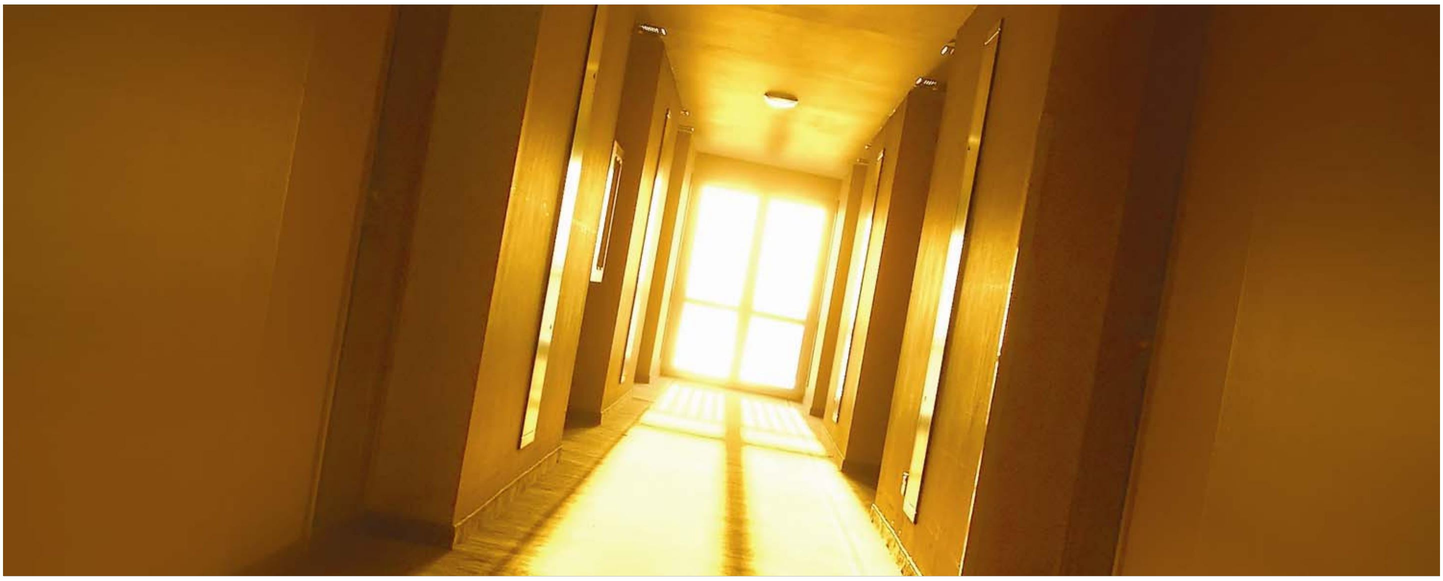

Green Public Procurement
Thermal Insulation Technical Background Report

Report for the European Commission – DG Environment by AEA, Harwell, June 2010

Owner, Editor: European Commission, DG Environment-G2, B-1049, Brussels.

Table of contents

1 Introduction

Following on from previous work in developing GPP criteria for eleven product groups[1], a further ten products and sub-products have been identified for the development of GPP purchasing criteria to add to the European Commission's GPP training Toolkit Module 3, which presents recommended GPP criteria for products and services. GPP is a voluntary instrument.

Thermal Insulation has been identified as a product group for criteria development. This report provides background information on the environmental impact of thermal insulation products, excluding insulation of pipework and ducts or foil insulation products, and outlines the key relevant European legislation affecting this product group. It then goes on to describe existing standards and ecolabels that cover this product group. Finally it outlines the rationale for the core and comprehensive environmental purchasing criteria that are being proposed for consultation.

This report accompanies the associated **Product Sheet** that contains the proposed purchasing criteria and ancillary information for green tender specifications and as such they should be read alongside one another.

The format for the purchasing recommendations comes in the form of two sets of criteria:

- The **core criteria** are those suitable for use by any contracting authority across the Member States and address the key environmental impacts for the product in question. They are designed to be used with minimum additional verification effort or cost increases.
- The **comprehensive criteria** are for those procurers wishing to purchase the best products available on the market. These may require additional verification effort or a slight increase in cost compared to other products with the same functionality.

