

$l_{mp,i}$: length of internal load-bearing walls [m]

$E_{FO,SE}$: disposal energy for footing material [MJ/kg]

3.6 : conversion factor from MJ to kWh

$\rho_{FO,SE}$: density of footing material [kg/m³]

pmp

7.1.3.6.3 Disposal energy for piles

$$E_{E,FO,PIE} = V_{PIE} . \frac{E_{FO,PIE,mat}}{3,6} . \rho_{FO,PIE}$$

Where:

$E_{E,FO,PIE}$: disposal energy for piles [kWh]

V_{PIE} : volume of piles [m³]

$E_{FO,PIE,mat}$: disposal energy for pile material [MJ/kg]

3.6 : conversion factor from MJ to kWh

$\rho_{FO,PIE}$: density of piles [kg/m³]

7.1.3.6.4 Disposal energy for foundation walls [kWh]

$$E_{E,FO,MU} = S_{Fond} . E_{E,FO,MU}$$

In the case where the construction is directly on the ground, then:

$$E_{E,FO,MU} = 0$$

Where:

$E_{E,FO,MU}$: disposal energy for foundation walls [kWh]

S_{Fond} : Nett area of foundation wall [m²]

$E_{E,FO,MU}$: approximate disposal energy for foundation walls [kWh/m²]

7.1.3.6.5 Manufacturing energy for floors

In the case where the construction is on a raft or over a void, then:

$$E_{EE,FO,PL} = 0$$

In the case of a cellar:

$$E_{E,FO,PL} = S_{PL} . E^{*}_{E,FO,PL}$$

Where:

$E_{E,FO,PL}$: disposal energy for floors [kWh]

S_{PL} : area of cellar floor [m²]

$E^{*}_{E,FO,PL}$: approximate disposal energy for floors [kWh/m²] – see 'Appendix 4'

7.1.3.7 Disposal energy for miscellaneous elements

By default, we shall consider that the disposal energy for miscellaneous elements is zero.

However, users will be left the possibility of manually entering data corresponding to their heating or ventilation systems or any other element they might wish to include in the calculation.

pmp

7.1.3.8 *Disposal transport energy*

$$E_{TE,mat} = \sum_{i=0}^{m} m_{mat,i}.\,K_{E,mat,i}.\,N_{km,i} + \sum_{j=0}^{l} S_{mat,j}.\,K_{E,mat,j}.\,N_{km,j} + \sum_{k=0}^{n} V_{mat,k}.\,K_{E,mat,k}.\,N_{km,k}$$

Where:

$E_{TE,mat}$: transport energy for disposal of the materials [kWh]

$m_{mat,i}$: mass of material i [kg]

$K_{E,mat,i}$: transport energy for material i [kWh/kg/km]

$S_{mat,j}$: area of material j [m²]

$K_{E,mat,j}$: transport energy for material j [kWh/m²/km]

$V_{mat,k}$: volume of material k [m³]

$K_{E,mat,k}$: transport energy for material k [kWh/m³/km]

$N_{km,}$: number of kilometres travelled for materials i , j and k [km]

7.2 Overall building greenhouse gas emissions profile

$$B_{G,GES} = GES_{I,G} + GES_{U,G} + GES_{E,G}$$

Where:

$B_{G,GES}$: building's overall greenhouse gas emissions profile [kg EqCO$_2$]

$GES_{I,G}$: initial overall greenhouse gas emissions [kg EqCO$_2$]

$GES_{U,G}$: overall greenhouse gas emissions in use [kg EqCO$_2$]

$GES_{E,G}$: overall greenhouse gas emissions for disposal [kg EqCO$_2$]

Reminder: (see 4.1 – 'Overall building greenhouse gas emissions profile'). Three other interpretations of this overall greenhouse gas emissions profile will be offered. It may be related to the energy reference area and/or the number of occupants.

$$B_{G,GES,S} = \frac{B_{G,GES}}{S_{Ref}}$$

Where:

$B_{G,GES,S}$: overall greenhouse gas emissions profile per unit area [kg EqCO$_2$/m²]

$B_{G,GES}$: building's overall greenhouse gas emissions profile [kg EqCO$_2$]

S_{Ref} : energy reference area [m²]

*****

$$B_{G,GES,O} = \frac{B_{G,GES}}{N_O}$$

Where:

$B_{G,GES,O}$: overall greenhouse gas emissions profile per number of occupants [kg EqCO$_2$/person]

$B_{G,GES}$: building's overall greenhouse gas emissions profile [kg EqCO$_2$]

pmp

N_O : number of occupants [-]

<p align="center">*****</p>

$$B_{G,GES,S,O} = \frac{\frac{B_{G,GES}}{S_{Ref}}}{N_O}$$

Where:

$B_{G,GES,S,O}$: overall greenhouse gas emissions profile per unit area and per number[of occupants [kg EqCO$_2$/m²/person]

$B_{G,GES}$: building's overall greenhouse gas emissions profile [kg EqCO$_2$]

S_{Ref} : energy reference area [m²]

N_O : number of occupants [-]

7.2.1 Initial overall greenhouse gas emissions

$$GES_{I,G} = GES_{F,mat} + GES_{T,mat}$$

Where:

$GES_{I,G}$: initial overall greenhouse gas emissions [kg EqCO$_2$]

$GES_{F,mat}$: greenhouse gas emissions from manufacturing materials [kg EqCO$_2$]

$GES_{T,mat}$: greenhouse gas emissions from transporting materials [kg EqCO$_2$]

<p align="center">*****</p>

$$GES_{F,mat} = GES_{F,PE} + GES_{F,PI} + GES_{F,PL} + GES_{F,FE} + GES_{F,ST} + GES_{F,FO} + GES_{F,DI}$$

Where:

$GES_{F,mat}$: greenhouse gas emissions from manufacturing materials [kg EqCO$_2$]

$GES_{F,PE}$: greenhouse gas emissions from manufacturing external walls [kg EqCO$_2$]

$GES_{F,PI}$: greenhouse gas emissions from manufacturing internal walls [kg EqCO$_2$]

$GES_{F,PL}$: greenhouse gas emissions from manufacturing floors [kg EqCO$_2$]

$GES_{F,FE}$: greenhouse gas emissions from manufacturing doors and windows [kg EqCO$_2$]

