Product Environmental Footprint Category Rules (PEFCR)

Thermal insulation products in building:

- **Applied in pitched roofs with massive timber rafters**
- **Applied in non-accessible flat roofs with concrete structure**

Draft on existing PCRs, Scope, Representative Products, and introduction to PEF Screening Study

Prepared by the Technical Secretariat of the PEF thermal insulation pilot

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List of Acronyms

B2B	Business to Business
B2C	Business to Consumer
BoM	Bill of Materials
CEN	European Committee for Normalisation
CML	Centre for Environmental Sciences in Leiden
CPR	Construction Products Regulation
DG	Directorate-General
ELCD	European Life Cycle Database
EN	European Norm
EoL	End of Life
EPD	Environmental Product Declaration
EPS	Expanded Polystyrene
ETICS	External Thermal Insulation Composite System
FU	Functional Unit
GHG	Greenhouse Gas
ILCD	International Life Cycle Data
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCT	Life Cycle Thinking
MEErP	Methodology for Energy related Products
NACE	Statistical classification of economic activities in the European Community
Nf	French Norm
PCR	Product Category Rules
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PIR	Polyisocyanurate
PUR	Polyurethane
RP	Representative Product
RSL	Reference Service Life
TC	Technical Committee
TS	Technical Secretariat
XPS	Extruded Polystyrene Foam

A Introduction

The primary purpose of this pilot project is to develop Product Environmental Footprint Category Rules (PEFCR) for thermal insulation products, creating a **level-playing field for thermal insulation stakeholders**. Two specific applications have been selected: pitched roofs with massive timber rafters and non-accessible flat roofs with concrete structure. Product Environmental Footprint (PEF) pilot studies are an initiative of the EU Commission's DG Environment, to develop PEFCRs for a specific product group based on the general guidelines of the PEF method[1].

PEFCRs provide specific guidance for calculating and reporting the life cycle environmental impacts for a product in a specific product group.

The objectives of the **PEF pilot study on thermal insulation products** are:

- to set up and validate the PEFCR for certain thermal insulation end-use applications, including efforts to develop and test environmental benchmarks,
- to test different compliance and verification systems, in order to set up and validate proportionate, effective and efficient compliance and verification systems,
- to test different business-to-business and business-to-consumer communication vehicles for PEF information in collaboration with stakeholders.

The PEFCR for this pilot covers all the thermal insulation products for the insulation of the pitched roofs and flat roofs as defined in the scope of this report[1].

A.1 Thermal insulation

According to the European Commission, buildings in 2010 accounted for 40% of primary energy consumption and 36 % of Greenhouse Gases emissions across the continent. It is one of the main levers to achieve the objectives of EU 2020 policy (20% reduction of GHG and energy consumption, achieving 20% renewable energy use).

This results in building thermal regulations of EU Member States for new and existing buildings, aimed at reducing the environmental impact of the building use phase. Thermal insulation plays a key role in this evolution of the construction sector by limiting heat transfer through the building envelope[2][3].

Future buildings will however not only be more energy-efficient, but their overall sustainability performance will be taken into account, which means that the environmental and health impacts of building products will increasingly be evaluated[4].

B Existing PCRs (Product Category Rules)

B.1 Introduction

Different standards have been developed to facilitate environmental evaluation based on LCA (ISO 14040 and ISO 14044) and more specifically for Type III environmental declarations (ISO 14025: 2006 the LCA based mechanism, more commonly known as Environmental Product Declarations (EPD)). The first European leading national standards regarding EPDs of

[1] A thermal insulation product is a product that is intended to reduce heat transfer through the structure against which, or in which, it is installed. Numerical limits can be set only when the specific application is defined (EN ISO 9229).

building products were the French NF P01-010 and the Dutch Standard NEN 8006 both established in 2004 for the environmental declaration of Building Products.

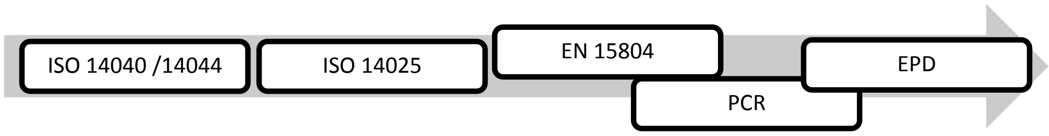

Figure 1 Environmental product declarations in building sector.

The building sector is currently implementing CEN/TC 350: EN 15804[5] and EN 15978[6]. In 2013 the PEF method[1] has been developed. The first step to finalise and shape the PEF method has been defined to be the PEF pilot phase, which is currently underway. PEFCRs resulting from the PEF pilot phase will become the product rules valid under the PEF[2], to be used by all stakeholders in the sector in the EU or internationally, who decide to measure the performance of their products based on the PEF Guide. CEN/TC88[7] using a similar approach is developing the PCR for thermal insulation products based on EN 15804 as the standard for thermal insulation.

B.2 Consistency analysis of EN 15804 and the PEF method

One of the outcomes of the work of CEN/TC350 "Sustainability of construction works" is the development of voluntary horizontal standardised methods for the assessment of the sustainability aspects of new and existing construction works, and for the environmental product declaration of construction products. The most similar work related to the PEF method at the product level is the EN 15804: Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products and at building level is the EN 15978: Sustainability of construction works - Assessment of environmental performance of buildings.

While the work of CEN TC350 focuses on construction products (in EN 15804) and construction works (in EN 15978), the PEF method is more general as it can be applied to all types of products in all different markets. The EN 15804 thus is more situated at the level of PEFCRs for different construction products than the general PEF method. This is therefore an important source to be considered when developing PEFCR for thermal insulation and for construction products in general.

EN 15804 developed within the framework of CEN TC350

In working group 3 of the CEN/TC 350 framework, core rules for the product category of construction products are developed: “EN 15804:2012+A1: 2013 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products, incl. amendment”.

The EN 15804 provides a structure to ensure that all EPDs are derived, verified and presented in a harmonised way[8]. It is organised in modules covering different life cycle stages. Some modules are mandatory (depending on the scope of the study - cradle to gate/cradle to gate with option/cradle to grave), others are optional (module D is optional). In France the regulation is based on the complete life cycle. It's mandatory to declare total production (A1-A3), total construction (A4-A5), total use (B1-B7) and total EoL (C1-C4) and the whole life cycle[9]. The indicators declared in the individual information modules of a product life cycle shall not be added up in any combination of the individual information modules into a total or subtotal of

[2] It should however be noted that a revision of the PEF Guide may require a revision of PEFCR.

the life cycle stages in order to give the user of the EPD more possibilities when aggregating information from different EPDs at the building level. This is hence an important difference compared to the PEF method.

In this pilot we made a **detailed comparison** of the PEF method and EN 15804 (Refer to Annex 7: “detailed consistency analysis of EN 15804 and the PEF method”). Four major differences are identified:

1- **Impact categories and impact assessment methods**: The PEF method includes a list of 14 midpoint impact categories that shall be considered, unless (1) otherwise specified in the PEFCR, or (2) exclusion of certain impact categories is justified as specified in the PEF Guide. The EN 15804 considers seven environmental impact categories for which the CML (IA version 4.1, October 2012) impact assessment methods from the University of Leiden must be used. In addition some other flow and material indicators are required to be included in EN 15804 based EPDs.
2- **Applications and use of the methods**: PEF studies are intended to be used for benchmarking and B2B and B2C communication, whereas EPDs according to the EN 15804 are developed to provide information for building assessment and at B2C communication building level only. That is why in the PEF method Normalisation and Weighting are approved, while this is not the case in EN 15804.
3- Recycling and End of Life: The PEF method includes both recycled content and recycling and energy recovery at end of life (EoL) within the system boundaries, whereas in EN 15804 the system boundary is defined as “until the end-of-waste state is reached”. For the allocation of the EoL related processes, the PEF method allocates 50% of the benefits and burdens of the recycling/reuse process to the consumer of recyclates and 50% to the “producer” of recyclates. In EN 15804 all burdens are allocate to the product until the end of waste condition is reached. No transfer of burdens or benefits is allowed between two product systems. The PEF guidelines on EoL allocation will be tested during the PEF pilots and may be adjusted if proved necessary.
4- Data quality requirements: The PEF method includes precise requirements for specific and generic data.

There are several other differences between the two methods such as: cut-off (not allowed during screening in PEF) and co-product allocation (according to the PEF method system expansion is allowed while this is not the case for EN 15804/ specific ratio is provided to define the borderline between physical and economical allocation in EN 15804 and not in PEF method).

Please refer to Annex 7: “detailed consistency analysis of EN 15804 and the PEF method” for a detailed comparison of both methods.

B.3 Available specific thermal insulation PCRs

There are existing PCRs for several product categories. Before starting the development of a new PEFCR for a certain product category, the PEF Guidance requires to carry out a thorough search to identify if PCRs for the same product category have been developed. All below mentioned PCRs are based on EN 15804, which is why the PEF and EN 15804 are analysed and compared in detail in Annex 7.

The main existing thermal insulation specific PCRs in Europe are:

- CEN/TC 88/WG 2 (Europe)
- International EPD® system (Sweden)
- IBU (Germany)

- Bau – EPD (Austria)
- Norge EPD system (Norway)

Working Draft for Product Category Rules (PCR) prEN 16783 [7]

Thermal insulation products – Product category rules (PCR) for factory made and in-situ formed products for preparing environmental product declarations – Complementary element (under study) latest version April 2014.

This standard provides specific product category rules for thermal insulation products based on the core rules for all construction products established in EN 15804. This PCR is intended for use in conjunction with EN 15804.

This PCR is valid for all insulation products and offers an overview of applications for thermal insulation.

PCR from the international EPD® system [10]

The International EPD® system - INSULATIONS MATERIALS latest version 2014-07-02. The PCR is valid until 2017-07-02.

This document provides Product Category Rules (PCR) for the assessment of the environmental performance of insulation materials and the declaration of their performance by an EPD. This PCR aims towards compliance with the European standard EN 15804[5].

The PCR document is a living document. If relevant changes in the LCA methodology or in the technology for the product category occur, the document will be revised and any changes will be published on the website.

The latest version of the document from July 2014 can be downloaded from: http://environdec.com/en/PCR/Detail/?Pcr=9604

IBU PCR

There are two main technical documents that form the framework for the creation of an EPD in the IBU program:

- **The Product Category Rules Part A**

  The PCR Part A specifies the contents of EN 15804 and describes the requirements for the background report and the calculation rules for the LCA. The PCR Part A is valid for all products and must therefore be used in all cases. In the "additions to Part A" further product-specific calculation rules are listed.

- **Specific PCR guidance texts Part B**

  Different product specific PCR guidance texts contain rules to be applied to all products within a defined scope (based on product families within the insulation market).

If a specific PCR text does not exist for a product, the creation of PCR Part B follows as the next step. The PCR guidance text specifies and complements the EN 15804 in the product-specific areas and serves as a template for the preparation of EPDs. In the database system the Part B serves as a template and indicates what information is required in each section.

For thermal insulation products the part B of some products is available on the website:

https://epd-online.com/Home/Index

Bau – EPD, Austrian EPD System

Bau – EPD has PCRs for thermal insulation products made from renewable materials, in-situ cellulose thermal insulation products and for thermal insulation products made from mineral wool.

All PCRs are based on the European standard EN 15804. The purpose of this document is to define clear guidelines for performing the underlying life cycle assessment (LCA).

PCRs for thermal insulations with final approval by Committee of Experts are published in 2014, to be revised if needed or after a period of 5 years.

The PCRs can be downloaded from http://www.bau-epd.at

Norwegian EPD System [11]

NPCR 12, Insulation materials, issued 10-12-2012 valid to 10.12.2017

These product category rules (PCR) are intended for companies preparing an Environmental Product Declaration (EPD) for all kind of Insulation products. The PCR is based on and represents a supplement to the European standard EN15804: 2012 - Sustainability of construction works – Environmental Product Declarations – core rules for the product category of construction products.

The PCRs can be accessed at www.epd-norge.no

Some other relevant PCRs are listed below:

- French XP P01-064 /CN[9]: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction - National addition to NF EN 15804+A1 – not available in English
- Dutch “Bepalingsmethode”: A method for determining the environmental performance of buildings and civil engineering works during their lifetime, based on EN 15804. This document prescribes how to follow the EN 15804 rules for the Dutch situation. It also gives additional information for some open ends of EN 15804 and adds different calculation rules and different default values.
- ITB (Poland) – (not available in English)
- Non-European PCRs such as the UL North American PCR[12] on insulation materials valid till September 2016 and the Australian draft PCR[13].

Ecodesign of thermal insulation in buildings study

A very relevant study was conducted on behalf of the European Commission DG Energy regarding the ecodesign of thermal insulation in buildings[14]. The study used parts of the MEErP methodology (Methodology for Energy related Products, DG ENTR 2011).

The Commission services conclude from the study that a specific ecodesign or energy labelling implementing measure should not be developed for this product group. It would not be appropriate either to adopt an ecodesign implementing measure only addressing product information requirements. It would be disproportionate administrative burden both for the authorities and institutions involved to carry such a measure through the adoption process, and for the manufacturers to implement it.

There is, however, a need for more clarity and information on the durability[15] of thermal insulation products, with a view to informing national and EU policy whether it is advisable to introduce product- or system-level requirements on this aspect. The Commission services therefore intend to explore, by the end of 2014, with the assistance of the European Standardisation Organisations, to what extent already existing EN standards and ongoing standardisation work cover durability appropriately for the purposes of collecting this information.

Commission services launched in June 2014 this PEFCR pilot for thermal insulation. The aim of the PEFCR is to provide specific rules to calculate the environmental footprint for thermal insulation products, including benchmark and, if appropriate, performance grades. The PEFCR will become increasingly relevant in the future, as more buildings in the EU become near-zero energy buildings, and further environmental improvements can only be achieved by addressing the entire lifecycle of building including thermal insulation products.

B.4 Non exhaustive list of thermal insulation EPDs

A non-limitative set of available EPDs and LCA studies on thermal insulations are listed in Annex 8 of this report. This task is not required by the PEF guidance document, but can result in valuable information for the construction of the PEFCR.

C Scope of the PEFCR (Product Environmental Footprint Category Rules)

C.1 Introduction

The building sector is responsible for a significant part of energy consumption, use of water and other raw materials and waste production, which causes impacts on the environment including human health.

The level of thermal insulation used in the envelope of the building influences the energy consumption for the heating and cooling of the building. The efficiency and effectiveness of the insulation depends on qualitative and quantitative characteristics. The qualitative aspects differ depending on the type of insulation product (differences in thermal conductivity, heat capacity...).

The most important dimensional aspect is the thickness of the insulation. The most important performance characteristic is the heat resistance of insulation. The right combination of qualitative and quantitative characteristics for a given application enables the elements of the building envelope to meet or exceed national thermal regulations. Different types of insulation products exist and insights into the impacts on the environment and human health of these different insulation products are gaining momentum.

According to ISO 9229, thermal insulation products for buildings are: *"factory made products in the form of rolls, bats, boards or slabs, with or without facings, or 'in-situ' applied materials, which have a primary function to reduce heat transfer through the structure against which, or in which, it is installed. Products covered by this definition may also be used in prefabricated thermal insulation systems and composite panels.*[3]*"*

Heat is transmitted in three different ways – **convection**, **conduction** and **radiation**. Heat flows naturally from a warmer to a cooler medium. In winter, the heat moves from all heated indoor spaces to the outdoors and during summer, heat might moves from outdoors to the interior of the building (when the outdoor temperature is higher than the indoor temperature).