Within the core and comprehensive criteria, the guidance follows the various stages of a public procurement procedure and explains how best to integrate environmental criteria at each stage:

- Subject matter. It means the title of the tender, i.e. a short description of the product, works or service to be procured.
- Technical Specifications. Provide a clear, accurate and full description of the requirement and standard to which goods, works or services should conform. Description of the minimal technical specifications which all bids need to comply with. Set specific environmental criteria, including hurdles and levels that need to be met for specific products.
- Selection Criteria. It is based in the capacity / ability of the bidders to perform the contract. Assist in the identification of appropriate suppliers, for example to ensure adequately trained personnel or relevant environmental policies and procedures are in place.
- Award Criteria. The award criteria on the basis of which the contracting authority will compare the offers and base its award. Award criteria are not pass/fail criteria, meaning that offers of products that don't comply with the criteria may still be considered for the final decision, depending on their score on the other award criteria.
- Contract Performance Clause - Specify the conditions that must be met in the execution of the contract, for example as to how the goods or services are to be supplied, including information or instructions on the products to be provided by the supplier.

It should be noted that the contractor is bound by the existing legal framework.

Where the verification for the criteria states that other appropriate means of proof can be used, this could include a technical dossier from the manufacturer, a test report from a recognised body, or other relevant evidence. The contracting authority will have to satisfy itself on a case by case basis, from a technical/legal perspective, whether the submitted proof can be considered appropriate.

[1] http://www.ec.europa.eu/environment/gpp

2 Abbreviations and definitions

AFS	Australian Forestry Standard
BRE	Building Research Establishment
CFC	Chlorofluorocarbon
CLP	Classification, Labelling and Packaging
CPD	Construction Products Directive
CPR	Construction Products Regulation
EPBD	Energy Performance in Buildings Directive
EPD	Environmental Product Declaration
EPS	Expanded polystyrene foam)
ER3	Essential Requirement 3
ESR	Energy Saving Recommended
EST	Energy Saving Trust
EWC	European Waste Catalogue
FSC	Forest Stewardship Council
GECA	Good Environmental Choice – Australia
GHG	Greenhouse Gas (emissions)
GPP	Green Public Procurement
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HWD	Hazardous Waste Directive
HWL	Hazardous Waste List
IARC	International Agency for Research on Cancer
LCIA	Life-cycle Impact Assessment
ODP	Ozone Depletion Potential
ODS	Ozone Depleting Substances
PEC	Primary Energy Consumption
PIR	Polyisocyanurate (foam)
PUR	Rigid Polyurethane (foam)
REACH	Regulation, Evaluation, Authorisation and Restriction of Chemical Substances
XPS	Extruded polystyrene

U-value: The *U-value* describes how well a building element conducts heat. The lower the value the better insulator a material is. Methodologically, it measures the rate of heat transfer through a building element over a given area under standard conditions.

U is the inverse of *R* i.e. $U = 1/R$ where R describes how thermal insulation is achieved by retarding the flow of heat through the material itself. The higher the R-value, the greater the insulation.

3 Definition, Scope and Background

Thermal insulation is used to keep buildings cooler in summer and warmer in winter by reducing the flow of heat through the exterior surfaces of the building.[2] The choice of insulation product will be guided by the application for which it is to be used, and the amount of insulation required will depend on the climate of the location, latitude and altitude at which the building is constructed.[3]

Buildings are responsible for 40-50% of Europe's energy use and the largest share of energy in buildings is heating. It is thought that up to 50% of buildings in Europe are uninsulated[4]; however thermal insulation can reduce the heat lost from buildings and therefore save energy and money. European legislation is driving increased installation of insulation through harmonisation of building standards up to the levels of the most ambitious Member States. This legislation, coupled with fluctuating energy prices, increased new-build activity, drives to refurbish older properties, increasing awareness of insulation benefits and government grants to encourage installation, is resulting in a rise in demand for insulation products.

The European market is split into two main product categories according to the chemical and physical structure of the insulation materials: inorganic mineral materials and organic materials. These are defined in the following section, where they have been split into four categories.

In 1999 building thermal insulation accounted for 65% of the total UK thermal insulation market, compared with 62% in 1995 and this was expected to increase by 8% between 2000-2004. The largest share of the market (52%) was represented by wall insulation products, 41% of which consisted of cavity wall insulation. Loft insulation had the second largest share, accounting for 25% of the market in 1999.[5] According to a recent study[6], inorganic fibrous materials will experience 5% growth in the next decade. It should be noted that these figures are for the UK only and therefore cannot be taken as representative of other EU countries, but indicate their magnitude.

Most thermal insulation products are covered by the Construction Products Directive (see 6.2), defined in harmonised European standards and assessed by test methods indicated in these standards. Construction products covered by the CPD have to be CE marked. CE marking is accompanied by specific technical information about specific performance of these products.