$GES_{F,ST}$: greenhouse gas emissions from manufacturing structure [kg EqCO$_2$]

$GES_{F,FO}$: greenhouse gas emissions from manufacturing foundations [kg EqCO$_2$]

$GES_{F,DI}$: greenhouse gas emissions from manufacturing miscellaneous elements [kg EqCO$_2$]

7.2.1.1 *Greenhouse gas emissions from manufacturing external walls*

$$GES_{F,PE} = \sum_{x=1}^{n} GES_{F,PE,x}$$

pmp

Where:

$GES_{F,PE}$: greenhouse gas emissions from manufacturing external walls [kg EqCO$_2$]

n : number of different walls [-]

$GES_{F,PE,x}$: Greenhouse gas emissions from manufacturing external wall x [kg EqCO$_2$]

*****

$$GES_{F,PE,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \{a_{m1,y} \cdot GES_{F,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y} + a_{m2,y} \cdot GES_{F,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y} + a_{m3,y} \cdot GES_{F,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}\}$$

Where:

$GES_{F,PE,x}$: Greenhouse gas emissions from manufacturing external wall x [kg EqCO$_2$]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$GES_{F,mi,y}$: greenhouse gas emissions from manufacturing material mi in layer y [kg EqCO$_2$/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

*****

$$N_{C,mi,y} = ENT\left(\frac{D_{V,B}}{D_{V,mi}}\right) + b$$

With:

$$b = 0 \; si \; \left(\frac{D_{V,B}}{D_{V,mi}}\right) - ENT\left(\frac{D_{V,B}}{D_{V,mi}}\right) = 0$$

$$b = 1 \; si \; \left(\frac{D_{V,B}}{D_{V,mi}}\right) - ENT\left(\frac{D_{V,B}}{D_{V,mi}}\right) \neq 0$$

Where:

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

ENT : Integer

$D_{V,B}$: building life [years] – see 5.4 – 'Building life'

$D_{V,mi}$: life of material mi [years] – see 5.5 – 'Material life'

7.2.1.2 *Greenhouse gas emissions from manufacturing internal walls*

In detail, the greenhouse gas emissions for internal walls will be calculated as follows:

pmp

$$GES_{F,PI} = \sum_{x=1}^{n} GES_{F,PI,x}$$

Where:

$GES_{F,PI}$: greenhouse gas emissions from manufacturing internal walls [kg EqCO$_2$]

n : number of different walls [-]

$GES_{F,PI,x}$: greenhouse gas emissions from manufacturing internal wall x [kg EqCO$_2$]

*****

$$GES_{F,PI,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \{a_{m1,y} \cdot GES_{F,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y} + a_{m2,y} \cdot GES_{F,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y} + a_{m3,y} \cdot GES_{F,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}\}$$

Where:

$GES_{F,PI,x}$: greenhouse gas emissions from manufacturing internal wall x [kg EqCO$_2$]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$GES_{F,mi,y}$: greenhouse gas emissions from manufacturing material mi in layer y [kg EqCO$_2$/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

*****

It will be possible to enter data for the internal walls per m² of standard wall, i.e.:

$$GES_{F,PI,x} = S_x \cdot GES_{F,PI,x}^{*}$$

Where:

$GES_{F,PI,x}$: greenhouse gas emissions from manufacturing internal wall x [kg EqCO$_2$]

S_x: nett area of wall x [m²]

$GES_{F,PI,x}^{*}$: approximate greenhouse gas emissions for internal wall x [kg EqCO$_2$/m²] – see 'Appendix 1'

We note that the greenhouse gas emissions from manufacturing internal doors are considered in section 7.2.1.4 'Greenhouse gas emissions from manufacturing doors and windows'.

7.2.1.3 *Greenhouse gas emissions from manufacturing floors*

In detail, the greenhouse gas emissions for floors will be calculated as follows:

$$GES_{F,PL} = \sum_{x=1}^{r} GES_{F,PL,x}$$

Where:

pmp

$GES_{F,PL}$: Greenhouse gas emissions from manufacturing floors [kg EqCO$_2$]

r : number of floors [-]

$GES_{F,PL,x}$: Greenhouse gas emissions from manufacturing floor x [kg EqCO$_2$]

*****

$$GES_{F,PL,x} = S_x . \sum_{y=1}^{q} e_y . \{a_{m1,y} . GES_{F,m1,y} . N_{C,m1,y} . \rho_{m1,y} + a_{m2,y} . GES_{F,m2,y} . N_{C,m2,y} . \rho_{m2,y} + a_{m3,y} . GES_{F,m3,y} . N_{C,m3,y} . \rho_{m3,y} \}$$

Where:

$GES_{F,PL,x}$: greenhouse gas emissions from manufacturing floor x [kg EqCO$_2$]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$GES_{F,mi,y}$: greenhouse gas emissions from manufacturing material mi in layer y [kg EqCO$_2$/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

Rather more approximately, it may be calculated as follows:

- <u>In the case where there is only a single composition for internal floors</u>:

$$GES_{F,PL} = S_{PL,AP} . GES_{F,PL}^*$$

Where:

$GES_{F,PL}$: greenhouse gas emissions from manufacturing floors [kg EqCO$_2$]

$S_{PL,AP}$: approximate area of internal floor [m²]

$GES_{F,PL}^*$: approximate greenhouse gas emissions from manufacturing floors [kg EqCO$_2$/m²] – see 'Appendix 2'

With:

$$S_{PL,AP} = A_{ch} - S_{Sol} - \sum_{g=1}^{t} P_g . e_{Ext} - \frac{e_{Ext}}{2} . l_{mit,g}$$

Where:

$S_{PL,AP}$: approximate floor area [m²]

A_{ch} : gross area of heated floor [m²]

S_{Sol} : area of ground floor [m²]

P_g : perimeter of floor g , including party wall(s) if any [m]

t : number of floors [-]

pmp

e_{Ext} average thickness of external walls [m]

$l_{mit,g}$: length of party wall for floor g [m]

- In the case where there are various compositions for internal floors:

$$GES_{F,PL} = \sum_r S_{PL,r} . GES^*_{F,PL,r}$$

Where:

$GES_{F,PL}$: greenhouse gas emissions from manufacturing floors [kg EqCO$_2$]

r : number of floors [-]