The λ value is a material characteristic and represents the thermal conductivity of a material and is expressed in W/(m.K).

Thermal insulation is identified based on thermal resistance, known as the R-value, which indicates the resistance to heat flow (heat transfer per unit area per unit time). The higher the R-value, the better the insulating effectiveness. The R-value of thermal insulation depends on the material's thermal conductivity and its thickness and is equal to $R=d/\lambda$ (expressed in $m^2.K/W$). ("d" represents the thickness and λ the thermal conductivity.)

The U-factor or "U-value", the overall heat transfer coefficient, is a measure of heat loss through a material or building element such as a wall, floor or roof. A low U value indicates high levels of insulation and shall be calculated according EN 6946 prescriptions.

[3] Numerical limits can be set only when the specific application is defined

C.2 Product category definition and scope

Scope: This pilot covers thermal insulation applied in **(a) pitched roofs with massive timber rafters structures or** **(b) non-accessible flat roofs with a concrete structure.**

The scope is limited to these two specific applications so that the insulation can be considered as a final product. This approach enables accurate evaluation of the entire life cycle, creating a coherent basis for comparisons and related benchmarking. Assessing insulation products without knowledge of the final application would not enable the identification of hotspots, i.e. the most relevant life cycle stages, processes and environmental impacts.

In consequence, different rules will need to be developed in future for other applications of thermal insulation in buildings, such as thermal insulation in floors, in walls. As it is assumed that some of the rules will be valid for all applications, the PEFCR is drafted in two parts:

- PART 1: Horizontal rules intended to be valid for all building envelope thermal insulation applications.
- PART 2: Vertical rules that are valid for the specific applications selected in the scope of the pilot. We have selected two specific applications: pitched roofs with massive timber rafters and non-accessible flat roofs with concrete loadbearing structure.

This approach guarantees consistency between the different rules of thermal insulation products for different applications. All these rules can be structured in one PEFCR with different subcategories, as shown in Figure 2. To limit the number of vertical parts, the definition of the applications should be as broad as possible, whilst allowing meaningful rules and benchmarking.

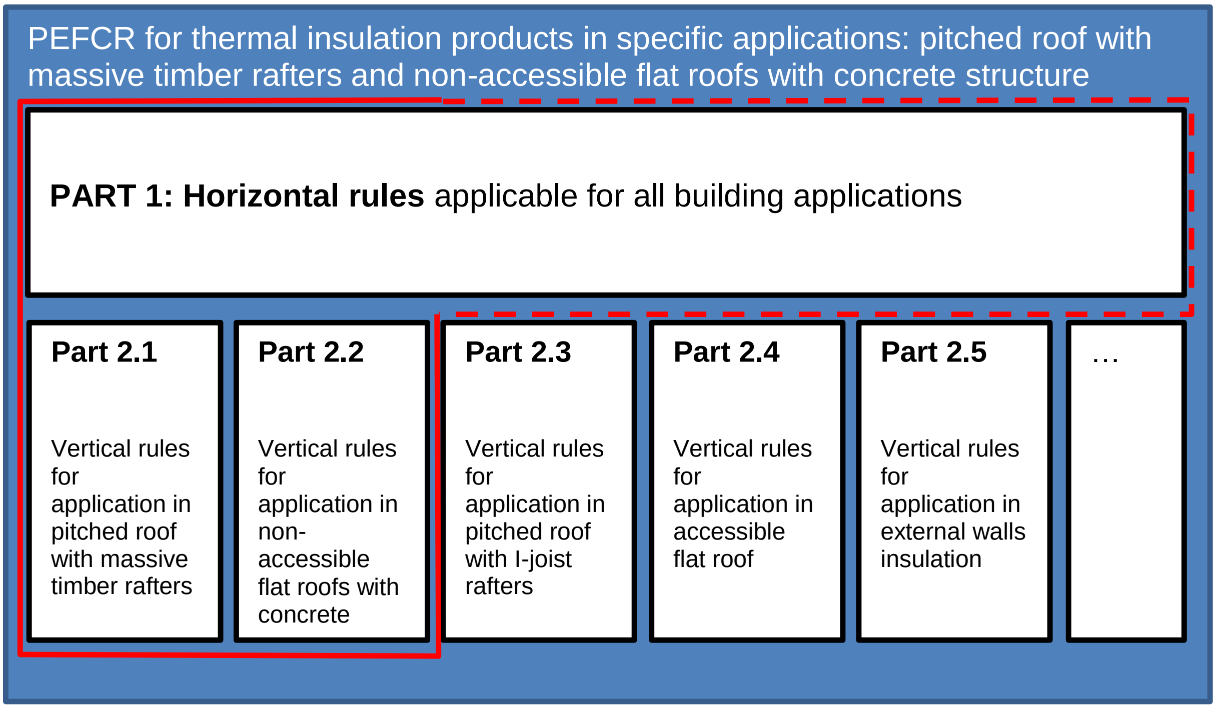

Figure 2 Structure of the PEFCR for thermal insulation products in specific applications

Note: Sensitivity analysis will verify which variations of the defined application can stay or extend the scope.

Note: The decision for a sensitivity analysis could be taken during the screening studies, on the basis of the added value of the assessment and the available budget.

C.2.1 Horizontal rules

The rules in the first part of the PEFCR refer to the ‘horizontal rules’ and are valid for the Product Category **Thermal insulation products in buildings.**

The scope of this first part of horizontal rules is limited to thermal insulation products **with a λ value lower or equal to 0.1 W/(m.K)**[4]. All products with a lower **R value than 0.25 (m^2.K)/W** [5] are excluded from the scope of the first (and in consequence also of the second part) of the PEFCR.

The primary intended use of the products in the scope of this part of the PEFCR is **the thermal insulation** of the building without excluding multi-functionality aspects. Both **factory-made** products and **in-situ** products are included.

Technical insulation (building equipment, industry and civil engineering) is **excluded** from the scope.

The horizontal rules are only valid for insulation products made of insulation materials that are participating in the pilot regardless of application.

Table 1 Material groups participating in the pilot

	EN standards
Glass wool	EN 13162: 2012 EN 14064 -1/2:2010
Stone wool	
EPS	EN 13163: 2012
XPS	EN 13164: 2012
PUR/PIR	EN 13165: 2012
Cellular glass	EN 13167: 2012
Wood fiber	EN 13171: 2012
Cellulose	ETA – EN 15101: pending citation in European official journal

C.2.2 Thermal insulation applications (vertical rules)

Several applications may be identified for the thermal insulation use at building level.

In the ISO/FDIS 9774 standard some examples of the most common applications of thermal insulation products in buildings are provided (Annexes 9 and 10). The ISO/FDIS 9774 standard provides guidelines on the thermal insulation for building applications (Guidelines for selecting properties).

DIN standards identify most common applications. These applications are mentioned in TC88 draft document. (Annex 11).

[4] Highest value mentioned in the product standards identified by TS partners (1 exemption was made in TC88 to go to 0.1)

[5] To exclude non-efficient products with a very low thickness

C.2.3 Selected application(s) for this pilot

Due to time restrictions the scope of this pilot is limited to two building applications, thermal insulation in pitched roofs with massive timber rafters and thermal insulation in non-accessible flat roofs with a loadbearing concrete structure. A more detailed description of the scope of the second part of the PEFCR consisting of the vertical rules for the selected applications is provided in the subsequent sections.

The choice of the applications in this pilot is based on their representativeness in Europe and that the products represented in the TS are all applicable in at least one of the applications. Based on these reasons, the following thermal insulation applications are selected for this pilot:

1. **Pitched roof with insulation above, between and/or under massive timber rafters**
2. **Non-accessible flat roof with a loadbearing concrete structure: conventional roof and inverted roof**

The applications have a narrow focus (see also description of the build-up in the subsequent sections) in order to allow for meaningful rules and benchmarking. The drawback of such a narrow focus is the high number subcategories of the PEFCR that will need to be developed in future. During the pilot we will examine the validity of the vertical rules for different variations of the build-up based on sensitivity analyses. If proven valid, the scope of the product category will be broadened.

C.2.4 Vertical rules for application in pitched roof with massive timber rafters

Figure 3 shows how thermal insulation is applied in the defined pitched roof for this pilot.

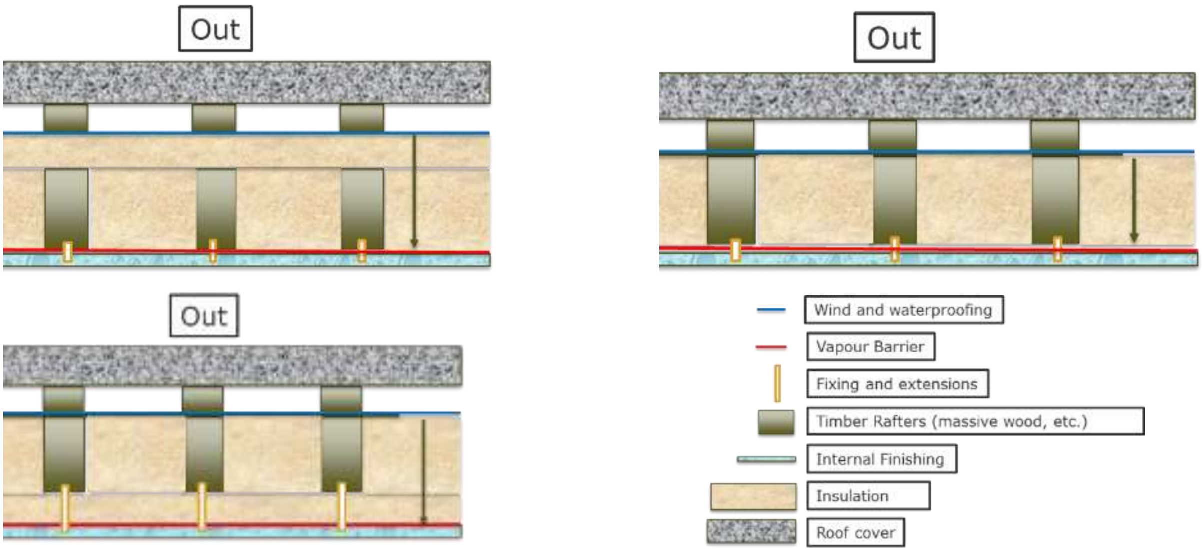

Figure 3 Cross section of pitched roof with massive timber rafters

The insulation is placed under, within or on top of the roof structure (or as a combination of these). Based on the insulation position (top between and/or under), the vapour barrier may be placed at different positions. As the insulation is sometimes placed between structural elements of the roof (e.g. rafters or perlings) and hence will determine the final U_c-value of the roof, it is important to include the structure in the scope of the assessment. Different types of structures for a pitched roof and different dimensions of the structural parts are used in current practice. In order to enable comparison between the different insulation alternatives, a fixed structure is defined.

For the pilot it is assumed that the structural part consists of rafters of massive timber. The rafter dimensions and their inter-distance differ across the 28 different Member States. For the pilot it is assumed that the rafter dimensions are **4.5 cm x 14 cm. The distance between the rafters is assumed to be 60 cm (axe to axe).** These values are based on a compromise between the different members of the TS, while this does not mean this is exactly equal to the dimensions of the common practice in one specific Member State.

<u>The scope of the thermal insulation in the pitched roof includes following parts:</u>

- Thermal insulation products, including packaging
- Necessary fixings for the installation of the thermal insulation
- If needed: additional extensions of the rafters to allow for insulation thicknesses larger than 14 cm if the insulation is put between the rafters
- Vapour barrier (may be placed at different positions based on the position of the insulation – If proven to be a common element (the same type of vapour barrier), the vapour barrier will be excluded
- Wind/water proofing.

Figure 4 shows the part excluded as common part in dark colour and the agreed dimensions. The timber rafters are included in the calculation of U_c-value as in some cases these are part of the insulation layer (the insulation is in some cases placed between the rafters). Including the rafter hence allows for comparisons between the different build-ups.

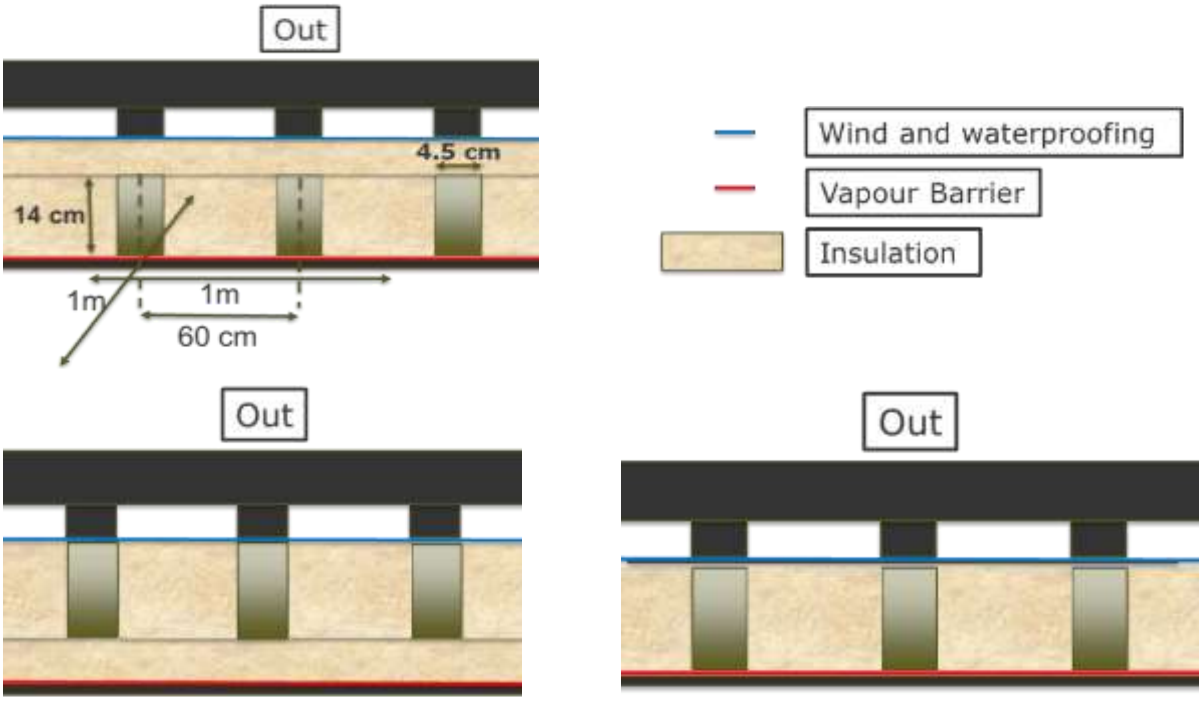

Figure 4 Scope of the pilot for the pitched roof (the part which is excluded from the scope is indicated in dark)

The following parts are **excluded from the scope**, as they are not influenced by the insulation layer (i.e. are used regardless of the type of insulation products) covered by this PEFCR:

- Timber rafters (4,5 cm x 14 cm; inter-distance of 60 cm) (axe to axe)
- Bracing of the roof structure
- Exterior finishing (everything placed outside of the wind/water proofing)
- Interior finishing (everything placed at the inner side of the vapour barrier)

Pre-fabricated building elements and insulation products incorporating parts defined as “common“ under this pilot project are used in the market but excluded from the scope. This exclusion for example covers sandwich panels. Only those prefab products for which all components belong to the scope of the pilot are included in the scope. All prefab products which include one or several of the parts that are excluded from the scope (e.g. interior finishing or exterior finishing, or laths for exterior finishing) are by definition excluded from the scope.