3.1 Applications

There are a wide variety of potential applications for thermal insulation products across Europe. This document refers to all types of insulation except those listed below:

1. Insulation for pipework and ducts.
2. Foil-based insulation products.

3.2 Materials

There are various products that can be applied to a number of these applications. Existing eco-labels and criteria sets tend to define thermal insulation using the four categories below. It should be noted that the uses for the following insulation products are not exhaustive. Similarly the insulation products listed are not exhaustive and other types of insulation do exist within the European market.

[2] Allen, E. (1999) Fundamentals of Building Construction Materials and Methods. 3rd ed. *John Wiley & Sons.*
[3] Roaf, S. *et al*. (2007) Ecohouse: a Design Guide. 3rd ed. *Architectural Press.*
[4] XCO2 Conisbee Ltd Consulting Engineers. *Insulation for Sustainability – A Guide* (research carried out for the Federation of European Rigid Polyurethane Foam Associations (BING))
[5] MSI Marketing Research for Industry Ltd (2000) MSI DATAPLUS: Thermal Insulation: UK: a report
[6] Ardente, et al. (2008) Building energy performance: A LCA case study of knaf-fibres insulation board. *Energy and Buildings 40, p 1-10.*

3.2.1 Inorganic mineral fibre

- **Stone wool** is based on natural minerals, e.g. volcanic rock, typically basalt or dolomite[7], and recycled post-production waste materials, melted, spun into fibres and then mixed with binder and impregnation oil.[6] There are a wide variety of products ranging from loose materials suitable for cavity wall insulation, to rolls and light boards for loft insulation and dense slabs used for light load bearing application to floors and roofs. The range includes slabs, pre-formed pipe insulation and wired matting[8].

- **Glass wool** is made from sand, limestone and soda ash with a high proportion of recycled glass and other minerals.[7] These are melted, spun into fibres, and mixed with organic resins before curing into products. These may be used for similar applications as stone wool.

- **Slag wool** is made from blast furnace slag (waste).[7]

The above products are often collectively referred to as mineral wool.

3.2.2 Organic oil/ coal derived

- **Polyurethane foam (PUR)** is a closed cell thermoset polymer. It can be applied as rigid foam, blown with CFC-free gas (generally HFCs, CO_2 or pentane), or as prefabricated products which have been moulded into discrete shapes. This product can be used as cavity wall insulation or as roof insulation, floor insulation, pipe insulation, insulation of industrial installations, ships as well as cooling and refrigeration equipment.[8]

- **Polyisocyanurate foam (PIR)** is also a closed cell thermoset polymer with many similarities to PUR, above. The key difference is in the ratio of the polyol and isocyanate co-polymers. PIR is typically used for metal faced panels, roof boards, cavity wall boards and pipe insulation. It is generally accepted that it has better fire resistance properties than PUR.

- **Phenolic foam** is also a thermoset polymer, however it can have an open or closed cell structure. In order to use the product as a foam the phenolic resins are mixed with an inorganic acid catalyst and a blowing agent (generally HFCs, CO_2 or pentane). The product is typically used to insulate pipework, roofs and walls[8].

- **Expanded polystyrene (EPS)** is a rigid cellular form of polystyrene, with an open cell structure. It is a thermoplastic polymer, so can be reprocessed and recycled more easily than thermoset polymers. Building and construction applications account for around two-thirds of demand for EPS: loose beads are used for closed cavity walls, roofs and floor insulation and boards can be produced by fusing beads together.[9] Pentane is used as a blowing agent.

- **Extruded polystyrene (XPS)** is also a thermoplastic polymer, however it has a closed cell structure and is often stronger, with a higher mechanical performance and is, in principle, often more expensive than EPS. It is made from solid polystyrene crystals and used to make insulation boards for roofing, flooring and wall application[9]. HFCs or pentane are used as blowing agents.

3.2.3 Organic plant/animal derived

- **Cellulose** is made from recycled newspaper, which has been treated with insect and fire resistant chemicals (typically mixtures of borates or boric acid or cheaper

[7] http://www.eurima.org/index.php?page=composition
[8] UK Market Transformation Programme Briefing Note BNIW01: Insulation industry, product and market overview, v1.0.
[9] http://www.icis.com/v2/chemicals/9076008/polystyrene-expandable/uses.html; BNIW01: Insulation industry, product and market overview, v1.0.

alternatives such as aluminium and ammonium sulphates. It can be wet or dry blown. It is sometimes formed into boards but is more usually blown into place. As such it can be used as loft or wall insulation.[8]

- **Cork** insulation boards come from cork oak, which is grown in Portugal, Spain and Northern Africa. It is used for flat roof insulation, is lightweight and ranges in thickness between 13mm and 305mm. It is a by-product of the bottling cork industry and can be recycled where facilities exist.[8]

- **Woodfibre** boards are rigid building boards made from sawmill off cuts that are pulped, soaked and formed into boards.[10]

- **Sheeps wool**, as the name suggests, comes from new or recycled wool. It is available in rolls or batts that have been treated with fire retardant chemicals.[8] Sheep's wool may require pre-treatment to remove pesticide residue from sheep dip and to prevent moth attack.