$S_{PL,r}$: area of internal floor r [m²][12]

$GES^*_{F,PL,r}$: approximate greenhouse gas emissions from manufacturing internal floor r [kg EqCO$_2$/m²] – see 'Appendix 2'

7.2.1.4 *Greenhouse gas emissions from manufacturing doors and windows*

$$GES_{F,FE} = GES_{F,FE,V} + GES_{F,FE,Ch} + GES_{F,FE,Esp}$$

With:

$GES_{F,FE}$: greenhouse gas emissions from manufacturing doors and windows [kg EqCO$_2$]

$GES_{F,FE,V}$: greenhouse gas emissions from manufacturing glazing and opaque panels for doors and windows [kg EqCO$_2$]

$GES_{F,FE,Ch}$: greenhouse gas emissions from manufacturing door and window frames [kg EqCO$_2$]

$GES_{F,FE,Esp}$: greenhouse gas emissions from manufacturing window spacers [kg EqCO$_2$]

7.2.1.4.1 *Greenhouse gas emissions from manufacturing glazing and opaque panels for doors and windows*

$$GES_{F,FE,V} = \sum_i \{(S_{THC,i} - S_{PO,i}). GES_{F,V,i}. N_{C,V,i} + S_{PO,i}. GES_{F,PO,i}. N_{C,PO,i}\}$$

Where:

$GES_{F,FE,V}$: greenhouse gas emissions from manufacturing glazing and opaque panels for doors and windows [kg EqCO$_2$]

i : number of doors and windows [-]

$S_{THC,i}$: total area of door or window i excluding frame [m²]

$S_{PO,i}$: area of opaque panel for door or window i [m²]

$GES_{F,V,i}$: greenhouse gas emissions from manufacturing glazing [kg EqCO$_2$/m²]

$GES_{F,PO,i}$: greenhouse gas emissions from manufacturing door or window opaque panel [kg EqCO$_2$/m²]

$N_{C,V,i}$: number of cycles in glazing V [-]

$N_{C,PO,i}$: number of cycles in opaque panel PO [-]

Let us note that:

$$S_{THC,i} = S_{Tot,i} - S_{Ch,i}$$

With:

$S_{THC,i}$: total area of door or window i excluding frame [m²]

$S_{Tot,i}$: total area of door or window i [m²]

$S_{Ch,i}$: area of frame for door or window i [m²]

The area of the frame is either given by the PHPP, or calculated as follows:

$$S_{Ch,i} = 2(h_i + l_i).e_{Ch,i} - 4(e_{Ch,i})^2$$

With:

$S_{Ch,i}$: area of frame for door or window i [m²]

h_i : height of door or window i [m]

l_i : width of door or window i [m]

$e_{Ch,i}$: thickness of frame of door or window i [m]

7.2.1.4.2 *Greenhouse gas emissions from manufacturing door and window frames*

$$GES_{F,FE,Ch} = \sum_i S_{Ch,i} . GES_{F,Ch,i} . N_{C,Ch,i}$$

Where:

$GES_{F,FE,Ch}$: greenhouse gas emissions from manufacturing door and window frames [kg EqCO$_2$]

i : number of doors and windows [-]

$S_{Ch,i}$: area of frame for door or window i [m²]

$GES_{F,Ch,i}$: greenhouse gas emissions from manufacturing door or window frames [kg EqCO$_2$/m²]

$N_{C,Ch,i}$: number of cycles of the frame Ch [-]

7.2.1.4.3 *Greenhouse gas emissions from manufacturing window spacers*

$$GES_{F,FE,Esp} = \sum_i (e_{v,i} + 2.d_{Esp,i}).0,001.\big[2(h_i - 2.e_{Ch,i}) + 2(l_i \\ - 2.e_{Ch,i})\big].\big(GES_{Esp,i}.\rho_{Esp,i}.N_{C,Esp,i}\big)$$

Where:

$GES_{F,FE,Esp}$: greenhouse gas emissions from manufacturing window spacers [kg EqCO$_2$]

$e_{v,i}$: total spacing between panes for window i [m]

$d_{Esp,i}$: thickness of spacers for window i [m][12]

0.001 : default profile length proposed [m]

h_i: height of door or window i [m]

$e_{Ch,i}$: thickness of frame of door or window i [m]

pmp

l_i: width of door or window i [m]

$GES_{Esp,i}$: greenhouse gas emissions from manufacturing spacers for window i [kg EqCO$_2$/kg]

$\rho_{Esp,i}$: density of spacers for window i [kg/m³]

$N_{C,Esp,i}$: number of cycles of spacer Esp [-]

In the case of triple glazing: $e_{v,i} = \sum Esp_i . 2$

In the case of quadruple glazing: $e_{v,i} = \sum Esp_i . 3$

7.2.1.5   *Greenhouse gas emissions from manufacturing structure*

$$GES_{F,ST} = GES_{ST}^* . m_{ST}$$

Where:

$GES_{F,ST}$: greenhouse gas emissions from manufacturing structure [kg EqCO$_2$]

GES_{ST}^* : approximate greenhouse gas emissions from manufacturing structure [kg EqCO$_2$/kg] – see 'Appendix 3'

m_{ST} : mass of the structure [kg]

7.2.1.6   *Greenhouse gas emissions from manufacturing foundations*

$$GES_{F,FO} = GES_{F,FO,RA} + GES_{F,FO,SE} + GES_{F,FO,PIE} + GES_{F,FO,MU} + GES_{F,FO,PL}$$

Where:

$GES_{F,FO}$: greenhouse gas emissions from manufacturing foundations [kg EqCO$_2$]

$GES_{F,FO,RA}$: greenhouse gas emissions from manufacturing rafts [kg EqCO$_2$]

$GES_{F,FO,SE}$: greenhouse gas emissions from manufacturing footings [kg EqCO$_2$]

$GES_{F,FO,PIE}$: greenhouse gas emissions from manufacturing piles [kg EqCO$_2$]

$GES_{F,FO,MU}$: greenhouse gas emissions from manufacturing foundation walls [kg EqCO$_2$]

$GES_{F,FO,PL}$: greenhouse gas emissions from manufacturing floors [kg EqCO$_2$]

7.2.1.6.1   *Greenhouse gas emissions from manufacturing rafts*

$$GES_{F,FO,RA} = 0$$

Where:

$GES_{F,FO,RA}$: greenhouse gas emissions from manufacturing rafts [kg EqCO$_2$]

The data for the rafts has already be entered under the external walls.