For the screening, alternatives are compared with an equal overall heat transfer co-efficient (Uc[6]-value) in order to enable meaningful comparisons. A **Uc-value of 0.14 W/(m²·K)** (R_T=7 m²K/W) has been fixed for the whole element, as this corresponds to the current common practice for new buildings in a moderate climate. A sensitivity analysis will also be made for Uc-values of 0.33 W/(m²·K) (R_T=3) and 0.10 W/(m²·K) (R_T=10) (0.33 for warm and 0.10 for cold continental climatic zones). The Uc-value does not relate to the insulation material solely but refers to the complete pitched roof. The thickness of insulation (taking account of thermal bridges) is based on the position of the insulation (above, between or/and below the rafters) and on the lambda values of the insulation material and of the wood rafters. The exact thickness of the insulation product is calculated by a third party based on the calculation of building element in order to achieve an equal performance as defined in the scope by all product specific build ups.

Note: The lambda value of the rafters is defined as 0.13 W/mK for all cases.

The list of participating insulation products is provided in table 2.

Table 2 Insulation products groups within the scope of pitched roof with massive timber rafters

Categories of product	EN standards
Glass wool product	EN 13162: 2012 EN 14064-1/2:2010
Stone wool product	
Wood fiber product	EN 13171: 2012
Cellulose product	ETA – EN 15101: pending citation in European official journal

C.2.5 Vertical rules for application in non-accessible flat roofs with concrete structure

Figure 5 and 6 show how insulation is applied in the defined flat roof for this pilot. From outside to inside the roof is composed of:

1- Roof cover (e.g. green roof)
2- Waterproofing (e.g. EPDM, bitumen-based roofing, PVC)
3- Insulation
4- Vapour barrier
5- Sloping layer
6- Structure (wood, metal, concrete, etc.)

For some insulation products, an inverted roof is used. For this type of roof, the insulation is put on top of the waterproof layer. For inverted roofs an additional layer is needed on top of the insulation layer as ballasting,

[6] The overall heat transfer co-efficient Uc W/(m²·K) is equal to 1/R_T

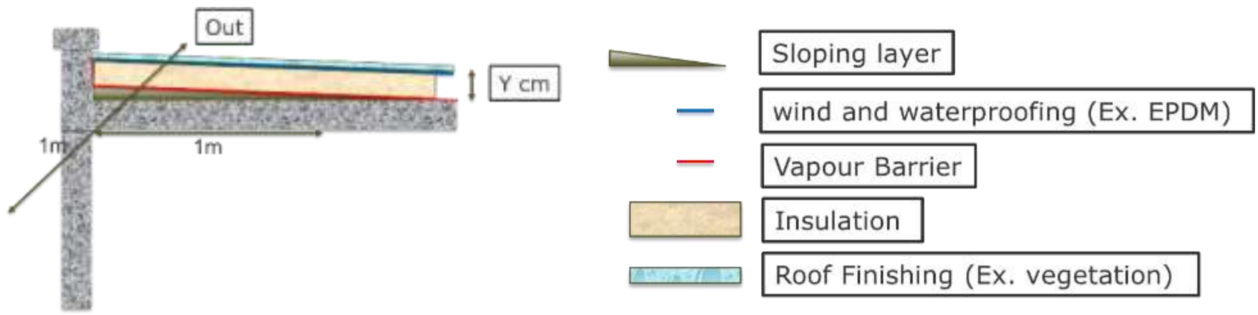

Figure 5 Cross section of non-accessible flat roof (conventional roof)

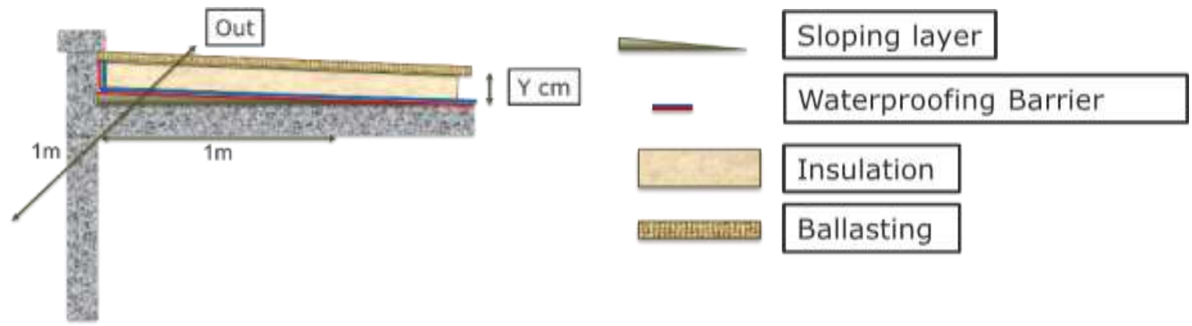

Figure 6 Cross section of non-accessible flat roof (inverted roof)

The scope is for thermal insulation applied to a concrete structure with required fixings and the necessary vapour and water proof membranes. The scope includes the insulation layer and the necessary fixings. The vapour barrier and the wind/water proofing are also included as the type of vapour barrier and wind/water proofing is often related to the choice of insulation material. The parts of the roof unrelated to the insulation layer (hence equal for all insulation products) are excluded from the scope. The parts of the roof which are included and excluded from the scope are explicitly mentioned in the subsequent paragraphs.

The scope of the thermal insulation in the flat roof includes following parts:

- Thermal insulation products, including packaging
- Necessary fixings (types which are most often used) for the installation of the thermal insulation
- Vapour barrier, if applicable
- Water proofing
- Aggregate ballast, if applicable.

All parts of the flat roof not influenced by the insulation layer (i.e. common to all types of insulation products) are excluded from the scope. For this reason, the structure is not included in the scope. Nevertheless, a structure in concrete is assumed as roof structure. The definition of the flat roof structure, although out of the scope, is necessary in order to define the way of fixing of the thermal insulation layer and for the choice of type of vapour screen and waterproof layer. The influence of the choice of vapour screen and fixing will be checked (by sensitivity analyses) in the screening step to evaluate its influence on the results or not. If the influence is minor, it can be concluded that the scope of the pilot is not limited to flat roofs with a concrete structure but are also valid for other types of structures.

Figure 7 and 8 shows the parts that are included in and excluded from the scope.

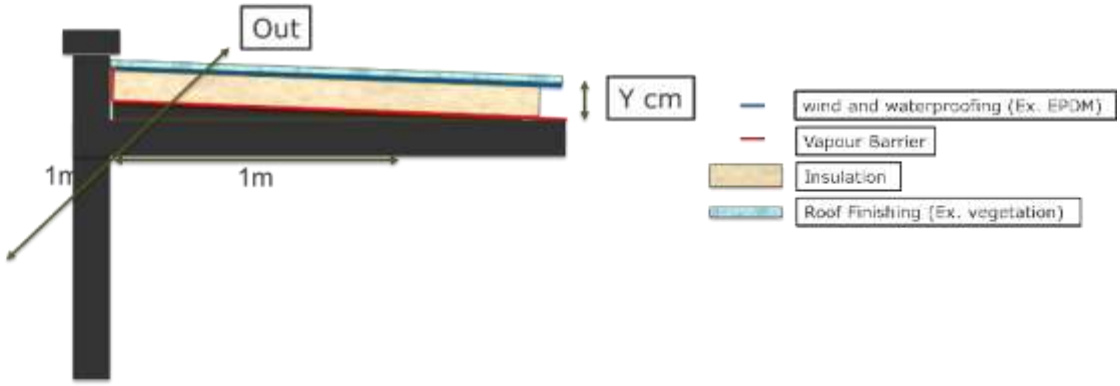

Figure 7 Scope of the pilot for flat roof conventional roof (excluded in dark colour)

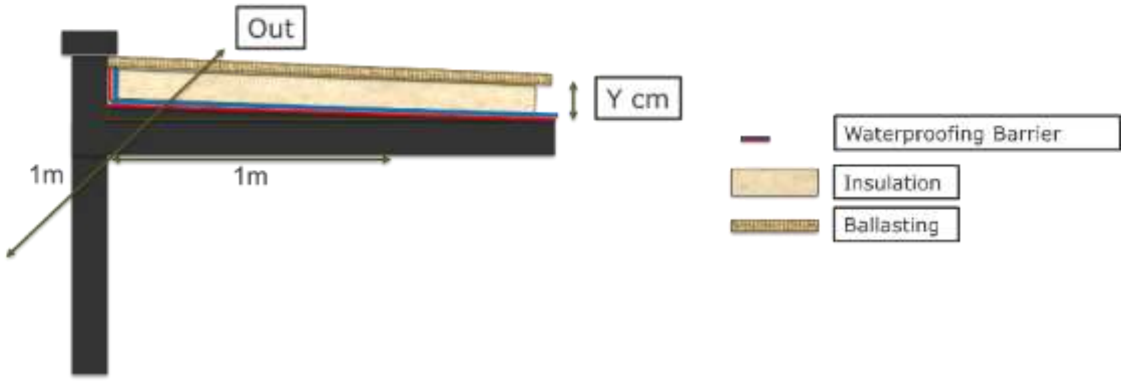

Figure 8 Scope of the pilot for flat roof inverted roof (excluded in dark colour)

The following parts are excluded from the scope considered by this specific pilot project as these are common to all insulation alternatives and are hence not influenced by the insulation layer:

- Interior finishing
- Concrete structure
- Sloping layer (insulation in sloping)
- Additional roof finishing (paving, green roof, etc.).

For the screening, alternatives are compared with an equal overall heat transfer co-efficient (U_c-value) in order to enable meaningful comparisons. An **U_c-value of 0.14 W/(m^2.K)** (R_T=7 m^{2}K/W) has been determined as this corresponds to the current practice for new buildings in Germany and future common practice going towards passive houses. Sensitivity analyses will be made for U_c 0.33 W/(m^2.K) (R_T=3) and 0.10 W/(m^2.K) (R_T=10) (0.33 for warm and 0.10 for cold continental climatic zones). The Uc-value hence does not relate to the insulation material solely and refer to the complete flat roof. The thickness of the insulation is based on the different lambda values of the insulation material. The exact thickness of the insulation layer is calculated by a third party based on the calculation of a building element in order to achieve an equal performance as defined in the scope by all product specific build ups.

For flat roofs, different types of prefab products are available on the market. Only those prefab products for which all components belong to the scope of the pilot are included in the scope. Pre-fabricated building elements and insulation products which include one or several of the parts excluded from the scope (e.g. interior finishing or roof finishing) are by definition excluded from the scope. This exclusion also covers for example tapered insulation products and sandwich panel

A list of participating insulation products is provided in Table 3.

Table 3 Insulation product groups within the scope of flat roofs

Categories of product	EN standards
EPS products	EN 13163: 2012
XPS products	EN 13164: 2012
PUR/ PIR (Boards) products	EN 13165: 2012
Cellular Glass	EN 13167: 2012

C.3 CPA/NACE codes for the proposed product category

F.41.2 - Construction of residential and non-residential buildings (C - Manufacturing)

The NACE code **F.41.2** covers a much wider product group than the products represented in this PEF thermal insulation pilot. However a single, more precise NACE code would not give the possibility to cover all insulation products.

C.4 Definition of the Functional Unit (unit of analysis)

According to the PEF guide the Functional Unit and reference flow shall be defined for the PEF study. The Functional Unit qualitatively and quantitatively describes the function(s) and duration of the function of the product.

Requirement for PEF studies: The Functional Unit for a PEF study shall be defined according to the following aspects:

- The function(s)/service(s) provided: "what";
- The extent of the function or service: "how much";
- The expected level of quality: "how well";
- The duration/life time of the product: "how long";

C.4.1 Horizontal rules

The function(s)/service(s) provided: "what"

A thermal insulation product is a product whose primary function is to reduce heat transfer through the building elements against which, or in which, it is installed. In this pilot the primary function is the thermal insulation.

The extent of the function or service: "how much"

The amount of products needed to insulate **1 m²** of a building element**.**

The expected level of quality: "how well"

A thickness that gives an overall heat transfer co-efficient of **X (U_c = X W/(m^2.K))".**

The duration/life span of the product: "how long" [15][16][17]

For PEF studies at the application level, the life span is also to be considered and needs to be defined in the functional unit. The expected average reference service life (RSL) of the building is 50 years in this study [7].

C.4.2 Vertical rules for application in pitched roof with massive timber rafters

The function(s)/service(s) provided: "what"

A thermal insulation product applied in a pitched roof build-up as defined in C.2.3. The product can be applied below, between and/or above the rafters depending on the product group.

Table 4 provides the position of insulation regarding the rafters within a pitched roof for each group of insulation in this pilot.

Table 4 Position of representative insulation products for pitched roof with massive rafters

Pitched roof with massive timber rafters	Position of the insulation product Top=T/ Between=B /Under=U /TopBetween=TB /BeetweenUnder=BU
Glass wool product	BU
Stone wool product	BU
Cellulose product	B
Wood fibre product	TB

The extent of the function or service: "how much"

The amount of products needed to insulate 1 m² of the defined pitched roof., including all ancillary materials required for fixing, extension of rafters (if needed), air-tightness, wind and water-proofing if not included in the thermal insulation product.

The expected level of quality: "how well"

A thickness that gives an overall heat transfer co-efficient between 0.33 $W/(m^2.K)$ (R_T=3) and 0.10 $W/(m^2.K)$ (R_T=10) during its application over the service life of the building element.

Note: The screening will be done for a value of U_c=0.14 $W/(m^2.K)$ (R_T=7) . Sensitivity analysis for U_c 0.33 $W/(m^2.K)$ (R_T=3) and 0.10 $W/(m^2.K)$ (R_T=10), will verify whether the conclusion of the screening are still valid for this range of U_c-values. But in case that the whole construction build up must be changed, other choices for the sensitivity analysis may be made.

The duration/life span of the product: "how long"

The PEF guide should be followed. The TS could not provide any specific guidance on how to measure the life span.

C.4.3 Vertical rules for application in non-accessible flat roofs

The function(s)/service(s) provided: "what"

A thermal insulation product applied in a flat roof build-up as defined in C.2.4. The product can only be applied above the structure.

The extent of the function or service: "how much"

The amount of products needed to insulate 1 m² of the defined flat roof, including all ancillary materials required for fixings, vapour course, water course, ballasting (only for inverted roof).

The expected level of quality: "how well"

A thickness that gives an overall heat transfer co-efficient between 0.33 $W/(m^2.K)$ (R_T=3) and 0.10 $W/(m^2.K)$ (R_T=10) during its application over the service life of the building element.

Note: The screening will be done for a value of U_c=0.14 $W/(m^2.K)$ (R_T=7) . Sensitivity analysis for U_c 0.33 $W/(m^2.K)$ (R_T=3) and 0.10 $W/(m^2.K)$ (R_T=10), will verify whether the conclusion of *the screening are still valid for this range of U_c-values. But in case that the whole construction build up must be changed, other choices for the sensitivity analysis may be made.*

The duration/life span of the product: “how long”

The PEF guide should be followed. The TS could not provide any specific guidance on how to measure the life span.[7]

C.5 System boundaries

All life cycle stages are included in the scope of this pilot and the PEFCR. The system boundaries correspond to the diagram in Figure 9.