- **Cotton insulation** is made from post-industrial recycled cotton textiles.

- **Hemp fibre** contains hemp, waste cotton fibres and a small amount of thermoplastic polyester binding fibres. It is available in rolls for wall, roof and floor insulation.[8]

- **Flax** insulation is formed by combining flax, which is grown in Europe, with polyester, diammonium hydrogen phosphate and borax.[6]

- **Compressed straw** is straw fused together. Available in insulation boards with heavyweight paper on each side.

3.2.4 Other

- **Foamed glass (Cellular glass)** is formed from a reaction between glass and carbon at high temperatures and has a cellular structure which is impermeable. This makes it ideal as a barrier against soil humidity. It is typically blown with CO_2 with the addition of sulphur gases.

- **Aerated glass** is also produced from recycled glass and is a closed cell material.

- **Expanded clay pellets** are small and expand at very high temperatures to become lightweight, porous and weight-bearing.[11]

- **Vermiculite** consists of a complex hydrated aluminium magnesium silicate. It is exfoliated into pellets which can be used as loose fill loft insulation.[8]

- **Foil products** consist of a number of layers of aluminium foil between layers of polyester wadding, or other insulation products, such as glass wool. The product works by reflecting heat and is often used in roofs and walls in warmer regions to reduce the flow of solar heat into buildings.[2] At present there is no agreed standard for measuring the performance of foil insulation products and there is some difference of opinion on how well foil products perform in terms of their thermal insulation properties. "Work is currently being undertaken by CEN/TC89 working group 12, entitled "reflective insulation products" to address this issue. This working group is investigating the thermal performance of thin multi-layer reflective insulating products, such as multi-foil insulation.[8]

[10] http://www.lime.org.uk/building_materials/Woodfibre_Insulation.asp
[11] *www.sustainablebuild.co.uk/InsulationMaterials.html*

4 Key Environmental Impacts

Since industrialisation the energy intensity of the production of building materials has increased due to the shift from locally produced raw materials and human energy to high temperature manufacturing processes that consume large amounts of fuel energy and use components and materials that have been transported across the world. This increase in the pre-use energy consumption of materials is accompanied however by the advent of insulating materials that can reduce the operational energy use of a building. Installing insulation materials in new and existing buildings is one of the best ways to reduce the environmental impact of buildings. In this respect, any insulation material can be deemed as preferable to no insulation. There is a range of insulating materials each with their own benefits in terms of environmental performance. For example, Hubermann and Pearlmutter (2008) state:

"*as operational energy use becomes lower, the role of embodied energy in minimizing overall consumption becomes increasingly prominent*".[12]

Another report, however states:

"Analysis shows that over a realistic timescale of 100years, the lifetime energy is not sensitive to the choice of insulating material – though it is, of course, extremely sensitive to the thermal standards or U-values achieved. This reiterates very clearly: thermal standards first, and longevity of performance second, are the two key environmental issues for choosing insulation materials."[13]

This point is further demonstrated in the Building Research Establishment's (BRE – UK) Green Guide to Housing Specification[14] which states:

"Low-density mineral wool, expanded polystyrene (EPS), corkboard and recycled cellulose are all good performers due to their minimal processing energy…Polyurethane (PUR) and extruded polystyrene (XPS) are both very highly processed, but as polyurethane foams have lower conductivity, less foam is required to provide similar thermal resistance, resulting in a better environmental profile."

Table 1 illustrates typical annual CO_2 savings that can be achieved through the use of different types of insulation for a standard sized domestic property in the UK. It should be noted that the amount of energy saved will be influenced by the type of insulation used, its thickness, construction techniques, etc. The figures listed in the table are 'typical' values.

Table 1. Typical annual CO_2 savings from a selection of insulation applications.[15]

Type of insulation	Typical annual CO_2 savings (kg)
External wall insulation	690-1060
Cavity wall insulation	750-880
Loft insulation to 6 inches	750-880
Internal wall insulation	560-690
Hot water tank lagging	190-500
Draught proofing on windows & doors	125-250
Hot water pipe lagging	125-190
Floor insulation	60-190

Energy however is not the only impact of construction on the environment.