7.2.1.6.2   *Greenhouse gas emissions from manufacturing footings*

$$GES_{F,FO,SE} = 0,5 . 0,5 \left(P_b - l_{mit,g} + l_{mp,i} \right) . GES_{F,FO,SE} . \rho_{FO,SE}$$

pmp

Where:

$GES_{F,FO,SE}$: greenhouse gas emissions from manufacturing footings [kg EqCO$_2$]

$GES_{F,FO,SE}$: depth of footing [m]

$GES_{F,FO,SE}$: width of footing [m]

P_b : perimeter of building [m]

$l_{mit,g}$: length of party wall for floor g [m]

$l_{mp,i}$: length of internal load-bearing walls [m]

$GES_{F,FO,SE}$: greenhouse gas emissions from manufacturing footing material [kg EqCO$_2$/kg]

$\rho_{FO,SE}$: density of footing material [kg/m³]

7.2.1.6.3   Greenhouse gas emissions from manufacturing piles

$$GES_{F,FO,PIE} = V_{PIE}.GES_{F,FO,PIE,mat}.\rho_{FO,PIE}$$

Where:

$GES_{F,FO,PIE}$: greenhouse gas emissions from manufacturing piles [kg EqCO$_2$]

V_{PIE} : volume of piles [m³]

$GES_{F,FO,PIE,mat}$: greenhouse gas emissions from manufacturing pile material [kg EqCO$_2$/kg]

$\rho_{FO,PIE}$: density of piles [kg/m³]

7.2.1.6.4   Greenhouse gas emissions from manufacturing foundation walls

$$GES_{F,FO,MU} = S_{Fond}.GES_{F,FO,MU}$$

In the case where the construction is directly on the ground, then:

$$GES_{F,FO,MU} = 0$$

Where:

$GES_{F,FO,MU}$: greenhouse gas emissions from manufacturing foundation walls [kg EqCO$_2$]

S_{Fond} : nett area of foundation wall [m²]

$GES_{F,FO,MU}$: approximate greenhouse gas emissions from manufacturing foundation walls [kg EqCO$_2$/m²]

7.2.1.6.5   Greenhouse gas emissions from manufacturing foundation floors

In the case where the construction is on a raft or over a void, then:

$$GES_{F,FO,PL} = 0$$

In the case of a cellar:

$$GES_{F,FO,PL} = S_{PL}.GES^*_{F,FO,PL}$$

Where:

$GES_{F,FO,PL}$: greenhouse gas emissions from manufacturing floors [kg EqCO$_2$]

S_{PL} : area of cellar floor [m²]

pmp

$GES_{F,FO,PL}^{*}$: approximate greenhouse gas emissions from manufacturing floors [kg EqCO$_2$/m²] – see 'Appendix 4'

7.2.1.7 *Greenhouse gas emissions from manufacturing miscellaneous elements*

By default, we shall consider that the greenhouse gas emissions from manufacturing miscellaneous element are zero.

However, users will be left the possibility of manually entering data corresponding to their heating or ventilation systems or any other element they might wish to include in the calculation.

7.2.1.8 *Greenhouse gas emissions from transport*

$$GES_{T,mat} = \sum_{i=0}^{m} m_{mat,i}.I_{mat,i}.N_{km,i} + \sum_{j=0}^{l} S_{mat,j}.I_{mat,j}.N_{km,j} + \sum_{k=0}^{n} V_{mat,k}.I_{mat,k}.N_{km,k}$$

Where:

$GES_{T,mat}$: greenhouse gas emissions from transporting materials [kg EqCO$_2$/T.km]

$m_{mat,i}$: mass of material i [kg]

$I_{mat,i}$: greenhouse gas emissions from transport of material i [kg EqCO$_2$/T]

$S_{mat,j}$: area of material j [m²]

$I_{mat,j}$: greenhouse gas emissions from transport of material j [kg EqCO$_2$/m²]

$V_{mat,k}$: volume of material k [m³]

$I_{mat,k}$: greenhouse gas emissions from transport of material k [kg EqCO$_2$/m³]

N_{km} : number of kilometres travelled for materials i , j and k [km]

7.2.2 **Overall greenhouse gas emissions in use**

$$GES_{U,G} = GES_{U,G,r}.S_{Ref}.D_{V,B}$$

Where:

$GES_{U,G}$: overall greenhouse gas emissions in use [kg EqCO$_2$]

$GES_{U,G,r}$: overall referenced greenhouse gas emissions [kg EqCO$_2$/m².y]

S_{Ref} : energy reference area [m²]

$D_{V,B}$: building life [years] – see 5.4 – 'Building life'

These are the greenhouse gas emissions arising out of use of the building, provided by the PHPP.

7.2.3 **Overall greenhouse gas emissions from disposal**

$$GES_{E,G} = GES_{E,mat} + GES_{TE,mat}$$

Where:

$GES_{E,G}$: overall greenhouse gas emissions from disposal [kg EqCO$_2$]

$GES_{E,mat}$: overall greenhouse gas emissions from disposal of the materials [kg EqCO$_2$]

$GES_{TE,mat}$: greenhouse gas emissions from transporting materials for disposal [kg EqCO$_2$]

With:

$$GES_{E,mat} = GES_{E,PE} + GES_{E,PI} + GES_{E,PL} + GES_{E,FE} + GES_{E,ST} + GES_{E,FO} + GES_{E,DI}$$

Where:

$GES_{E,mat}$: overall greenhouse gas emissions from disposal of the materials [kg EqCO$_2$]

$GES_{E,PE}$: greenhouse gas emissions from disposal of external walls [kg EqCO$_2$]

$GES_{E,PI}$: greenhouse gas emissions from disposal of internal walls [kg EqCO$_2$]

$GES_{E,PL}$: greenhouse gas emissions from disposal of floors [kg EqCO$_2$]

$GES_{E,PL}$: greenhouse gas emissions from disposal of doors and windows [kg EqCO$_2$]