The system boundaries refer to all building products included in the scope of the pilot (see sections C.2.4 and C.2.5).

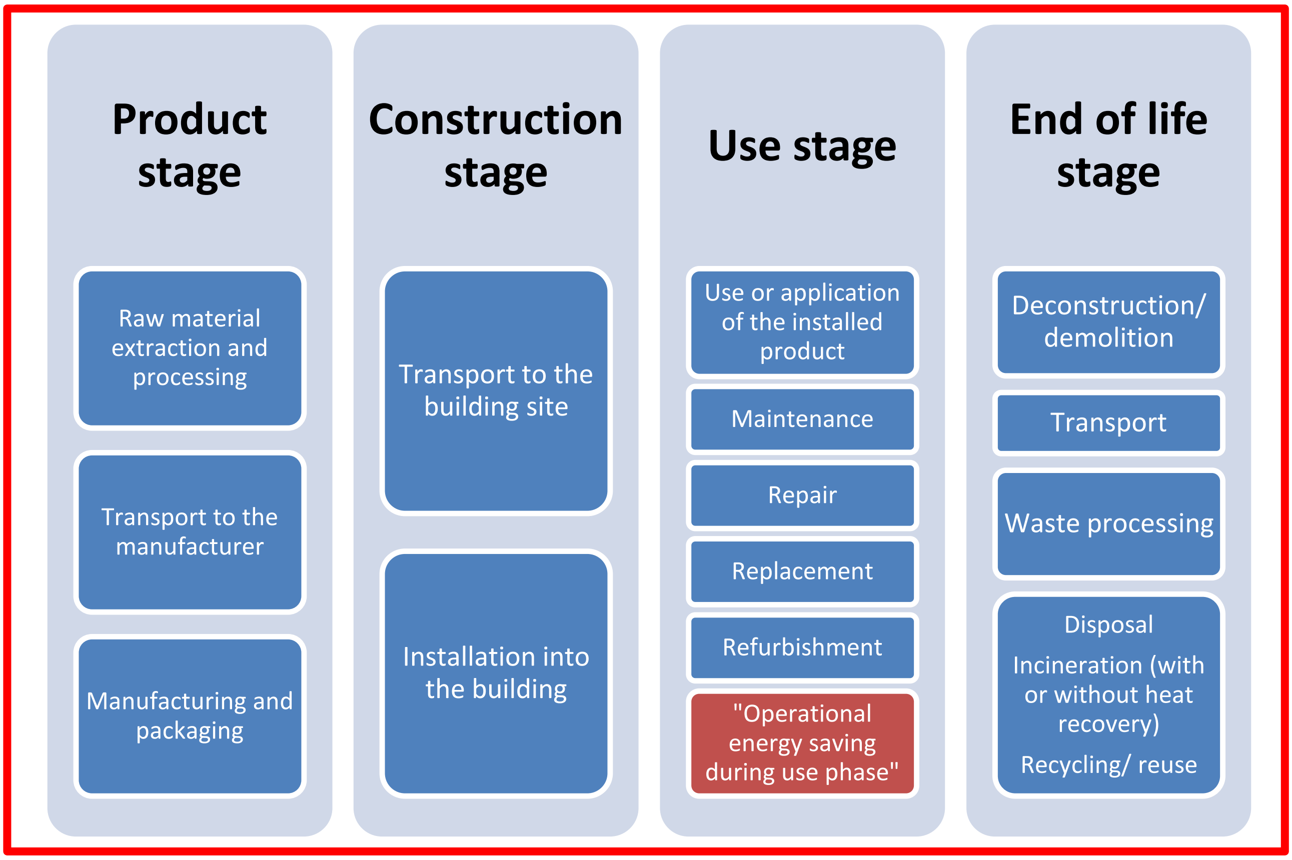

Figure 9 System boundary for thermal insulation pilot

[7] The flat roofs tend to need more frequent maintenance due to the life of the wind and waterproofing membrane, this PEFCR assumes that the insulation materials are applied correctly and in standard conditions. If justified by the market, maintenance, repair, replacement and refurbishment of the insulation will be taken into consideration.

D Definition of the Representative Products and description of the model for the PEF screening study

D.1 Introduction

According to the PEF Guidance document, at least one Representative Product has to be defined for each PEFCR as it forms the basis for the modelling of the PEF screening. When within a product category several different applications are supported (as is the case for this pilot), several Representative Products may need to be identified. Also, when a product category is made of various technologies which all deliver the same function (as is the case for this pilot), several Representative Products may be needed to ensure that the PEFCR will cover the specific data collection of all these technologies and to allow the identification of relevant life cycle stages and hotspots for each technology used.

According to the PEF Pilot Guidance document, the “representative product” may or may not be a real product that is sold on the market. Especially when the market is made up of different technologies, the “representative product” may be a virtual (non-existing) product with the average sales weighted characteristics of all technologies around. On the other hand, e.g. if the market and technical information is incomplete, a real product that would represent ‘the representative’ may be chosen.

The Representative Products are used as the basis of the PEF screening to:

1) Identify relevant life cycle stages and processes
2) Identify hotspots
3) Identify relevant impact categories
4) Facilitate the comparison between products that fall within the same Representative Product
5) Facilitate, where relevant, the development of benchmarks

The Representative Product model report should include the following elements:

- Bill of materials (BOM) or if more suitable, ingredients;
- A flow diagram (system boundaries) covering the entire life cycle
- Assumptions related to transportation systems;
- Assumptions related to use scenario (if relevant);
- Assumptions related to End of Life (if relevant).

In line with the above guidelines, representative products have been defined for the two applications this PEFCR refers to. However, ‘horizontal’ rules for the definition of the representative product have been defined. These horizontal rules on the definition of representative product will assure consistency of thermal insulation products PEFCR in buildings. The horizontal rules for the definition of the representative product for thermal insulation products in buildings are described in section D.2. The description of the presentative products as defined in line with the rules of section D.2 for the pitched roof application and flat roof application are elaborated in the sections D3.1 and D3.2 respectively.

D.2 Representative Product in PEF thermal insulation horizontal rules

Representative products for thermal insulation products applied in buildings shall be defined according to the following rules, in order of priority:

- A virtual (non-existing) or real product with the average estimated sales weighted characteristics for the specific application;

- A virtual (non-existing) or real product with the average weighted characteristics from other indicators than the average sales (average production, etc.) for the specific application;
- A virtual (non-existing) or real product accepted by the experts within the sector and validated by other product groups representatives (expert judgment) for the specific application.

In all cases, (virtual or real), the product has to be relevant to the defined application. In addition the sensitivity analysis has to be done on the ingredients (based on expert judgment) to cover all possible range of products included within the scope for the corresponding product group.

D.3 List of Representative Products for selected applications

Six groups of thermal insulation products (i.e. mineral wool, EPS, XPS, PUR/PIR, Cellulose, Wood fibre) are included in the scope of this PEFCR.

In this pilot, for each screening at least one supporting study is engaged to test different issues (most relevant Life Cycle stages and impacts/ EoL allocation/ impact categories/ Data quality/ Benchmark) for each representative product.

For the benchmark we need to define 1 merged representative product for the pitched roof and 1 for the flat roof at the end. In order to merge the selected products to one single representative product the results of screening are needed. (The merging will be done after the screening step based on expert judgment and following the results of the screening).

D.3.1 Representative Products for pitched roof with massive timber rafters

List of agreed insulation material groups for PEF screening:

- Glass wool
- Stone wool
- Cellulose
- Wood fibre

The Technical Secretariat members define for their thermal insulation product how the insulation is put in the roof (i.e. under the rafters, between the rafters, on top of the rafters, or a combination of these). More than one alternative is possible. Table 5 provides the specific characteristics of the thermal insulation representative products for the pitched roof. For each insulation material, the Representative Product for the specific application (i.e. thermal insulation under the rafters, between the rafters, on top of the rafters or a combination of those) is selected. This Representative Product is defined as the average product.

Table 5 Characteristics of representative insulation product groups for pitched roof

Pitched roof with massive timber rafters		Position of the insulation product	Lambda (W/m.K)	U_c value W/(m².K)	Density (kg/m³)
Glass/stone wool product (metal frame)	Top	NO	-	0.14	
	Between	YES	0.035		Glass wool=19 Stone wool=40
	Under	YES	0.035		Glass wool=19 Stone wool=45
Cellulose product	Top	NO	-	0.14	42
	Between	YES	0.040		
	Under	NO	-		
Wood fibre product	Top	YES	0.045	0.14	180
	Between	YES	0.039		45
	Under	NO	-		-

D.3.2 Representative Products for non-accessible flat roofs with concrete structure

List of agreed insulation groups for PEF screening:

- EPS products
- XPS products
- PUR/ PIR (Boards) products
- Cellular Glass products

Table 6 provides the specific characteristics of the thermal insulation products for the flat roof. For each insulation material, the Representative Product for the flat roof on a concrete structure is selected. This Representative Product is defined as the average product.

Table 6 Characteristics of representative insulation product groups for flat roof with concrete structure

Flat roof	Density (kg/m³)	Type of flat roof (conventional or inverted roof)	Lambda (W/m.K)	U_c value W/(m².K)
EPS products	15	Conventional roof	0.031	0.14
XPS products	35	Inverted	0.031	0.14
PUR/ PIR (Boards) products	32	Conventional roof	0.025	0.14
Cellular Glass	117	Conventional roof	0.041	0.14

D.4 Bill of materials

The Bill of Materials will be provided in the screening phase.

D.5 Transportation systems Assumptions

Transportation scenarios are necessary for different life cycle stages. All transport LCI data (road, rail and water) is based on the ELCD database[1]. In most cases as the insulation product has a low density, the transport is volume based. In some cases there is also mass base transport, particularly for some of the in-situ insulation products.

As most of insulation within Europe is transported by truck, we consider road transport (lorry) for the screening. Based on transported amount product, 3 types of trucks are considered in this pilot:

- Type 1: Articulated lorry transport; Euro 0,1,2,3,4 (European average); 40 t total weight, 27 t max payload
- Type 2: Lorry transport; Euro 0,1,2,3,4 (European average); 22 t total weight, 17,3 t max payload
- Type 3: Small lorry transport; Euro 0,1,2,3,4 (European average); 7,5 t total weight, 3,3 t max payload

Based on expert judgment, in this pilot the loading rate is fixed at 85% (for products compressed in packaging real load shall be considered / for volume, mass and pallet based transport a maximum 85% loading rate of total volume, mass and pallet number is considered as default scenario) and the empty returns is fixed at 20% (except transport to construction site with 100% empty returns).

Zero waste generated during the transport (including the storage and distribution) is assumed.

D.6 Installation system Assumptions

Both in-situ and factory made insulation products are considered during the screening phase. All impacts related to the equipment and tools (including the energy and material consumption) used during installation phase for both in-situ and factory made installation are included in the screening.

A default waste percentage of 2% has been agreed on for thermal insulation products for the screening phase. Packaging waste is also considered during the screening.

D.7 Use scenario assumptions

A Functional Unit (for each application) is associated to the product with a defined R value to model the use phase for the screening.

In case the European Harmonised Standard is not available for a product group then the lambda shall be based on technical approval or CE marking[8]. In all other cases, evidence should be provided that similar rules are applied.

It is assumed that the insulation products are applied correctly and in standard conditions for screening. Therefore there is no impact for maintenance, repair, replacement and refurbishment.

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[8] In that case of "CE marking", evidence should be provided that similar rules are applied for the determination of Lambda values.

D.7.1 Operational energy during use phase

The environmental burdens of thermal insulation products have to be seen in parallel with the benefits in the use phase of the building. Increasing the insulation level will increase the burdens related with production and end of life of the insulation product but reduce the burdens related with energy use of the building. There is an optimum in this balance.

There are two different ways to measure the operational energy related to the insulation during building use phase:

- **Benefits:** measure the benefits regarding the improved thermal performance in building due to the use of insulation and showed as credit (- impact)
- **Burdens**: measure the thermal loss trough the insulated element and showed as burdens (+ impact)
- **Nothing:** no benefits and or burdens linked to the use of insulation

Thermal insulation products are energy-related products. They are installed in the building envelope with a view to reducing heat transfer through the building envelope. The pilot decided that the only way forward would be to keep the benefits. Showing the benefits will also provide additional information regarding the efficient and effective insulation level for different climate zones. Additional information regarding the operational energy benefits during use phase will be provided during the screening phase.

D.8 End of Life assumptions

The scenario of End of Life and waste treatment varies significantly across the EU. In some Member States, this waste stream is to a large extent disposed of, using up valuable space in landfills. The recycled fraction varies from less than 1% to over 90% in some member states.

For the PEF project the Technical Secretariat undertook a very wide research to find European and/or National End of Life scenarios. Unfortunately, the End of Life scenarios identified for some member states[17] do not permit to extrapolate any Europe-wide scenario. (for insulation products scenarios may also depend on the end-use application and the fixing method). In the absence of sufficient existing information provided by authorities, a common End of Life scenario has been selected for each product group accepted by other professional federations based on expert judgments for screening phase that we provide during screening phase.

D.8.1 Transportation Assumptions during the End of Life

The distances from building to end of life treatment facilities for each EoL scenario are:

- 50 km for landfill and composting;
- 100 km for incineration;
- 150 km for recycling and re-use.

The truck used to transport the waste is a Euro 0,1,2,3,4 (European average) with maximum 27 t payload capacity (ELCD).

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Annex 1 PEF reference "product" cradle to gate information for the thermal insulation pilot "case factory-made mineral wool" 2014 - v.1.0

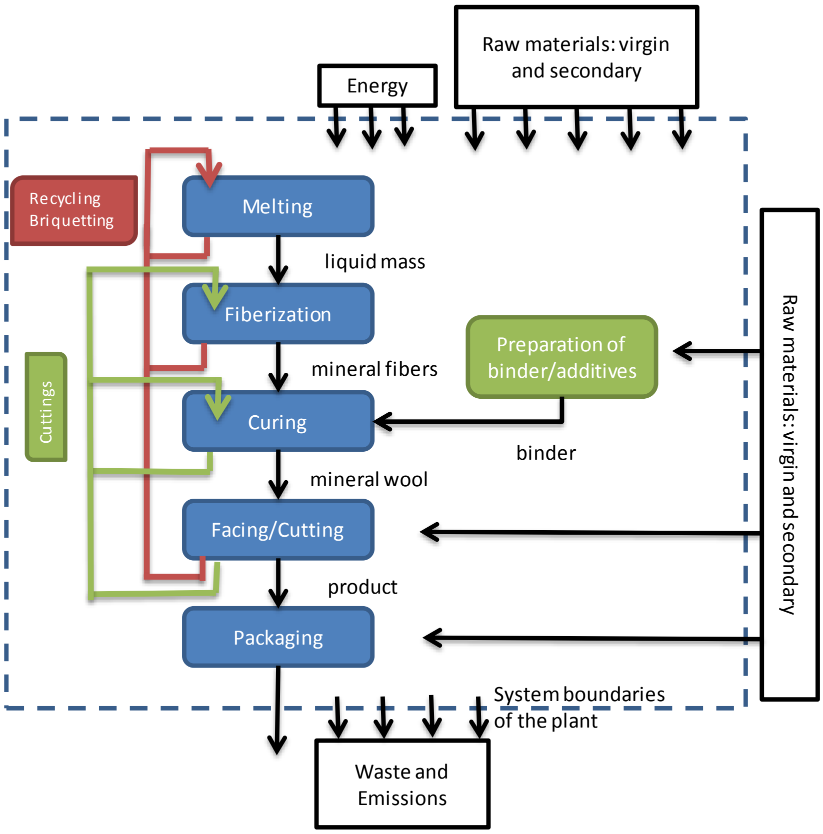
Introduction

Mineral wool is the generic name that covers 3 types of wool: glass wool, stone wool and slag wool. In the context of this PEF pilot study only glass wool and stone wool will be assessed, as slag wool is not a representative product for the European market.