[12] Hubermann and Pearlmutter (2008) A life-cycle energy analysis of building materials in the Negav desert. *Energy and Buildings 40 p837-848*
[13] XCO2 Conisbee Ltd Consulting Engineers. *Insulation for Sustainability – A Guide* (research carried out for the Federation of European Rigid Polyurethane Foam Associations (BING))
[14] Anderson, J and Howard, N. (2000) The Green Guide to Housing Specification. *BRE Publications.*
[15] MSI Marketing Research for Industry Ltd (2000) MSI DATAPLUS: Thermal Insulation: UK: a report, pg 42

4.1 Summary of Life-Cycle Phases

The life cycle of a thermal insulation product consists of a number of key phases, which are summarised as follows:

- Extraction and processing of raw materials:
  - Mining operations and refining ores for the manufacturing process will result in environmental issues and impacts; these include high energy use, physical disturbance of the landscape and pollution from toxic emissions, which may affect land, water and air. There is scope to use recycled content within many insulation products, which would reduce the impacts at this stage.

  OR

  - Cultivation and cropping/harvesting plants. The lifecycle impacts of this stage consider the fertilisers and fuel used to sew and harvest the crop and the water consumed through irrigation. Water and ground pollution could result from these activities if not properly managed and contained. Another key factor is the diversion of land away from other activities, such as forestry or food production. If an area of forestry has been cleared in order to grow crops for insulation, then the potential of the crops to absorb CO_2 compared to the trees should be considered. The diversion of food crops has social (employment) issues as well and could lead to higher importation of food to the area, with concomitant environmental impacts.

- Insulation manufacture – The manufacturing processes for the different categories of insulation vary, however all have significant environmental impacts, including energy consumption, the use of materials with hazardous properties and the production of hazardous wastes.

- Packaging – The insulation is cut to size and wrapped in packaging to allow transportation. This packaging has environmental implications through its manufacture and if oil-based polymers are used it could result in additional non-biodegradable waste if not reused or recycled properly.

- Transport to retail unit – The main environmental impact is energy consumption (fuel use) and associated air quality and GHG emissions by the vehicles.

- Installation – transportation from the retail unit to the building where the insulation is to be used has an impact through fuel use and vehicle emissions. The efficiency of the installation also affects the degree of wastage and the efficiency of the insulation (gaps in the insulation can reduce its effectiveness). Also, heavier insulation products may require additional equipment and fixtures to secure them in place compared to lighter (less dense) alternatives.

- End of life – reducing further environmental impact will depend on the management and handling of insulation products at the end of their useful life; mismanagement can result in increased impacts on the environment, for example hazardous waste being disposed of to landfill or the emission of toxic particulates into the atmosphere. Disposal options for insulation depend on the type of material used: some will have to be disposed of as hazardous waste.

For each of the phases listed there will be an element of energy input. There will also be emissions to air, land and water and some degree of waste and resource use, which will either be suitable for reuse or recycling or have to be sent for disposal. The sections below outline in further detail the environmental impacts associated with thermal insulation materials.

4.2 Key Environmental Impacts

While there are benefits to a top down approach for the whole building, provided by Directives such as the EPBD, a product based approach is also necessary for those who wish to specify that the most environmentally sustainable materials be used within the sustainably designed building, or for whom refurbishment is the focus and where the EPBD would not apply. Construction products have large volume sales with significant scales of impact and these are experienced throughout the EU.

A number of studies have considered the life cycle of thermal insulation materials and their impacts on buildings. One criticises the use of LCA on insulation materials alone, stating that the LCA should be completed for the whole building rather than its component parts.[4] However, for an LCA to be carried out on the whole building it is necessary for information on the impact of the component parts to be collated. Also, another study rated insulation as the most effective strategy for reducing energy consumption and the second most effective for reducing annual energy costs[16], indicating the importance of the impact of insulation for the whole-building LCA.

In addition to this a number of other environmental issues are also applicable to insulation materials. These include the use of hazardous materials in their production and the end of life management of insulation.

4.2.1 Manufacturing Impacts - Energy Use

The primary function of insulation is to save energy and any type of insulation will save more energy across its lifetime than it requires for its manufacture. However, as this is the case for any insulation material, embodied energy can be used as a differentiator between materials.