$GES_{E,ST}$: greenhouse gas emissions from disposal of structure [kg EqCO$_2$]

$GES_{E,FO}$: greenhouse gas emissions from disposal of foundations [kg EqCO$_2$]

$GES_{E,DI}$: greenhouse gas emissions from disposal of miscellaneous elements [kg EqCO$_2$]

7.2.3.1 *Greenhouse gas emissions from disposal of external walls*

$$GES_{E,PE} = \sum_{x=1}^{n} GES_{E,PE,x}$$

Where:

$GES_{E,PE}$: greenhouse gas emissions from disposal of external walls [kg EqCO$_2$]

n : number of different walls [-]

$GES_{E,PE,x}$: greenhouse gas emissions from disposal of external wall x [kg EqCO$_2$]

*****

$$GES_{E,PE,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \{a_{m1,y} \cdot GES_{E,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y} + a_{m2,y} \cdot GES_{E,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y} + a_{m3,y} \cdot GES_{E,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y}\}$$

Where:

$GES_{E,PE,x}$: greenhouse gas emissions from disposal of external wall x [kg EqCO$_2$]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$GES_{E,mi,y}$: greenhouse gas emissions from disposal of material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

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7.2.3.2 *Greenhouse gas emissions from disposal of internal walls*

In detail, the greenhouse gas emissions from disposal of internal walls will be calculated as follows:

$$GES_{E,PI} = \sum_{x=1}^{n} GES_{E,PI,x}$$

Where:

$GES_{E,PI}$: greenhouse gas emissions from disposal of internal walls [kg EqCO$_2$]

n : number of different walls [-]

$GES_{E,PI,x}$: greenhouse gas emissions from disposal of internal wall x [kg EqCO$_2$]

<center>*****</center>

$$GES_{E,PI,x} = S_x \cdot \sum_{y=1}^{q} e_y \cdot \{ a_{m1,y} \cdot GES_{E,m1,y} \cdot N_{C,m1,y} \cdot \rho_{m1,y} + a_{m2,y} \cdot GES_{E,m2,y} \cdot N_{C,m2,y} \cdot \rho_{m2,y}$$
$$+ a_{m3,y} \cdot GES_{E,m3,y} \cdot N_{C,m3,y} \cdot \rho_{m3,y} \}$$

Where:

$GES_{E,PI,x}$: greenhouse gas emissions from disposal of internal wall x [kg EqCO$_2$]

S_x: nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material y in layer [-]

$GES_{E,mi,y}$: greenhouse gas emissions from disposal of material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

<center>*****</center>

It will be possible to enter data for the internal walls per m² of standard wall, i.e.:

$$GES_{E,PI,x} = S_x \cdot GES_{E,PI,x}^{*}$$

Where:

$GES_{E,PI,x}$: greenhouse gas emissions from disposal of internal wall x [kg EqCO$_2$]

S_x : nett area of wall x [m²]

$GES_{E,PI,x}^{*}$: approximate greenhouse gas emissions for disposal of internal wall x [kg EqCO$_2$/m²] – see 'Appendix 1'

We note that the disposal energy for internal doors is considered in section 7.2.3.4 'Manufacturing energy for doors and windows'.

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7.2.3.3 *Overall greenhouse gas emissions from disposal of floors*

In detail, the greenhouse gas emissions from disposal of floors will be calculated as follows:

$$GES_{E,PL} = \sum_{x=1}^{r} GES_{E,PL,x}$$

Where:

$GES_{E,PL}$: greenhouse gas emissions from disposal of floors [kg EqCO$_2$]

r : number of different floors [-]

$GES_{E,PL,x}$: greenhouse gas emissions from disposal of floor x [kg EqCO$_2$]

*****

$$GES_{E,PL,x} = S_x . \sum_{y=1}^{q} e_y . \{ a_{m1,y} . GES_{E,m1,y} . N_{C,m1,y} . \rho_{m1,y} + a_{m2,y} . GES_{E,m2,y} . N_{C,m2,y} . \rho_{m2,y} \\ + a_{m3,y} . GES_{E,m3,y} . N_{C,m3,y} . \rho_{m3,y} \}$$

Where:

$GES_{E,PL,x}$: greenhouse gas emissions from disposal of floor x [kg EqCO$_2$]

S_x : nett area of wall x [m²]

q : number of layers per element [-]

e_y : thickness of layer y [m]

$a_{mi,y}$: percentage of material mi in layer y [-]

$GES_{E,mi,y}$: greenhouse gas emissions from disposal of material mi in layer y [MJ/kg]

$N_{C,mi,y}$: number of cycles of material mi in layer y [-]

$\rho_{mi,y}$: density of material mi in layer y [kg/m³]

Rather more approximately, it may be calculated as follows:

- <u>In the case where there is only a single composition for internal floors</u>:

$$GES_{E,PL} = S_{PL} . GES_{E,PL}^*$$

Where:

$GES_{E,PL}$: greenhouse gas emissions from disposal of floors [kg EqCO$_2$]

$S_{PL,AP}$: area of internal floor [m²]

$GES_{E,PL}^*$: approximate greenhouse gas emissions from manufacturing floors [kg EqCO$_2$/m²] – see 'Appendix 2'

- <u>In the case where there are various compositions for internal floors</u>:

$$GES_{E,PL} = \sum_{r} S_{PL,r} . GES_{E,PL,r}^*$$

Where:

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$GES_{E,PL}$: greenhouse gas emissions from disposal of floors [kg EqCO₂]

$S_{PL,r}$: area of internal floor r [m²][12]

$GES_{F,PL,r}^{*}$: approximate greenhouse gas emissions from disposal of internal floor r [kg EqCO₂/m²] – see 'Appendix 2'

r : number of floors [-]

7.2.3.4 *Greenhouse gas emissions from disposal of doors and windows*

$$GES_{E,FE} = GES_{E,FE,V} + GES_{E,FE,Ch} + GES_{E,FE,Esp}$$

Where:

$GES_{E,FE}$: greenhouse gas emissions from disposal of doors and windows [kg EqCO₂]

$GES_{E,FE,V}$: greenhouse gas emissions from disposal of glazing and opaque panels for doors and windows [kg EqCO₂]

$GES_{E,FE,Ch}$: greenhouse gas emissions from disposal of door and window frames [kg EqCO₂]