Cradle to gate flow chart

The system boundaries within the product stage are set from raw materials sourcing for glass wool and stone wool via processing steps like melting, fiberization and hardening to the final packed product ready for delivery (factory gate). The cradle to gate calculation also includes all external and internal transports related to the material supply and processing. The following figure illustrates the production process in general separated into single processes.

1.1 Glass wool



1.2 Stone wool

The overall process for stone wool is at this level of detail similar to the process of glass wool. The internal recycling is in this case a process as for example briquetting.

Annex 2 PEF reference "product" cradle to gate information for the thermal insulation pilot "case factory-made Cellular Glass" 2014 - v.1.0

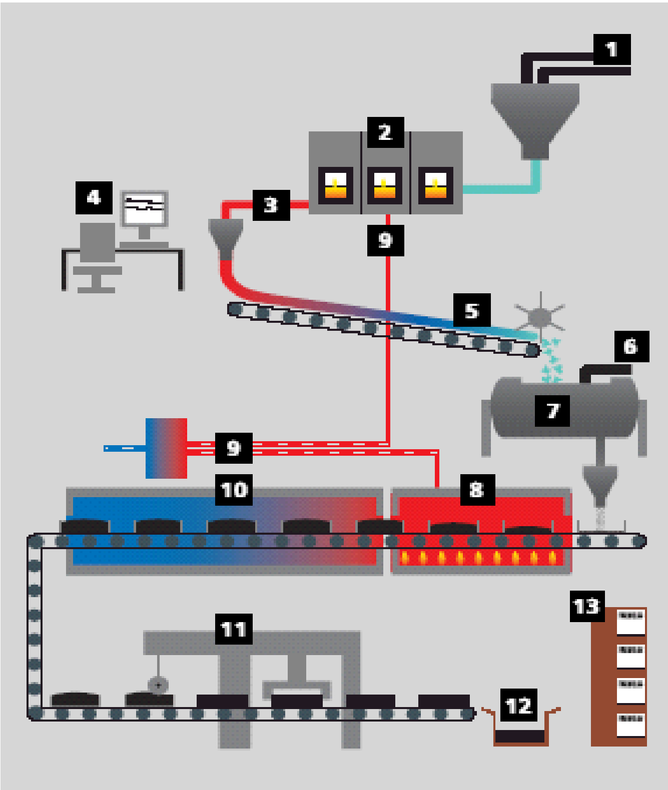
Introduction

Factory made cellular glass products, are used as thermal insulation in buildings. These slabs can be integrated within roofs; floors; façade & walls. The CPR-harmonized product standard is the EN 13167.

Cradle to gate flow chart

Different steps to produce Cellular Glass insulation products are:

1. Mixing and batching of the raw materials.
2. Melting within the furnace with a constant temperature of 1250°C.
3. Molten glass is drawn out of the furnace.
4. Control room for monitoring the production.
5. The glass is drawn off and falls onto the conveyor band where it cools down before entering into the ball mill.
6. Addition of "carbon black".
7. Ball mill grounds all ingredients into a fine powder before putting into stainless steel moulds
8. The filled moulds pass through a cellulating oven (foaming furnace) with a temperature of 850° C.
9. This is where the material gains its unique cell structure.
10. Energy recovery of heat
11. The Cellular Glass blocks passes through an annealing oven to allow carefully controlled cooling of the block without thermal stress.
12. The blocks are cut to size and sorted by batch. Production Waste returns back into the process. Cellular Glass slabs are then packaged, labelled and palletized.
13. Finished Cellular Glass products are stored and prepared for transport.



Annex 3 PEF reference "product" cradle to gate information for the thermal insulation pilot "Expanded Polystyrene (EPS)" 2014 - v.1.0

Introduction

EPS insulation is used for thermal and contact sound insulation in buildings in the form of factory made boards or as a loose fill thermal insulating material. During the production of the raw material, pentane is added, in order to serve as a blowing agent in the subsequent process.

The EPS thermal insulation product covered by this pilot is the homogeneous EPS insulating material. This product is used for the insulation of walls, roofs, ceilings, floors and perimeters. EPS is used in many other forms such as material combination to composite boards or laminated insulating boards, shape moulded products or loose fill applications. No case study is foreseen for these additional applications.

Cradle to gate flow chart

Basic materials

The basic material is polystyrene. Polystyrene is a thermoplastic polymer and can be processed into foam plastic by the application of heat.

There are minor variations between input and output quantities because of measured data from production processes where recycled material from in-house production is also integrated. However, the variation is always less than 3 %.

The blowing agent pentane partially leaks from the product during production. The pentane emitted during product stage is taken into account. Data on the pentane emission during the production process vary, depending on the manufacturer and the bulk density. An average of 66 % of the pentane leaks during production. The emission of pentane when applied depends on many frame conditions.

The emission of pentane during the use stage depend on various parameters, e.g. on the foam structure, the temperature, the open surface and the air change when mounted.

Polystyrene

Polystyrene is produced by the polymerization of styrene monomers. Styrene is commonly produced by the dehydrogenation of ethyl benzene, a product from the refining of the two fossil raw materials crude oil and natural gas. The raw material polystyrene is delivered to the foam manufacturer as bead-shaped granules. In order to enable the foaming process, the blowing agent pentane is added during the polymerization process. For the assessment of the manufacturing process of polystyrene in this study.

Pentane

Pentane is a component of natural gas and fuels. It is obtained by distillation and is used as a blowing agent in foam production because it expands under heat.

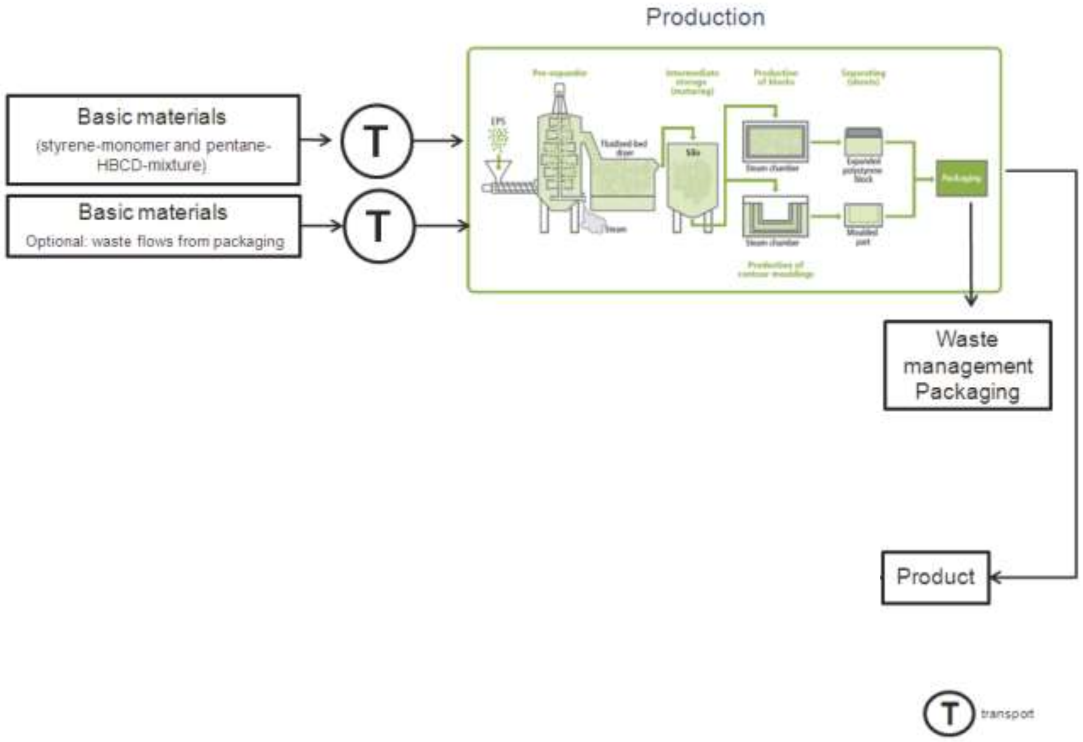
Flame retardant

For rigid foam insulating materials, the general building regulations apply. The material is evaluated and labelled in terms of fire behaviour. In order to obtain the fire protection classification level required for the intended application of the construction product, the expanded polystyrene has to be treated with a flame retardant. For regulatory reasons phase out of the old flame retardant towards a new one PFR (polymeric flame retardant) is ongoing.

Graphite:

Graphite is a frequently occurring mineral in nature. The mined product is available in different forms (e.g. granules, powder). In the declared EPS products, graphite improves the reflection of thermal radiation and thereby the insulating performance of the EPS products at reduced layer thickness.

System boundaries flow chart



Annex 4 PEF reference "product" cradle to gate information for the thermal insulation pilot "Extruded Polystyrene Foam (XPS)" 2014 - v.1.0

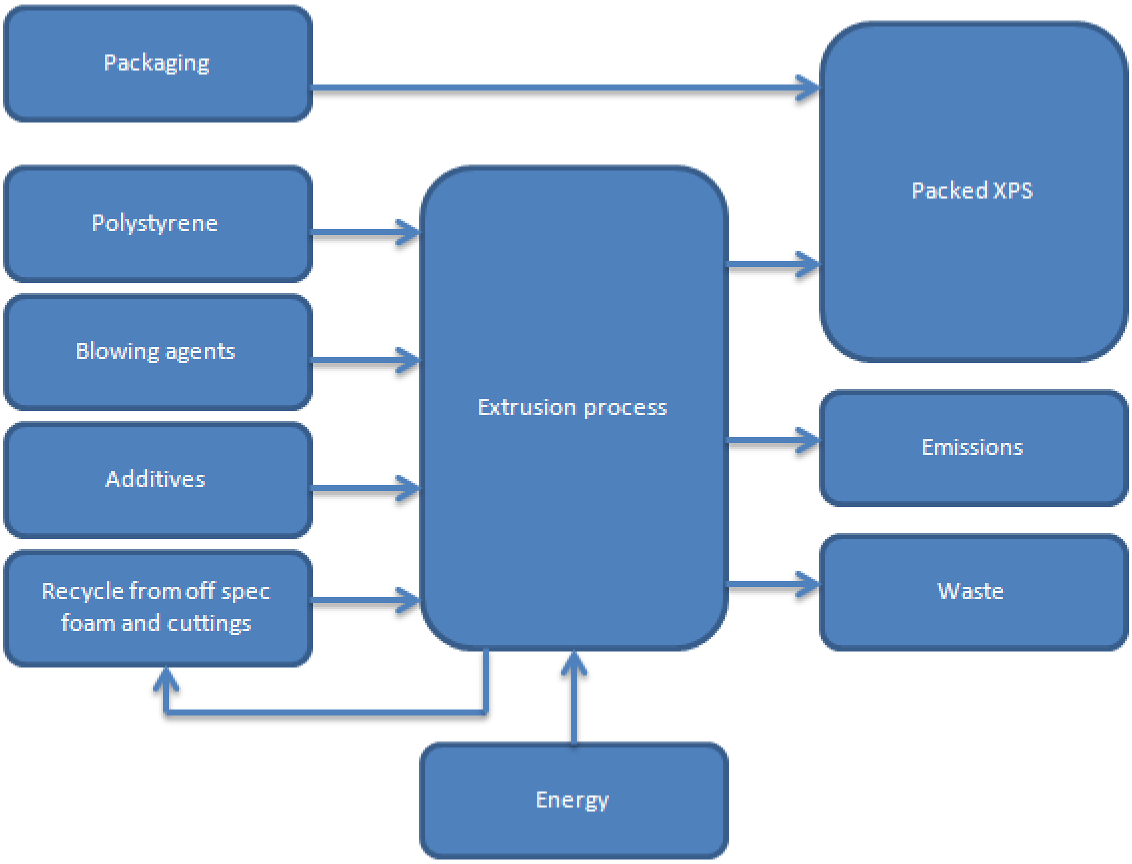
Introduction

Extruded Polystyrene Foam (XPS) is a rigid cellular plastic insulation material, with or without a skin and which has a closed cell structure. The products are manufactured in the form of boards with various edge treatments and mostly supplied without facing.

The variety of the performance properties of XPS and more specifically low thermal conductivity, high to very high mechanical properties and low water absorption, make them suitable for use in a large number of applications

The XPS products under the scope of this PEF project dedicated to Building applications are covered by the EN 13164 standard Factory made XPS products for buildings.

Cradle to gate flow chart - XPS



The polystyrene is extruded and expanded with the help of blowing agent gases. Some additives such as colorant, flame retardant or processing aids are used as well. A polyethylene film is used for packaging the foam boards in bundles.

Annex 5 PEF reference "product" cradle to gate information for the thermal insulation pilot "Polyurethane (PU)" 2014 - v.1.0

Introduction

Polyurethane (PU) insulation stands for a group of polymeric products with a thermal conductivity starting at 0.022 W/(mK) and offering a high compressive strength at low densities.

The product group comprises polyurethane (PUR) and polyisocyanurate (PIR).

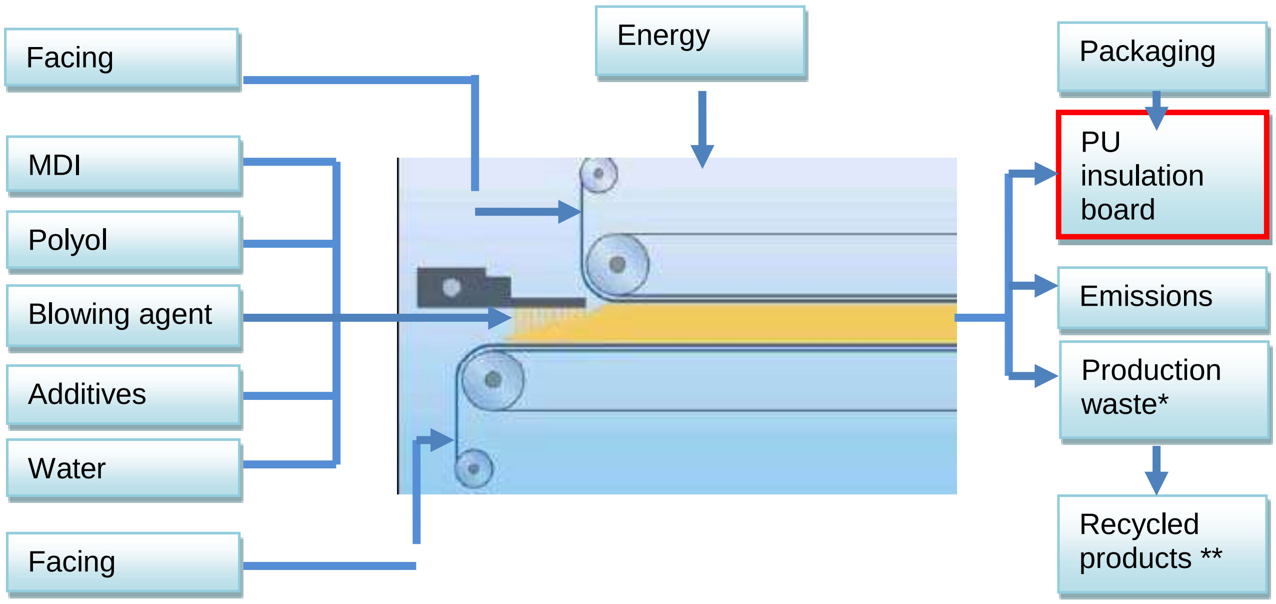
PU thermal insulation products covered by this pilot scheme are available in a number of different forms. For the purpose of the screening study, a factory-made faced PU-board will be selected.