The energy required to manufacture a building product is called the primary energy consumption (PEC) or embodied energy. The energy input however varies greatly depending on the type of insulation. However, comparing insulation products is not as simple as comparing embodied energy figures - the intended end use of the insulation material is a major factor. For example different densities of different insulation materials can be required to achieve similar levels of thermal resistance. While Product A might require less energy to produce than Product B, twice the thickness of Product A might be required to achieve the desired thermal resistance making Product B the more attractive option for that end use. Similarly the requirements for strength, compressibility, moisture resistance, fire resistance and maximum thickness must all be considered.

The suitability of the insulation product will also be affected by the size of the location of its intended use, as well as its potential exposure to ventilation and water; since the thermal resistance of some materials reduces when wet or exposed to wind. Heavy insulation materials may require additional fixtures for installation and these fixtures carry with them their own lifecycle impacts on the environment. It must also be considered that for some insulation products' feedstock energy can be recovered at the end of life via incineration and recovery of energy through this process. Recycling of insulation may also provide some benefit in reducing embodied energy for the product, although this is currently mainly done for production waste and some construction waste, not end of life waste.

Under Mandate 350 (see Section 6.3.1) the relevant CEN working group aims to establish a methodology for calculating the use of non-renewable energy use (measured in mega joules – MJ) for different stages of the product lifecycle. The Mandate will lay down the methodology which will allow manufacturers to calculate these values and list the use of non-renewable energy use and many other environmental/sustainability values in an environmental product declaration (EPD). The EPD will allow contracting authorities to benchmark products based on a comparison of the information included in the EPD.

Table 2. Embodied energy for a selection of insulation materials[17]

Material	Boundaries	Embodied energy (MJ/kg)	Embodied carbon (kg CO2/kg)
Cellulose	Cradle to Gate	0.94 – 3.3	-
Cork	Cradle to Gate	4	0.19
Fibreglass (glass wool)	Cradle to Site	28	1.35
Flax	Cradle to Grave	39.5	1.7
Mineral wool	Cradle to Gate	16.6	1.2
Rockwool (stonewool)	Cradle to Site	16.8	1.05

[16] Insulation ranked second behind heating, ventilation and air conditioning (HVAC) systems due to the cost of electricity compared with gas. Blanchard and Reppe (1998) Life cycle analysis of a residential home in Michigan. *Academic paper, University of Michigan.*
[17] Hammond, G and Jones, C (2008) Inventory of Carbon and Energy (ICE) Version 1.6a. (www.bath.ac.uk/mech-eng/sert/embodied/)

Paperwool	Cradle to Grave	20.2	0.63
Expanded polystyrene (EPS)	Cradle to Gate	88.6	2.5
Polyurethane	Cradle to Gate	72.1	3
Woodwool (loose)	Cradle to Gate	10.8	-
Woodwool (board)	Cradle to Gate	20	0.98
Recycled wool	Cradle to Gate	20.9	-

Table 2 shows the typical embodied energy (of manufacture) of a variety of insulation materials per kilogram of material and shows a range of values. Whilst this is useful information, it is important for contracting authorities to take into account not only the embodied energy, but also the end-use application of the materials, which takes the amount of material into account (thickness used and its density), the lifetime of the material and, most importantly, the thermal properties of the material for a given level of insulation. As such it is more useful to present the embodied energy in terms of the final application in the building taking these issues into account. The data in the following table has been supplied by PU Europe (ex-BING) the European association representing the manufacturers of rigid polyurethane foam *insulation* materials in Europe.

Table 3. Embodied energy of materials for 100m^2 roof with thermal resistance of 3.33 m^{2}K/W[18]

Type of insulation	Thermal conductivity	Thickness in mm	Weight in kg	Total embodied energy in MJ
Cork	0.040	133	1,733.33	12,220
EPS	0.035	117	291.6	28,933
PUR/PIR	0.024	80	264.00	33,317
Stone wool	0.038	127	1,520.00	33,622
Glass wool	0.037	123	1,295.00	44,807
XPS	0.036	120	420.00	46,284
Wood fibre	0.050	167	4,000.00	68,000

This table shows that there are a wide range of thicknesses and weights needed to achieve the same goal: from almost 300 – 4000kg. Similarly there are a wide range of embodied energies, not entirely dependent on material type, e.g. whilst cork has a very low embodied energy, it has a higher thermal conductivity therefore a greater thickness would be required to achieve the same level of insulation as PUR/PIR. This would also increase the weight of the material required, making the material unsuitable in certain situations and potentially requiring additional fixtures to install the material.