$GES_{E,FE,Esp}$: Greenhouse gas emissions from disposal of window spacers [kg EqCO₂]

7.2.3.4.1 *Greenhouse gas emissions from disposal of glazing and opaque panels for doors and windows*

$$GES_{E,FE,V} = \sum_{i} \left\{ \left(S_{THC,i} - S_{PO,i} . N_{C,V,i} \right) . GES_{E,V,i} + S_{PO,i} . GES_{E,PO,i} . N_{C,PO,i} \right\}$$

Where:

$GES_{E,FE,V}$ *: greenhouse gas emissions from disposal of glazing and opaque panels for doors and windows [kg EqCO₂]*

i : number of doors and windows [-]

$S_{THC,i}$: total area of door or window i excluding frame [m²]

$S_{PO,i}$: area of opaque panel for door or window i [m²]

$GES_{E,V,i}$: greenhouse gas emissions from disposal of glazing [kg EqCO2/m²]

$GES_{E,PO,i}$: greenhouse gas emissions from disposal of door or window opaque panels [kg EqCO₂/m²]

$N_{C,V,i}$: number of cycles in glazing V [-]

$N_{C,PO,i}$: number of cycles in opaque panel PO [-]

7.2.3.4.2 *Greenhouse gas emissions from disposal of door and window frames*

$$GES_{E,FE,Ch} = \sum_{i} S_{Ch,i} . GES_{E,Ch,i} . N_{C,Ch,i}$$

Where:

$GES_{E,FE,Ch}$: greenhouse gas emissions from disposal of door and window frames [kg EqCO₂]

i : number of doors and windows [-]

$S_{Ch,i}$: area of frame for door or window i [m²]

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$GES_{E,Ch,i}$: greenhouse gas emissions from disposal of door or window frame i [kg EqCO$_2$/m²]

$N_{C,Ch,i}$: number of cycles of the frame Ch [-]

7.2.3.4.3 *Greenhouse gas emissions from disposal of window spacers*

$$GES_{E,FE,Esp} = \sum_i (e_{v,i} + 2.d_{Esp,i}).0,001.\big[2(h_i - 2.e_{Ch,i}) + 2(l_i - 2.e_{Ch,i})\big].\big(GES_{E,Esp,i}.\rho_{Esp,i}.N_{C,Esp,i}\big)$$

Where:

$GES_{E,FE,Esp}$: Greenhouse gas emissions from disposal of window spacers [kg EqCO$_2$]

$e_{v,i}$: total spacing between panes for window i [m]

$d_{Esp,i}$: thickness of spacers for window i [m][9]

0.001 : default profile length proposed [m]

h_i : height of door or window i [m]

$e_{Ch,i}$: thickness of frame of door or window i [m]

l_i: width of door or window i [m]

$GES_{E,Esp,i}$: greenhouse gas emissions from disposal of spacers for window i [kg EqCO$_2$/kg]

$\rho_{Esp,i}$: density of spacers for window i [kg/m³]

$N_{C,Esp,i}$: number of cycles of spacer Esp [-]

In the case of triple glazing: $e_{v,i} = \sum Esp_i.2$

In the case of quadruple glazing: $e_{v,i} = \sum Esp_i.3$

7.2.3.5 *Greenhouse gas emissions from disposal of structure*

$$GES_{E,ST} = GES_{ST}^*.m_{ST}$$

Where:

$GES_{E,ST}$: greenhouse gas emissions from disposal of structure [kg EqCO$_2$]

GES_{ST}^* : approximate greenhouse gas emissions from disposal of structure [kg EqCO$_2$/kg] – see 'Appendix 3'

m_{ST} : mass of the structure [kg]

7.2.3.6 *Greenhouse gas emissions from disposal of foundations*

$$GES_{E,FO} = GES_{E,FO,RA} + GES_{E,FO,SE} + GES_{E,FO,PIE} + GES_{E,FO,MU} + GES_{E,FO,PL}$$

Where:

$GES_{E,FO}$: greenhouse gas emissions from disposal of foundations [kg EqCO$_2$]

$GES_{E,FO,RA}$: greenhouse gas emissions from disposal of rafts [kg EqCO$_2$]

---

[9] We shall adopt a default value of 0.004 m.

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$GES_{E,FO,SE}$: greenhouse gas emissions from disposal of footings [kg EqCO$_2$]

$GES_{E,FO,PIE}$: greenhouse gas emissions from disposal of piles [kg EqCO$_2$]

$GES_{E,FO,MU}$: greenhouse gas emissions from disposal of foundation walls [kg EqCO$_2$]

$GES_{E,FO,PL}$: greenhouse gas emissions from disposal of floors [kg EqCO$_2$]

7.2.3.6.1   Greenhouse gas emissions from disposal of rafts

$$GES_{E,FO,RA} = 0$$

Where:

$GES_{E,FO,RA}$: greenhouse gas emissions from disposal of rafts [kg EqCO$_2$]

The data for the rafts has already be entered under the external walls.

7.2.3.6.2   Greenhouse gas emissions from disposal of footings

$$GES_{E,FO,SE} = 0,5 \cdot 0,5 \left(P_b - l_{mit,g} + l_{mp,i}\right).GES_{E,FO,SE} \cdot \rho_{FO,SE}$$

Where:

$GES_{E,FO,SE}$: greenhouse gas emissions from disposal of footings [kg EqCO$_2$]

0,5 : depth of footing [m]

0,5 : width of footing [m]

P_b : perimeter of building [m]

$l_{mit,g}$: Length of party wall for floor $GES_{E,FO,SE}$ [m]

$l_{mp,i}$: length of internal load-bearing walls [m]

$GES_{E,FO,SE}$: greenhouse gas emissions from disposal of footing material [kg EqCO$_2$/kg]

$\rho_{FO,SE}$: density of footing material [kg/m³]

7.2.3.6.3   Greenhouse gas emissions from disposal of piles

$$GES_{E,FO,PIE} = V_{PIE}.GES_{E,FO,PIE,mat} \cdot \rho_{FO,PIE}$$

Where:

$GES_{E,FO,PIE}$: greenhouse gas emissions from disposal of piles [kg EqCO$_2$]