Cradle to gate flow chart for factory-made products with flexible or rigid facings

PU is formed in a reaction between two components, the polyether and / or polyester polyol and the isocyanate (MDI). Additives include water and catalysts. A blowing agent is added in most cases. Furthermore, a flame retardant may be part of the recipe.

The main primary material of PU foam is crude oil / natural gas. Furthermore, the polyols may be produced from recyclates (PET, cooking oils) or plant-based sources (sugar, soybean, lignin etc.).

Various production methods exist to manufacture PU thermal insulation products. The most common is the continuous lamination process as shown in the flow chart. Others include continuous or discontinuous block foam production, discontinuous sandwich panel production and in-situ production. Composite products and insulated building elements require additional production steps.



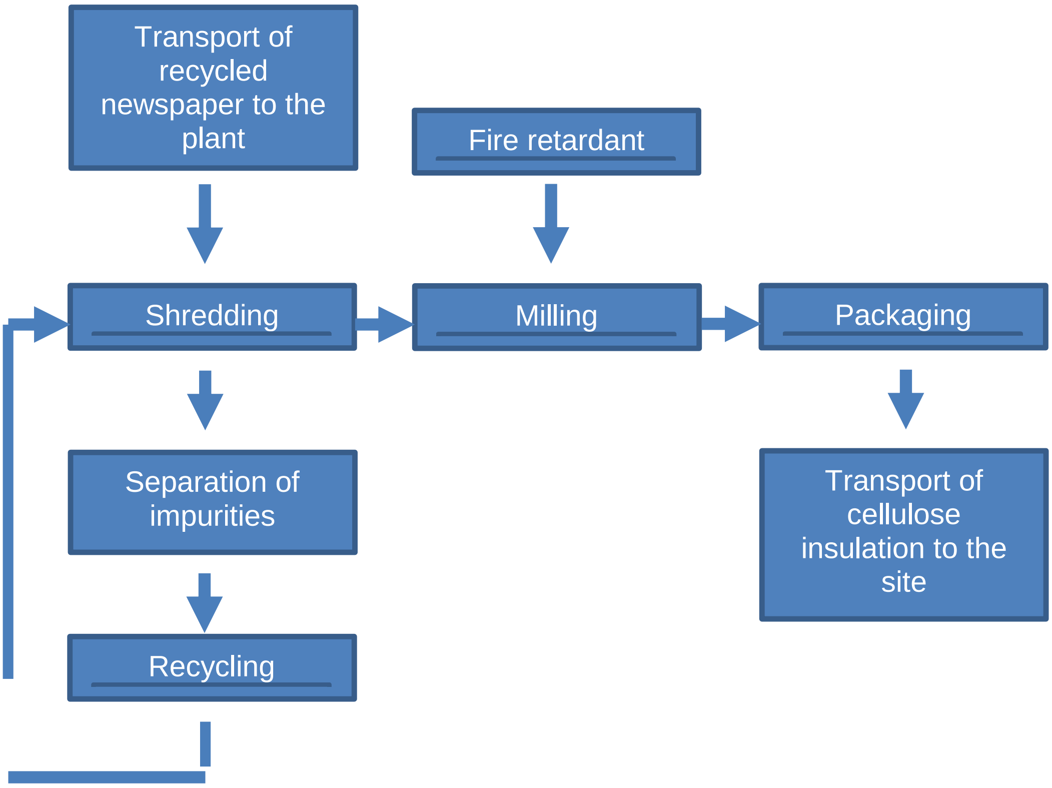
Flow chart: Continuous lamination process for the production of faced PU boards and panels.
* *Production waste accounts for about 6% of overall material input.*
** *About 70% of production waste is recycled (open loop).*

Annex 6 PEF reference “product” cradle to gate information for the thermal insulation pilot “Cellulose” 2014 - v.1.0

Introduction

Cellulose Insulation material is made of recycled newspaper. It is an insulation material that is mainly applied as loose cellulose insulation material, sometimes converted into mats and in some cases applied in a wet spraying process. It is used for thermal and acoustical insulation of buildings.

Cradle to gate flow chart



The recycled newspaper is transported to the cellulose insulation production plant. There impurities are separated and the paper is shredded. Paper which is falsely separated with impurities is recycled into the process. When milling the shredded paper, fire retardants are added. The final product is packed and transported to the construction site.

Annex 7 PEF reference "product" cradle to gate information for the thermal insulation pilot "Wood fiber board" 2014 - v.1.0

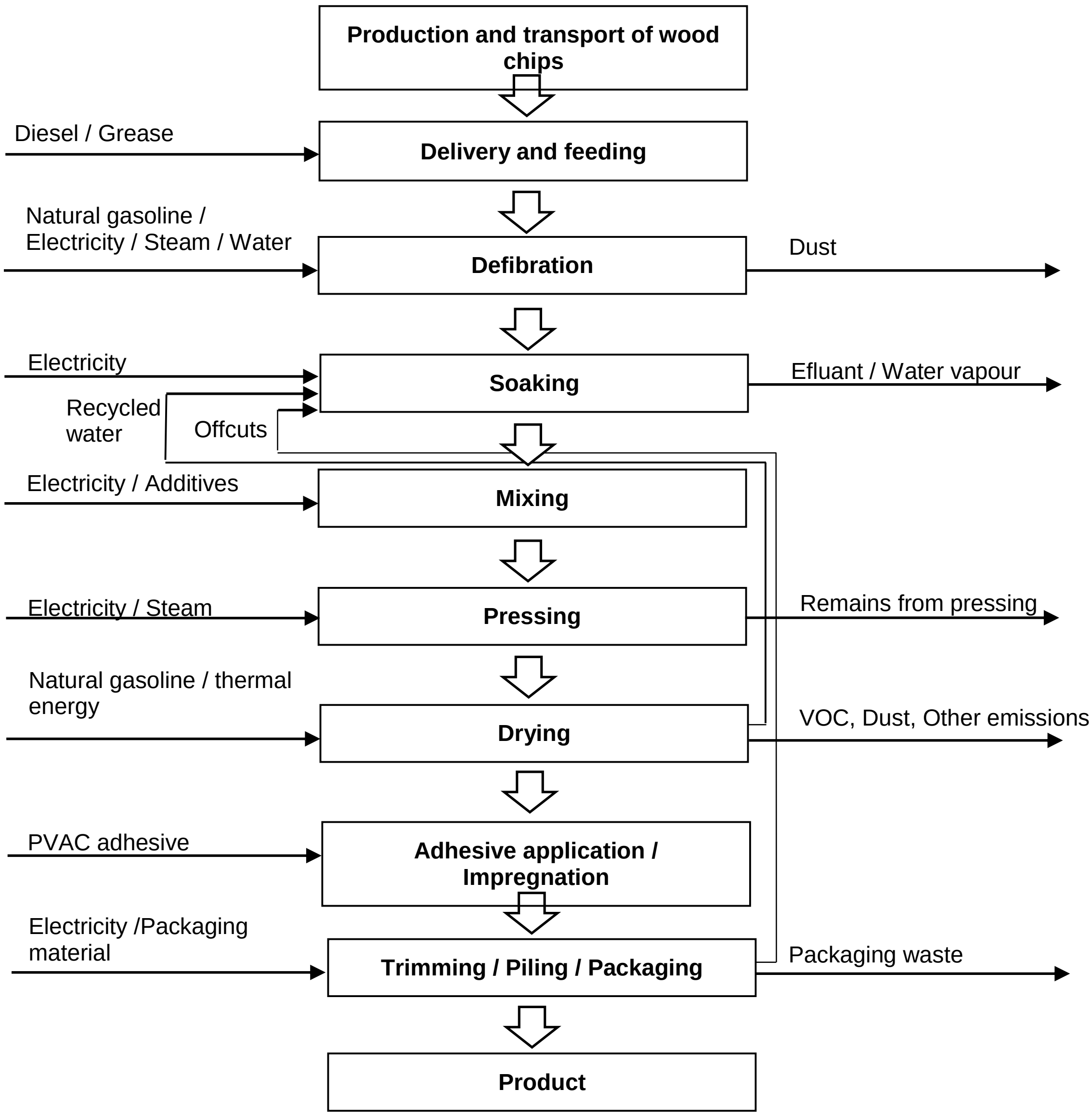
Introduction

Wood fiber insulation board is an engineered wood product in conformity with standard EN 13171. Wood fiber insulation board consists of 90 % to 95 % of wood fibers which have been produced in either the dry or the wet process from wood residues from sawmills (e.g. sidings) and from wood chips. Softwood is preferred due to its higher fiber quality.

Cradle to gate flow chart

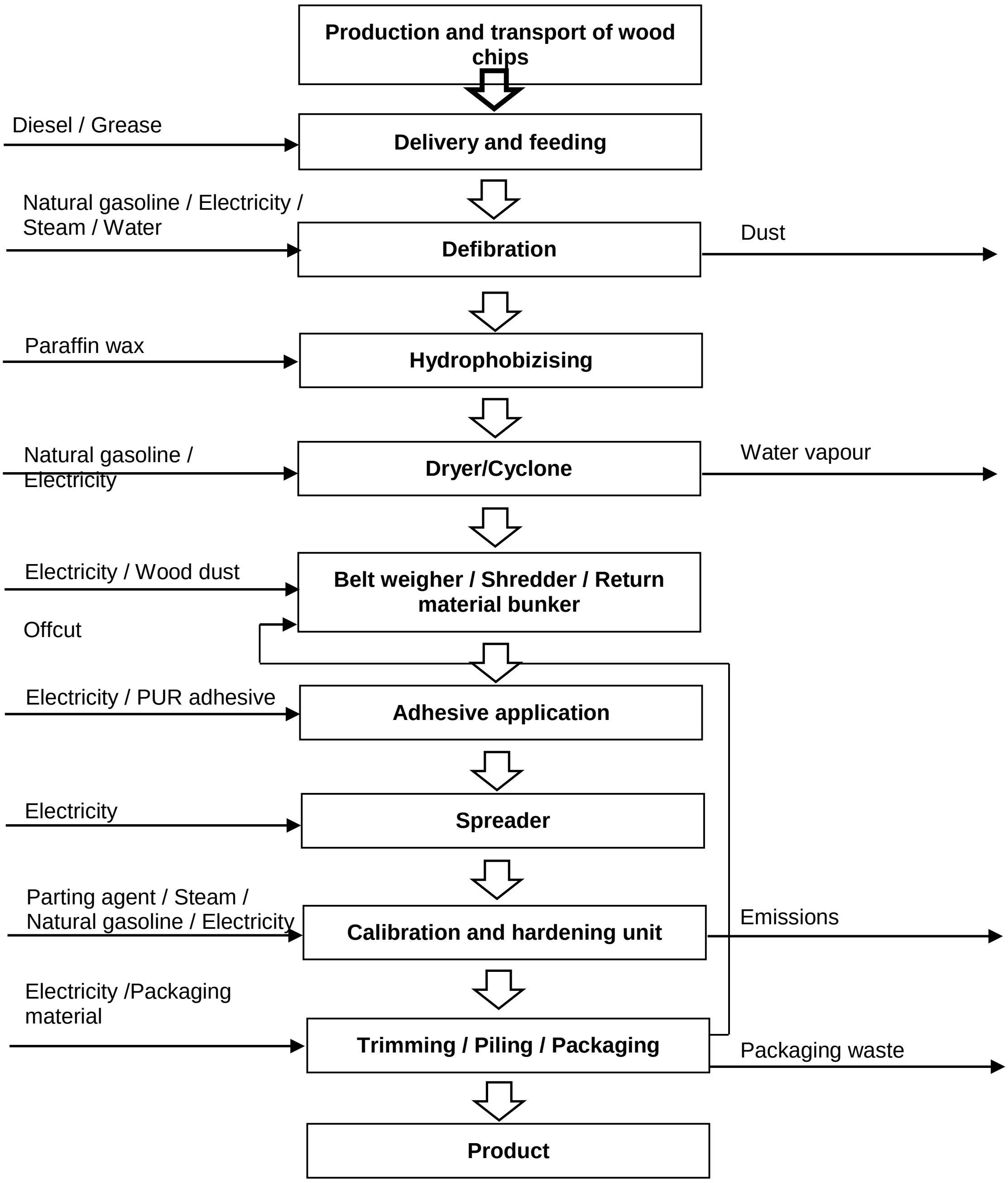
In the wet process, the raw material is grinded and then mixed into a mash with up to 98% water. This mash is then formed into a so-called fiber cake. After pressing most water out of the mat, the fiber cake is the cut and dried in the drying channel with temperatures between 160 to 220 °C. The addition of binders is usually not required, as the heating of the liquid lignin as part of the wood bonds the fibers during cooling. For special purposes (higher strength, hydrophobic properties), resins or bitumen-containing agents can be added. Thicker board are produced from gluing together several standard boards.

Wet Process



In the dry process, the fibers are dried directly after grinding and mixed with up to 4% resin, (e.g. PUR resin). For the production of flexible insulation boards, synthetic textile fibers or fibers from corn starch are added to the wood fibers. Subsequently, the fibers are sprinkled in desired thickness, pressed, hardened with a mixture of vapour and air and then cut, stacked and packed.

Dry Process



Production is subject to the regulations of the Industrial Emissions Directive (EU-IED, 2011) if the production capacity exceeds 600 m3 per day where one or more of the following wood-based panels are produced: fiberboard, particleboard or oriented strand board.

The typical thickness of wood fiber insulation board is in a range 20 - 300 mm.