4.2.2 Energy Saved In-use

As outlined in the introduction to this section, the energy saving potential of the insulation product is vital to the good energy efficient performance of the building in which it will be installed. Three different measures are used when describing heat transfer through insulation materials, as described briefly here:

- **Thermal conductivity**, measured in W/mK describes how well a material conducts heat. It is the amount of heat (in watts) transferred through a square area of material of given thickness (in metres) due to a difference in temperature (in degrees Kelvin) either side of the material. The lower the thermal conductivity of the material the greater the material's ability to resist heat transfer, and hence the greater the insulation's effectiveness. E.g. air has a low thermal conductivity of 0.025 W/mK (and has been used as an insulating material, along with other gases) whilst copper has a high value of 401 W/mK (and is often used on the bottom of cooking utensils for rapid heat transfer). Commonly used insulants tend to have a thermal conductivity between 0.019 W/mK and 0.046 W/mK.[19]

[18] Table of figures provided by PU Europe (ex-BING) during Phase 1 of the EU GPP consultation on Thermal Insulation Products.
[19] MSI DATAPLUS: Thermal Insulation: UK: a report (2000) MSI Marketing Research for Industry Ltd

- **Thermal resistance** (R-value), measured in m^2K/W. This is the rate that heat (in Watts) is transferred through a square metre of material multiplied by the difference in temperature (in degrees Kelvin) either side of the material: the higher the R-value the greater the insulation's effectiveness. The thermal resistance of a material is calculated by dividing the thickness (in metres) of the material by its thermal conductivity.[20]

- **Thermal transmittance** (U-value), measured in W/m^2K. This describes how well the material conducts heat. It is the rate that heat (in Watts) is transferred through a square metre of material, divided by the difference in temperature (in degrees Kelvin) either side of the material – it is the inverse of the R-value (i.e. 1/R) and the lower the U value the better the insulation.

Using the first of these measures, thermal conductivity, Table 4 outlines typical thermal conductivity values for a variety of insulation products at different densities and temperatures.

Table 4. Typical thermal conductivity values for a variety of insulation products.[5]

Type of insulation	Nominal density (kg/m^3)	Mean Temperature (^oC)	Thermal Conductivity (W/mK) at nominal density
Glass mineral wool	10-200	10	0.037-0.031
Rock mineral wool	20-200	10	0.033-0.034
Expanded polystyrene (EPS)	15-30	10	0.038-0.033
Extruded polystyrene (XPS)	28-45	10	0.027-0.026
Phenolic foam	35-60	10	0.018-0.022
Polyisocyanurate foam (PIR)	32-50	10	0.023
Polyurethane foam (PUR)	35-50	10	0.023
Cork	112	10	0.038
Exfoliated vermiculate	109	10	0.066

Using a comparative mean temperature of 10^oC, 35-60kg/m^3 of Phenolic foam is better at resisting heat transfer than 109kg/m^3 of vermiculite. Meanwhile, 15-30kg/m^3 of EPS has a similar level of thermal conductivity to 112kg/m^3 of cork. This demonstrates that the density of a material cannot be used in isolation to decide between products. The thermal conductivity value must be considered in combination with the embedded energy for, as demonstrated in Section 4.2.1, EPS has a poor performance in terms of embodied energy. Also, new products are coming onto the market, which use aluminium membranes, for example, to improve the thermal conductivity of the material. This adds an extra layer of complexity when comparing insulation products because the use of such products reduces the thermal conductivity value. It should be noted that different thicknesses and densities of insulation materials can have a knock on effect on the building design as additional studwork may be required to support the insulation, or the thickness of a wall may be increased.

4.2.3 Hazardous Materials

One of the main issues associated with the environmental impact of insulation relates to the blowing agents used to make and apply foamed insulation products. Until recently these blowing agents used chlorofluorocarbons (CFCs) to increase their thermal efficiency, however these gases were phased out under the Montreal Protocol due to their impact on stratospheric ozone depletion (see Section 6.6). Hydrochloro-fluorocarbons (HCFCs) were introduced as a replacement, however these are still detrimental to the ozone layer due to their chlorine content and are likewise controlled by the Montreal Protocol. Both CFCs and HCFCs also contribute to climate change.[21]

Carbon dioxide, HFCs and pentane are current common alternative blowing agents to HCFCs and are generally less damaging for the environment.[22] Although pentane does not have the *stratospheric* ozone depletion problems that HCFCs and CFCs do, it does however have ground-level *tropospheric* ozone creation potential (when in the presence of NO_x gases) and is a relatively large contributor to this problem.[23] Although ozone is needed high up in the stratosphere to 'filter out' the excesses of the