V_{PIE} : *volume of piles [m³]*

$GES_{E,FO,PIE,mat}$: greenhouse gas emissions from disposal of pile material [kg EqCO$_2$/kg]

$\rho_{FO,PIE}$: density of piles [kg/m³]

7.2.3.6.4   Greenhouse gas emissions from disposal of foundation walls

$$GES_{E,FO,MU} = S_{Fond}.GES_{E,FO,MU}$$

In the case where the construction is directly on the ground, then:

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$$GES_{E,FO,MU} = 0$$

Where:

$GES_{E,FO,MU}$: greenhouse gas emissions from disposal of foundation walls [kg EqCO$_2$]

S_{Fond} : nett area of foundation wall [m²]

$GES_{E,FO,MU}$: approximate greenhouse gas emissions from disposal of foundation walls [kg EqCO$_2$/m²]

7.2.3.6.5   Greenhouse gas emissions from disposal of floors

In the case where the construction is on a slab or over a void, then:

$$GES_{E,FO,PL} = 0$$

In the case of a cellar:

$$GES_{E,FO,PL} = S_{PL} \cdot GES^*_{E,FO,PL}$$

Where:

$GES_{E,FO,PL}$: greenhouse gas emissions from disposal of floors [kg EqCO$_2$]

S_{PL} : area of cellar floor [m²]

$GES^*_{E,FO,PL}$: approximate greenhouse gas emissions from disposal of floors [kg EqCO$_2$/m²] – see 'Appendix 4'

7.2.3.7   Greenhouse gas emissions from disposal of miscellaneous elements

By default, we shall consider that the greenhouse gas emissions from disposal of miscellaneous elements are zero.

However, users will be left the possibility of manually entering data corresponding to their heating or ventilation systems or any other element they might wish to include in the calculation.

7.2.3.8   Greenhouse gas emissions from disposal transport

$$GES_{TE,mat} = \sum_{i=0}^{m} m_{mat,i} \cdot I_{E,mat,i} \cdot N_{km,i} + \sum_{j=0}^{l} S_{mat,j} \cdot I_{E,mat,j} \cdot N_{km,j} + \sum_{k=0}^{n} V_{mat,k} \cdot I_{E,mat,k} \cdot N_{km,k}$$

Where:

$GES_{TE,mat}$: greenhouse gas emissions from transporting materials for disposal [kg EqCO2]

$m_{mat,i}$: mass of material i [kg]

$I_{E,mat,i}$: greenhouse gas emissions from disposal transport for material i [kg EqCO$_2$/kg/km]

$S_{mat,j}$: area of material j [m²]

$I_{E,mat,j}$: greenhouse gas emissions from disposal transport for material j [kg EqCO$_2$/m²/km]

$V_{mat,k}$: volume of material k [m³]

$I_{E,mat,k}$: greenhouse gas emissions from disposal transport for material k [kg EqCO$_2$/m³/km]

$N_{km,i}$: number of kilometres travelled for materials i , j , and k [km]

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8 DATA REQUIRED

In order to obtain results concerning a building 's overall energy and greenhouse gas emissions profile, it will first be necessary to enter the data concerning this building.

Two methods may be used. For those using the PHPP2007 software, a large part of the data will be extracted directly from that program and imported into the BeGlobal module. It will then only remain to fill in the information not provided by the PHPP, but which is essential for the calculations.

For those users without the PHPP2007 software, it will be possible to perform all the calculations, but more information will have to be given. Nevertheless, these calculation will be slightly more approximate.

The data required are detailed in the User Guide, which covers the method for using the BeGlobal software step by step. We invite you to refer to this.

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9 RESULTS

After entering the data for their project, users of the BeGlobal module will obtain a set of results.

The building's overall energy and greenhouse gas emissions profiles will be expressed in various units:

- kWh/m²/an
- kg EqCO$_2$/m²/y

- kWh/m²
- kg EQCO$_2$/m²

- kWh/m²/number of occupants
- kg EqCO$_2$/m²/number of occupants

- kWh/number of occupants
- kg EqCO2/number of occupants

A section discussing the interpretation of the results will be written after the tool's testing phase and will be presented in the BeGlobal module User Guide.

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10 REFERENCES

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GROBE, C., 2008. Construire une maison passive, conception, physique de la construction, détails de construction, rentabilité. *[Building a passive house, design, physics of the construction, constructional details, profitability]* Paris, L'Inédite, 148 p. ISBN 978-2-35032-120-2

Passivhaus Institut, 2007. Passive house design software 2007 – PHPP 2007 – Requirements relating to passive house certification. 201 p.

(1) SPW – Wallonia environment portal, *Authorized centres for sorting/recycling inert waste from construction and demolition.* http://environnement.wallonie.be/

11 APPENDICES

11.1 Appendix 1 – Default values proposed for approximate energy and greenhouse gas emissions for manufacture and disposal of internal walls

Wall type	Approximate total primary energy, manufacture [kWh/m²]		Approximate primary energy, disposal [kWh/m²]		Approximate greenhouse gas emissions, manufacture [kg EqCO$_2$/m²]		Approximate greenhouse gas emissions, disposal [kg EqCO$_2$/m²]	
	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois
Light masonry partition wall 1	3724.363586	3724.363586	209.27972	209.27472	188.3694341	188.3674341	9,780898	9,780838
Light masonry partition wall 2	3726.953586	3753.511232	209.27972	209.27472	188.5304341	189.9389205	9,780898	9,780838
Timber partition with acoustic insulation (MW)	4832.712853	4831.832853	279.41196	279.41396	240.9311636	239.8141636	13,060244	13,059914
Timber partition without acoustic insulation	4305.981673	4305.841673	209.54672	209.54772	215.8642516	214.7572516	9,796128	9,795918
Metal partition with acoustic insulation (MW)	3708.868898	3708.088898	279.30396	279.30496	187.4597311	187.0277311	13,052764	13,052444
Metal partition without acoustic insulation	3182.137718	3182.097718	209.43872	209.43872	162.3928191	161.9708191	9,788648	216,067952

Detail of the assumptions made and the materials chosen as per the database:

Light masonry partition wall 1:

	KBOB	Ecobilan de parois
10 mm mineral coating	'Mineral coating'	'Plaster coated'
90 mm terracotta brick	'Terracotta brick'	'Terracotta brick'
10 mm mineral coating	'Mineral coating'	'Plaster coated'