Annex 8 Detailed consistency analysis of EN 15804 and the PEF method

	Criteria	PEF Guide	EN 15804
1	**Goal**		
1.1	LCT-based	Yes.	Yes
1.2	Applications and exclusions	**In-house applications** may include support to environmental management, identification of environmental hotspots, environmental improvement and performance tracking; **External applications** (e.g. B2B, B2C) cover a wide range of possibilities, responding to customer and consumer demands, marketing, **benchmarking**, environmental labelling, etc. **Normalisation and weighting development.**	EU standard provides the means for developing a Type III environmental declaration of construction products and construction services. **Benchmarking is not allowed at product or application level but allowed by the contribution they make to the environmental performance of the building. (**EPD that are not in a building context are not tools to compare construction products and construction services)**.** **Normalisation and weighting are only considered at the building level.** EPD are meant as modules to be used for the assessment at building level.
1.3	Communication Target audience	B2B and B2C.	B2B
2	**SCOPE**		
2.1	Functional unit	The unit of analysis for a PEF study shall be defined according to the following aspects: The function(s)/ service(s) provided: "**what**"; The magnitude of the function or service: "**how much**"; The duration of the service provided or service life time: "**how long**"; The expected level of quality: "**how well**". An appropriate reference flow shall be determined in relation to the unit of analysis. The quantitative input and output data collected in support of the analysis shall be calculated in relation to this flow.	The FU (Refers to ISO 14040/44) of a construction product is based on 1) quantified, relevant functional use or performance characteristics of the construction product when integrated into a building, taking into account the functional equivalent of the building 2) Referent Service Life (According to EN 15686) or required service live of the building.
2.2	System boundary	The system boundaries shall include all processes linked to the product supply chain relative to the unit of analysis. Cradle-to-grave as default approach, or different if otherwise specified in PEFCRs. The processes included in the system boundaries shall be divided into foreground processes (i.e. core processes in the product life cycle for which direct access to information is available) and background processes (i.e. those processes in the product life cycle for which no direct access to information is possible).	System boundaries for the life cycle stages and the information modules included are transparent, well defined and applicable to any construction product. Setting of the system boundaries follows 2 principles: 1) modularity principle, 2) polluter pays principle

	Criteria	PEF Guide	EN 15804
2.3	Cut-off	Not allowed at screening phase.	Allowed. According to the EN 1580 in case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1 % of renewable and non-renewable primary energy usage and 1 % of the total mass input of that unit process. The total of neglected input flows per module, e.g. per module A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and module D shall be a maximum of 5 % of energy usage and mass.
3	**IMPACT CATEGORIES**		
3.1	Impact categories Life Cycle Impact Assessment (LCIA) methods.	A default set of 14 mid- point impact categories shall be considered, unless (1) otherwise specified in the PEFCR, or (2) exclusion of certain impact categories is justified as specified in the PEF Guide. Default set of provided mid-point LCIA methods shall be used.	A set of 7 mid-points is mandatory: • global warming potential (kg CO2 equiv) • depletion potential of the stratospheric ozone layer, ODP (kg CFC 11 equiv) • acidification potential of soil and water, AP (kg SO2 equiv) • eutrophication potential P (kg (PO4)3- equiv) • formation potential of tropospheric ozone, POCP (kg Ethene equiv) • abiotic depletion potential (ADP-elements) for non-fossil resources (kg Sb equiv.) • abiotic depletion resources fossil (MJ, net caloric value)
3.2	Modelling approach (attributional vs. consequential)	Takes elements from both attributional and consequential modelling approaches.	Only Attributional

	Criteria	PEF Guide	EN 15804
4	**DATA QUALITY**		
4.1	Data quality	Data quality is assessed against the following criteria: • Technological representativeness • Geographical representativeness • Time-related representativeness • Completeness • Parameter uncertainty • Methodological Appropriateness & Consistency (i.e. completion of Resource Use and Emissions Profile according to this general Guide). Data quality requirements shall be met (for both specific and generic data) by any PEF study intended for external communication. For PEF studies (claiming to be in line with this Guide) intended for in-house applications, the specified data quality requirements should be met (i.e. are recommended), but are not mandatory. In the final Resource Use and Emissions Profile, for the processes or activities accounting for at least 70 % of contributions to each impact category (based on the screening exercise, if conducted), both specific and generic data shall achieve at least an overall “good quality” level. A semi-quantitative assessment of data quality shall be performed and reported for these processes. […] Regarding the level at which assessment of data quality shall be conducted.	The quality of the data shall be addressed in the report, the following specific requirements apply for construction products 1) data as current as possible; 2) based on 1 year average data; 3) the time period over which inputs and outputs from the system shall be accounted for is 100 years from the year for which the data set is deemed representative. A longer time period shall be used if relevant; 4) technological coverage shall reflect physical reality for the declared product; 5) generic data: guidance for the use is provided in CEN/TR 15941, generic data shall be checked for plausibility; 6) data sets shall be complete according to the system boundary within the limits set by the criteria for the exclusion of inputs and outputs.
4.2	Data type and data collection Data collection template	**Specific data** shall be obtained for all foreground processes and for background processes, where appropriate. However, in case generic data is more representative or appropriate than specific data (to be justified and reported) for foreground processes, generic data shall be also used for the foreground processes. **Generic data** should be used only for processes in the background system, unless (generic data) are more representative or appropriate than specific data for foreground processes, in which case generic data shall also be used for processes in the foreground system. Generic data (provided they meet the data quality requirement specified in the PEF Guide) shall, where available, be sourced from: • Data developed in line with the requirements for the relevant PEFCRs • Data developed in line with the requirements for PEF studies • ILCD Data Network (data that comply with ILCD requirements for Situation A) • ELCD Data collection template: the template provided is informative.	Generic data may be used for all life cycle stages except product manufacture in module A3 for which average or specific data is needed.

	Criteria	PEF Guide	EN 15804
5	**ALLOCATION**		
5.1	Allocation/multi-functionality hierarchy	The following PEF multifunctionality decision hierarchy shall be applied for resolving all multifunctionality problems: (1) subdivision or system expansion; (2) allocation based on a relevant underlying physical relationship (substitution may apply here); (3) allocation based on some other relationship. In addition the PEF guide also has some specific requirements for allocation of transport and allocation of multifunctionality during recycling processes.	Should be avoided as far as possible. For co-product allocation: 1) subdivision: inputs and outputs should be partitioned between different co-products; 2) based on physical properties (mass, volume,…) when the difference in revenue from the co-product is low (1% of difference in revenue is considered very low and a difference of more than 25% is regarded as high) 3) based on economic values; 4) material flows carrying specific inherent properties, (eg biogenic carbon content) shall always be allocated reflecting the physical flows, irrespective of the allocation chosen for the process.
5.2	Allocation for recycling	Specific guidance (including formula!) provided, also accounting for energy recovery.	see module D (not mandatory)
6	**OTHER ENVIRONMENTAL IMPACTS**		
6.1	Fossil and biogenic carbon emissions and removals	Removals and emissions of biogenic carbon sources shall be kept separated in the Resource Use and Emissions Profile. A separate inventory of emissions/removals of biogenic carbon sources implies that the following characterisation factors (see section 6.1.2) shall be assigned for the environmental footprint impact category Climate Change: "-1" for removals of biogenic carbon dioxide; "+1" for emissions of biogenic carbon dioxide; "+25" for methane emissions."	The consideration of emissions and removals of biogenic carbon as input flows and output flows as carbon expressed in CO2-eq as part of the GWP are ruled in EN 16485, which has been acknowledged by CEN TC 350 WG3 to provide the correct rules in line with EN 15804.
6.2	Direct land use change/ indirect land use change	Greenhouse gas emissions from direct land use change shall be allocated to goods/services for 20 years after the land use change occurs using the IPCC default values table. **Indirect Land Use Change**: Greenhouse gas emissions that occur as a result of indirect land use change shall not be considered in the default EF impact categories.	The consideration of GHG emissions from direct land use change are ruled in EN 16485, referring to the same rules of IPCC as the PEF.
6.3	Carbon storage and delayed emissions	Credits associated with temporary (carbon) storage or delayed emissions shall not be considered in the calculation of the PEF for the default impact categories, unless otherwise specified in a supporting PEFCR.	It is ruled in EN 16485 that "credits" from temporary carbon storage shall not be included in the calculations of the GWP according to EN 15804 but can be reported as additional information.
6.4	Emissions off-setting	Shall not be included in the assessment.	Not mentioned

	Criteria	PEF Guide	EN 15804
7	REVIEW AND REPORT		
7.1	Review and reviewer qualifications	Unless otherwise specified in relevant policy instruments, any study intended for external communication shall be reviewed by an independent and qualified external reviewer (or review team). A study to support a comparative assertion intended to be disclosed to the public shall be based on relevant PEFCRs and reviewed by an independent external reviewer together with a stakeholder panel. Minimum requirements on reviewer qualifications apply.	Not in the scope of the standard.
7.2	Reporting	The study report shall minimal include: a summary, a main report, and an Annex. These shall contain all the elements specified. Any additional supporting information can be included, e.g. a Confidential Report – (The content of these mandatory reporting elements closely follows ISO 14044 requirements on reporting. However, if the assessment supports comparative assertions (to be disclosed to the public), ISO reporting requirements goes beyond PEF reporting requirements)	chapter 7 content of the EPD
7.3	Interpretation of results	The environmental footprint interpretation phase shall include the following steps: (1) assessment of the robustness of the PEF model"; (2) identification of hotspots"; (3) "estimation of uncertainty"; and (4) "conclusions, limitations and recommendations". Optional tool for interpretation of results: completeness check, sensitivity check, consistency check. (These are mandatory in ISO 14044).	
7.4	Uncertainty of results	At least a qualitative description of uncertainties shall be provided. TIP: Quantitative uncertainty assessments can be calculated for variance associated with significant processes and characterisation factors using Monte Carlo simulations.	

	Criteria	PEF Guide	EN 15804
8	**ADDITIONAL PARAMETERS**		
8.1	Parameters describing resource use		• use of renewable primary energy excluding renewable primary energy resources used as raw material (MJ, net caloric value) • use of renewable primary energy resources used as raw materials (MJ, net caloric value) • total use of renewable primary energy resources (primary energy & primary energy resources used as raw materials) (MJ, net caloric value) • use of non-renewable primary energy excluding non-renewable primary energy used as raw materials (MJ, net caloric value) • use of non-renewable primary energy used as raw materials (MJ, net caloric value) • total use of non-renewable primary energy resources (primary energy primary energy resources used as raw materials) (MJ, net caloric value) • use of secondary material (kg) • use of renewable secondary fuels (MJ, net caloric value) • use of non-renewable secondary fuels (MJ, net caloric value) • net use of fresh water (m3)
8.2	Other environmental information describing different waste categories and output flows		• Waste categories • hazardous waste disposed (kg) • non-hazardous waste disposed (kg) • radioactive waste disposed (kg) • Output flows • components for reuse (kg) • materials for recycling (kg) • materials for energy recovery (kg) • exported energy (MJ per energy carrier)
9	**Scenarios and additional technical information**		
9.1	Construction process stage		
9.2	Transport to building site		• Fuel type and consumption of vehicle or vehicle type used for transport e.g. long distance truck, boat etc. (l) • distance (km) • Capacity utilisation (including empty returns) (%) • Bulk density of transported products (m3) • Volume capacity utilisation factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaged products) (Not applicable)

	Criteria	PEF Guide	EN 15804
9.3	Installation in the building		• Ancillary materials for installation (specified by material) (kg) • water use (m3) • other resource use (kg) • Quantitative description of energy type (regional mix) and consumption during the installation process (kWh or MJ) • Waste materials on the building site before waste processing, generated by the product's installation (specified by type) (kg) • Output materials (specified by type) as result of waste processing at the building site e.g. of collection for recycling, for energy recovery, disposal (specified by route) (kg) • Direct emissions to ambient air, soil and water (kg)
9.4	B1 use stage related to the building fabric		B1: Environmental aspects and impacts connected to the normal (i.e. anticipated) use of products, not including those related to energy and water use, which are dealt with in B6 and B7) e.g. release of substances from the facade, roof, floor covering, walls and other surfaces (interior or exterior) are reported as additional information (see 7.4).
9.5	B2 - Maintenance		• Maintenance process (Description or source where description can be found) • Maintenance cycle (Number per RSL or year) • Ancillary materials for maintenance, e.g. cleaning agent, specify materials (kg/cycle) • Waste material resulting from maintenance (specify materials)(kg) • Net fresh water consumption during maintenance (m3) • Energy input during maintenance, e.g. vacuum cleaning, energy carrier type, e.g. electricity, and amount, if applicable and relevant (kWh)
9.6	B3 - repair		• Repair process (Description or source where description can be found) • Inspection process (Description or source where description can be found) • Repair cycle (Number per RSL or year) • Ancillary materials, e.g. lubricant, specify materials (kg or kg / cycle) • Waste material resulting from repair, (specify materials) (kg) • Net fresh water consumption during repair (m3) • Energy input during repair, e.g. crane activity, energy carrier type,

	Criteria	PEF Guide	EN 15804
			e.g electricity, and amount (kWh / RSL, kWh / cycle3)
9.7	B 4 Replacement		• Replacement cycle (Number per RSL or year) • Energy input during replacement e.g. crane activity, energy carrier type, e.g. electricity and amount if applicable and relevant (kWh) • Exchange of worn parts during the product's life cycle, e.g. zinc galvanised steel sheet, specify materials (kg)
9.8	B5- Refurbishment		• Refurbishment process (Description or source where description can be found) Refurbishment cycle (Number per RSL or year) • Energy input during refurbishment e.g. crane activity, energy carrier type, e.g. electricity, and amount if applicable and relevant (kWh) • Material input for refurbishment, e.g. bricks, including ancillary materials for the refurbishment process e.g. lubricant, (specify materials) (kg or kg / cycle) • Waste material resulting from refurbishment (specify materials) (kg) • Further assumptions for scenario development, e.g. frequency and time period of use, number of occupants (Units as appropriate)
9.9	B6 - use of energy and B7, use of water		If additional technical information is provided in the EPD for building integrated technical systems using energy or water related to the operation of the building,
9.10	End-of-life	The PEF method does include recycling and energy recovery at end of life (EoL) within the system boundaries. The basis scenario for recycling within PEF studies start from a 50%/50% allocation (50% of all impacts and credits will be allocated to the product system that uses the recyclables and 50% of all impacts and credits will be allocated to the forth bringing product system that generates the waste that can be recycled).	The system boundary is defined as "until the end-of-waste state is reached". Furthermore the EN 15804 standard states: "Materials from which energy is recovered with an efficiency rate below 60% are not considered materials for energy recovery." • Collection process specified by type (kg collected separately and kg collected with mixed construction waste) • Recovery system specified by type (kg for reuse, kg for recycling and kg for energy recovery) • Disposal specified by type (kg product or material for final deposition) • Assumptions for scenario development, e.g. transportation (Units as appropriate)

Annex 9 Non exhaustive list of thermal insulation EPDs

Name of Manufacturer	Category	EPD database		Mineral wool (except stone & glass)	Glass wool	Wood fiber	Stone wool	EPS (Expanded polystyrene)	XPS (Extruded polystyrene)	Hemp wool	Polyurethane	Gravel ,aggregate, granulate	Recycled Cotton fiber	Plasterboard + polyurethane	Plasterboard + polystyrene	Vacuum Insulation Panel	Foam Glass	Straw bale	Resin	Expanded perlite	Cellulose	Unknown
			Total	**7**	**220**	**12**	**92**	**176**	**44**	**2**	**39**	**4**	**1**	**11**	**32**	**1**	**2**	**1**	**1**	**1**	**2**	**1**
Saint Gobain Isover	Glasswool	Norwegian EPD Foundation	**1**		2																	
Glava	Glasswool	Norwegian EPD Foundation	**1**		1																	
Saint-Gobain Byggevarer	Light Weight Aggregate	Norwegian EPD Foundation	**1**									1										
ROCKWOOL	Stonewool	Norwegian EPD Foundation	**1**				1															
Glasitt	Granulate/ aggregate	Norwegian EPD Foundation	**1**									1										
Stiferite S.r.l	polyurethane insulation	Environdec	**1**								1											
Sirap Insulation	XPS – extruded polystyrene	Environdec	**1**						1													
Sirap Insulation	EPS expanded polystyrene	Environdec	**1**					1														
The Freudenberg Politex Group	Panels thermal and acoustic insulation	Environdec	**1**																			1
Rolan	Stonewool	Environdec	**1**				1															
ISOLAT	Polyurethane	FRENCH INIES	**1**								1											
Cavac	Rolls/ Hemp wool	FRENCH INIES	**1**							1												
Métisse Le Relais	Recycled Cotton fibre	FRENCH INIES	**1**										1									
Efisol	polyurethane	FRENCH INIES	**15**								15											
EXIBA	XPS	FRENCH INIES	**1**						1													