Light masonry partition wall 2:

	KBOB	Ecobilan de parois
10 mm mineral coating	'Mineral coating'	'Plaster coated'
90 mm expanded clay concrete block	'Stone, light concrete: expanded clay'	'Expanded clay concrete block'
10 mm mineral coating	'Mineral coating'	'Plaster coated'

Timber partition with acoustic insulation:

	KBOB	Ecobilan de parois
12 mm Paper-lined	'Paper-lined plasterboard'	'Paper-lined plasterboard'

	plasterboard		

200 mm with 87.5 % mineral wool	'Glassfibre wool'	'Glassfibre wool'
200 mm with 12.5 % timber studding	'Solid timber spruce / pine / larch, kiln-dried, planed'	'Framing in European coniferous timber'
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'

Timber partition without acoustic insulation:

	KBOB	*Ecobilan de parois*
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'
70 mm with 12.5 % timber studding	'Solid timber spruce / pine / larch, kiln-dried, planed'	'Framing in European coniferous timber'
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'

Metal partition with acoustic insulation:

	KBOB	*Ecobilan de parois*
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'
200 mm with 99.6 % mineral wool	'Glassfibre wool'	'Glassfibre wool'
200 mm with 0.4 % aluminium studding	'Bare aluminium profiles'	'Aluminium profile (30% recycl.)''
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'

Metal partition without acoustic insulation:

	KBOB	*Ecobilan de parois*
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'
70 mm with 0.4 % aluminium studding	'Bare aluminium profiles'	'Aluminium profile (30% recycl.)''
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'

11.2 Appendix 2 – Default values proposed for approximate energy and greenhouse gas emissions for manufacture and disposal of internal floors

Floor type	Approximate total primary energy, manufacture [kWh/m²]		Approximate primary energy, disposal [kWh/m²]		Approximate greenhouse gas emissions, manufacture [kg EqCO$_2$/m²]		Approximate greenhouse gas emissions, disposal [kg EqCO$_2$/m²]	
	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois
Beam-and-block	No data	3776.884955	No data	348.7872	No data	187.2503338	No data	16,30302
Timber	9651.471911	9356.683369	418.61944	418.49344	477.0834951	455.7319105	19,712236	19,673706
Concrete slab	5058.194656	3539.700589	279.17896	279.17396	253.8584581	175.9177994	13,050154	13,049874

Detail of the assumptions made and the materials chosen as per the database:

Beam-and-block:

	KBOB	*Ecobilan de parois*
8 mm tiling	'Ceramic/stoneware paving'	'Stoneware/ceramic tiling'
80 mm screed	'Cement screed'	'Cement screed'
4 mm compression screed	**No data**	'Compression screed on beam-and-block'
130 mm or 160 mm infill blocks	**No data**	'Concrete infill blocks'
10 mm mineral coating	'Mineral coating'	'Plaster coated'

Timber:

	KBOB	*Ecobilan de parois*
10 mm wood floor covering	'Solid beech / oak, kiln-dried, planed'	'Solid wooden floor – European coniferous'
24 mm wood fibre	'Low-density particle board'	'Wooden fibre board'
15 mm OSB	'OSB fibreboard, PF bonding, wet areas'	'OSB board'
230 mm with 16 % timber structure	'Solid timber spruce / pine / larch, kiln-dried, planed'	'Framing in European coniferous timber'
20 mm with 10 % framing	'Solid timber spruce / pine / larch, kiln-dried, planed'	'Framing in European coniferous timber'
12 mm Paper-lined plasterboard	'Paper-lined plasterboard'	'Paper-lined plasterboard'

Concrete slab:

	KBOB	*Ecobilan de parois*
8 mm tiling	'Ceramic/stoneware paving'	'Stoneware/ceramic tiling'
60 mm screed	'Cement screed'	'Cement screed'
160 mm C25/30 concrete	'C25/30 concrete especially for foundations / slabs'	'Ordinary reinforced concrete (slabs)'
10 mm mineral coating	'Mineral coating'	'Plaster coated'

11.3 Appendix 3 – Default values proposed for approximate energy and greenhouse gas emissions for manufacture and disposal of structures

Structure type	Approximate total primary energy, manufacture [kWh/m²]		Approximate primary energy, disposal [kWh/m²]		Approximate greenhouse gas emissions, manufacture [kg EqCO$_2$/m²]		Approximate greenhouse gas emissions, disposal [kg EqCO$_2$/m²]	
	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois
Metal	509.1580169	508.4580169	69.61824	69.61824	25.18855497	26.02355497	3,254016	3,254016
Concrete	236.221366	236.312366	69.82024	69.81924	11.2095344	11.2525344	3,264516	3,264416
Timber	1776.001972	1775.901972	69.72624	69.72724	87.64498746	86.53998746	3,261496	3,261486

Detail of the assumptions made and the materials chosen as per the database:

	KBOB	Ecobilan de parois
Metal	'Reinforcing steel'	'Reinforcing steel'
Concrete	'C25/30 concrete especially for foundations / slabs'	'Ordinary reinforced concrete (slabs)'
Timber	'Solid timber spruce / pine / larch, kiln-dried, planed'	'Framing in European coniferous timber'

11.4 Appendix 4 – Default values proposed for approximate energy and greenhouse gas emissions for manufacture and disposal of foundation floors

Floor type	Approximate total primary energy, manufacture [kWh/m²]		Approximate primary energy, disposal [kWh/m²]		Approximate greenhouse gas emissions, manufacture [kg EqCO$_2$/m²]		Approximate greenhouse gas emissions, disposal [kg EqCO$_2$/m²]	
	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois	KBOB	Ecobilan de parois
Concrete slab	3301.855223	3539.700589	279.17896	279.17396	253.8584581	175.9177994	13,050154	13,049874

Detail of the assumptions made:

Concrete slab:

	KBOB	*Ecobilan de parois*
8 mm tiling	'Ceramic/stoneware paving'	'Stoneware/ceramic tiling'
60 mm screed	'Cement screed'	'Cement screed'
160 mm C25/30 concrete	'C25/30 concrete especially for foundations / slabs'	'Ordinary reinforced concrete (slabs)'

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