Name of Manufacturer	**Category**	**EPD database**		**Mineral wool (except stone & glass)**	**Glass wool**	**Wood fiber**	**Stone wool**	**EPS (Expanded polystyrene)**	**XPS (Extruded polystyrene)**	**Hemp wool**	**Polyurethane**	**Gravel ,aggregate, granulate**	**Recycled Cotton fiber**	**Plasterboard + polyurethane**	**Plasterboard + polystyrene**	**Vacuum Insulation Panel**	**Foam Glass**	**Straw bale**	**Resin**	**Expanded perlite**	**Cellulose**	**Unknown**
Knauf	Polyurethane	FRENCH INIES	**13**								13											
Knauf	Glass wool	FRENCH INIES	**42**		42																	
Knauf	EPS expanded polystyrene	FRENCH INIES	**32**					32														
Knauf	Plasterboard + expanded polystyrene	FRENCH INIES	**6**												6							
Knauf	Plasterboard + polyurethane	FRENCH INIES	**1**											**1**								
Pittsburgh Corning	FOAMGLASS (cellular glass)	FRENCH INIES	**1**														1					
Placoplatre	EPS expanded polystyrene	FRENCH INIES	**87**					87														
Placoplatre	Plasterboard + polystyrene expanded	FRENCH INIES	**24**												24							
Placoplatre	Plasterboard + polyurethane	FRENCH INIES	**8**											**8**								
Poliuretanos	Polyurethane	FRENCH INIES	**4**								4											
Promat	Stonewool (laine de laitier)	FRENCH INIES	**2**				2															
Reseau Français de la Construction Paille	Straw	FRENCH INIES	**1**															1				
Rockwool France	Stonewool (laine de roche)	FRENCH INIES	**45**				51															
Ruaud	Stonewool (laine de roche)	FRENCH INIES	**1**				1															
Eurocoustic (saint gobain)	Stonewool	FRENCH INIES	**11**				11															
ISOVER (saint gobain)	Glasswool	FRENCH INIES	**131**		131																	

Name of Manufacturer	**Category**	**EPD database**		**Mineral wool (except stone & glass)**	**Glass wool**	**Wood fiber**	**Stone wool**	**EPS (Expanded polystyrene)**	**XPS (Extruded polystyrene)**	**Hemp wool**	**Polyurethane**	**Gravel ,aggregate, granulate**	**Recycled Cotton fiber**	**Plasterboard + polyurethane**	**Plasterboard + polystyrene**	**Vacuum Insulation Panel**	**Foam Glass**	**Straw bale**	**Resin**	**Expanded perlite**	**Cellulose**	**Unknown**
ISOVER (saint gobain)	Hempwool	FRENCH INIES	**1**							1												
ISOVER (saint gobain)	Wood fibre	FRENCH INIES	**3**			3																
ISOVER (saint gobain)	Stonewool	FRENCH INIES	**18**				18															
ISOVER (saint gobain)	EPS expanded polystyrene	FRENCH INIES	**10**					10														
SINIAT	Plasterboard + polyurethane	FRENCH INIES	**2**											**2**								
SINIAT	Plasterboard + EPS expanded polystyrene	FRENCH INIES	**2**												2							
SINIAT	EPS expanded polystyrene	FRENCH INIES	**39**					39														
Thermalwiss embourg	expanded perlite	FRENCH INIES																		1		
URSA	Glasswool	FRENCH INIES	**37**		37																	
ALLIGATOR	EPS expanded polystyrene	IBU (Germany)	**1**					1														
ALSECCO	EPS expanded polystyrene	IBU (Germany)	**1**					1														
CAPAROL	EPS expanded polystyrene	IBU (Germany)	**1**					1														
CLIMOWOO L	glasswool	IBU (Germany)	**1**		1																	
DOW CORNING	Vacuum Insulation Panels	IBU (Germany)	**1**													1						
DOW DEUTSCHLA ND	XPS extruded polystyrene	IBU (Germany)	**1**						1													
FPX	XPS extruded polystyrene	IBU (Germany)	**1**						1													

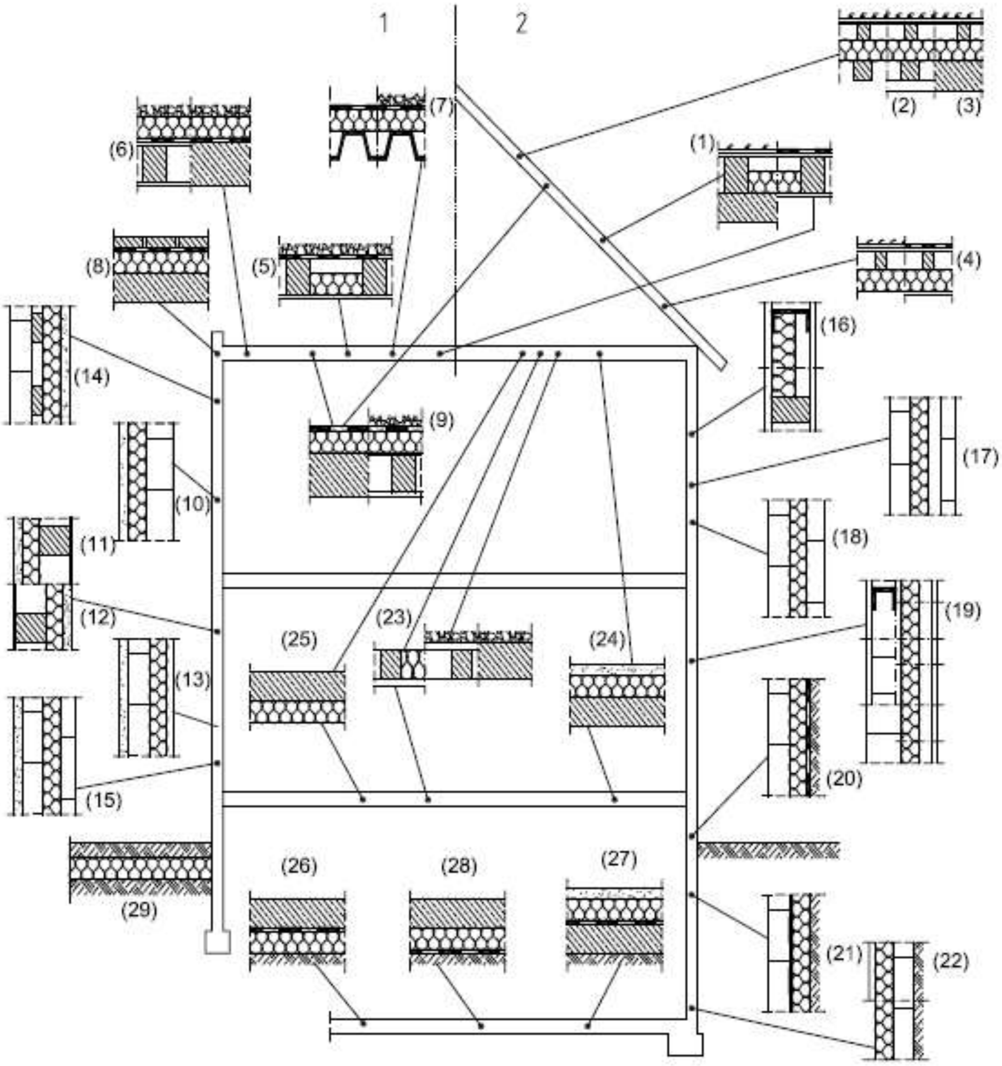
Name of Manufacturer	**Category**	**EPD database**		**Mineral wool (except stone & glass)**	**Glass wool**	**Wood fiber**	**Stone wool**	**EPS (Expanded polystyrene)**	**XPS (Extruded polystyrene)**	**Hemp wool**	**Polyurethane**	**Gravel ,aggregate, granulate**	**Recycled Cotton fiber**	**Plasterboard + polyurethane**	**Plasterboard + polystyrene**	**Vacuum Insulation Panel**	**Foam Glass**	**Straw bale**	**Resin**	**Expanded perlite**	**Cellulose**	**Unknown**
Gutex	Wood fibre	IBU (Germany)	**2**			2																
IVZ	EPS expanded polystyrene	IBU (Germany)	**3**					3														
IVPU	Polyurethane	IBU (Germany)	**1**								1											
Kingspan	Resin insulant	IBU (Germany)																	1			
Knauf	Stonewool	IBU (Germany)	**1**				1															
Knauf	Wood wool/fibre	IBU (Germany)	**1**			1																
Knauf	EPS expanded polystyrene and wood fibre	IBU (Germany)	**1**			1		1														
Knauf	Stonewool and wood fibre	IBU (Germany)	**1**			1	1															
Knauf	Mineral wool	IBU (Germany)	**1**	1																		
Knauf	Stonewool	IBU (Germany)	**1**				1															
Knauf	woodfibre	IBU (Germany)	**1**			1																
Heradesign Decken Division	woodfibre	IBU (Germany)	**1**			1																
Knauf	Stonewool	IBU (Germany)	**1**				1															
Knauf	Glasswool	IBU (Germany)	**1**																			
Knauf	Stonewool	IBU (Germany)	**1**				1															
Kronoply	Wood fibre	IBU (Germany)	**1**			1																
misapor	Foam glass gravel	IBU (Germany)	**1**									1										
pavatex	Wood fibre	IBU (Germany)	**1**			1																
Pittsburgh Corning	Foam glass	IBU (Germany)	**1**														1					
Porextherm	Vacuum Insulation	IBU (Germany)	**1**																			

Name of Manufacturer	Category	EPD database		Mineral wool (except stone & glass)	Glass wool	Wood fiber	Stone wool	EPS (Expanded polystyrene)	XPS (Extruded polystyrene)	Hemp wool	Polyurethane	Gravel ,aggregate, granulate	Recycled Cotton fiber	Plasterboard + polyurethane	Plasterboard + polystyrene	Vacuum Insulation Panel	Foam Glass	Straw bale	Resin	Expanded perlite	Cellulose	Unknown
PU europe	Polyurethane	IBU (Germany)	**4**								4											
ISOVER Saint-Gobain	Stonewool	IBU (Germany)	**1**				1															
ISOVER Saint-Gobain	Glasswool	IBU (Germany)	**3**		3																	
Deutsche ROCKWOOL	Mineral wool	IBU (Germany)	**3**	3																		
TECHNOpor	Foam glass gravel	IBU (Germany)	**1**									1										
URSA	Glass wool	IBU (Germany)	**3**		3																	
URSA	Stonewool	IBU (Germany)	**1**				1															
URSA	Mineral wool	IBU (Germany)	**2**	2																		
Xella	Mineral	IBU (Germany)	1	1																		
Termex	Cellulose	EPD																			1	
Isocell	Cellulose	EPD																			1	

Annex 10 Examples of the most common applications of thermal insulation products in buildings

Application			Sketch No.
Roof	Pitched roof	Unloaded insulation between rafters, fully supported	1
		Insulation separating rafters and outer covering	2
		Insulation separating supporting construction and outer covering	3
		Insulation beneath rafters	4
	Flat roof	Insulation between rafters or beams	5
		Inverted, insulation above roofing membrane including roof gardens and parking decks	6
		On steel deck, insulation beneath roofing membrane	7
		Accessible to light or heavy traffic or loads from roof garden (soil layer, plants, etc.) and parking decks (concrete pavers or slabs), insulation beneath roofing membrane	8
		Accessible only to maintenance personal, insulation beneath roofing membrane	9
Wall		Masonry or concrete wall, external insulation covered by rendering	10
		Timber stud construction, outside insulation and rendering directly supported by the studs	11
		Timber stud construction, insulation at the internal side with rendering	12
		Masonry or concrete wall, fully supported internal insulation supporting light protective internal facing (e.g. gypsum board)	13
		Masonry or concrete wall, internal insulation supporting light protecting facing, partly supported by studs	14
		Masonry or concrete wall, internal insulation with heavy self-supported protective internal facing (e.g. tiles at roomside)	15
		Timber or metal stud construction with boards covering, insulation between the studs	16
		Cavity wall construction, insulation between the leaves, cavity ventilated	17
		Cavity wall construction, cavity fully filled with insulation, outer leave not watertight	18
		Timber or metal stud construction with boards covering, insulation supported by boards; or masonry or concrete wall, supporting the insulation with ventilated exterior covering	19
		Wall under ground, external insulation behind waterproof membrane with mechanical protection	20
		Wall under ground, external insulation with direct contact to the ground	21
		Cellar or crawlspace hall, internal insulation with or without covering	22
Ceiling/floor		Insulation over the supporting construction or between the beams	23
		Insulation under load distributing flooring, fully supported	24
		Insulation under the construction	25
Foundation		Concrete, insulation under the slab with direct contact to the ground	26
		Concrete, insulation supported by the slab, above waterproof membrane, beneath load distributing flooring	27
		Concrete, insulation under the slab above waterproof membrane	28
		Frost insulation in or against the ground	29

Annex 11 Examples of the most common applications of thermal insulation products in buildings (according to ISO/FDIS 9774) – sketches

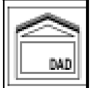
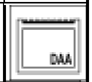
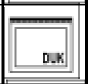
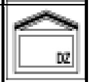
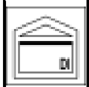
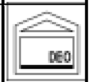
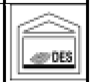
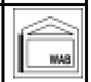
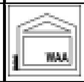
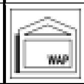
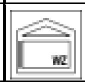
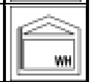
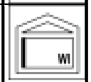
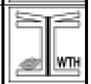
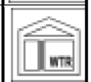
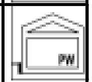


Key

1 flat roof
2 pitched roof

insulating product
waterproofing layer
timber or metallic studs, concrete or rafters
masonry or concrete
rendering
concrete
gravel
ground

Annex 12 Applications for thermal insulation in buildings based on DIN standard

Area of Application	Designation	Application description	
Ceiling, Roof	DAD	External insulation of warm pitched roof or ceiling insulation, protected against weathering, insulation under cover	
	DAA	External insulation of roof or ceiling, protected against weathering, insulation under water proofing	
	DUK	External insulation of the roof, exposed to the weather (inverted roof)	
	DZ	Insulation between the rafters, two-shell roof, top floor ceiling not readily walkable but accessible	
	DI	Interior insulation of the ceiling (underside) or the roof, insulation under the rafters / supporting structure, false ceiling etc.	
	DEO	Interior insulation of the ceiling or floor plate (top side) below floor screed without acoustic dampening requirements	
	DES	Interior insulation of the ceiling or floor plate (top side) below screed with acoustic dampening requirements	
Wall	WAB	External wall insulation behind covers	
	WAA	External wall insulation behind seal	
	WAP	External Thermal Insulation Composite System with render	
	WZ	Insulation of double-leaf walls, cavity wall insulation	
	WH	Insulation of wood frame and wood panel construction	
	WI	Interior wall insulation (insulation of walls from inside)	
	WTH	Insulation between the house partition walls with sound insulation requirements (between adjacent houses)	
	WTR	Insulation of partitioning walls (within one house)	
Perimeter	PW	External thermal insulation of walls in contact with soil (outside of the water proofing)	
	PB	External thermal insulation under the floor panel in contact with soil (outside of water proofing)