[20] UK Building Regulations (1990 edition) Approved Document L: Conservation of fuel and power.
[21] http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-ts.pdf
[22] Anderson, J and Howard, N. (2000) The Green Guide to Housing Specification. *BRE Publications.*
[23] *Photochemical ozone creation potentials for a large number of reactive hydrocarbons under European conditions*, Atmospheric Environment, Volume 30, Issue 2, January 1996, Pages 181-199, R. G. Derwent, M. E. Jenkin, S. M. Saunders.

sun's harmful UV rays and thereby protect plant, animal and human life, it is not good to have ozone at ground level as it can be very damaging to the same plants and animals. As such, the use of pentane should be undertaken with suitable abatement and collection technology. HFCs have no ozone depletion, but have high global warming potential and can reduce conductivity. There are HFC blowing agents in development with very low global warming potential.

There are a variety of other substances within insulation products that can be regarded as toxic to the environment and to human health. Many of these are covered by the REACH legislation which applies to substances manufactured or imported into the EU in quantities of 1 tonne per year or more. Generally, it applies to all individual chemical substances on their own, in preparations or in articles, such as insulation products (if the substance is intended to be released during normal and reasonably foreseeable conditions of use from an article).[24] CEN 351 is developing standard assessment methods to deal with the emission of dangerous substances from construction products to indoor air and release to soil, surface water and ground water. Further information on CEN 351 can be found in Section 6.3.2.

4.2.4 Packaging

Definitions for packaging and specific types of packaging, including primary, secondary and tertiary are included in Article 3 of Directive 94/62/EC on packaging and packaging waste and can be summarised as:

- 'packaging` shall mean all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. 'Non-returnable` items used for the same purposes shall also be considered to constitute packaging.

As outlined in below, the Packaging Directive aims to ensure packaging waste is dealt with effectively and sets targets for Member States with regard to the recovery and recycling of packaging materials. These targets were revised by Directive 2004/12/EC and are summarised below, with full details available in Article 6 of the Directive.

- no later than 31 December 2008 60 % as a minimum by weight of packaging waste will be recovered or incinerated at waste incineration plants with energy recovery;
- no later than 31 December 2008 between 55 % as a minimum and 80 % as a maximum by weight of packaging waste will be recycled;
- no later than 31 December 2008 the following minimum recycling targets for materials contained in packaging waste will be attained:
  - (i) 60 % by weight for glass;
  - (ii) 60 % by weight for paper and board;
  - (iii) 50 % by weight for metals;
  - (iv) 22,5 % by weight for plastics, counting exclusively material that is recycled back into plastics;
  - (v) 15 % by weight for wood.

The relevance of packaging as a key environmental impact depends on factors such as product life time and the types of materials used.

In the course of this study, consultation feedback suggests that using the same packaging criterion across different product groups is not an appropriate approach. In addition, for the majority of products in this study packaging is not a key issue, given their long life times, energy consumption during manufacturing and that some use energy in the use phase.

Commentators suggest that other factors also make this approach inappropriate, these are outlined below:

- The lack of a definitive evidence base to use when setting and justifying specific criteria.

[24] http://www.hse.gov.uk/reach/about.htm

- Focussing on a single parameter e.g. recycled content, may lead to sub-optimal environmental results. For example packaging with an increased recycled content may be less robust so more may be required to protect the goods whilst in transit.

- A fixed parameter value does not allow a flexible approach to the issue and may mean few suppliers can satisfy the requirement(s).

Consequently a packaging criterion is not included in the GPP specification. However, an explanatory note highlighting relevant issues that contracting authorities may wish to consider are included. Contracting authorities can determine for themselves the importance they wish to place on packaging and the particular issues that are relevant to them depending on their existing policies and practices.

4.2.5 Recycled Content

ISO 14012 defines recycled content as: the proportion, by mass, of recycled material in a product or packaging. Only pre-consumer and post-consumer materials shall be considered as recycled content, consistent with the following usage of the terms:

- **Pre-consumer material:** Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

- **Post-consumer material:** Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain."[25]

Some insulation products with recycled content are thicker than their non-recycled counterparts and hence can impact on the design of the building, e.g. wider foundations may be required or wider doorframes. These requirements could result in greater use of virgin materials in the wider construction project. Also, in order to decide whether a product is recyclable, it is important to consider whether facilities exist to recycle insulation materials and whether a sufficient amount of recycling material is available and whether the recycling process would result in products of a sufficient technical quality. One should check therefore the quality of the recycled insulation product with recycled content as this may vary between materials and will impact on the product's lifespan and durability.

4.2.6 End of Life Management

Recycling of many insulation products is possible, as demonstrated in

Table 5. In many cases this is preferable due to the cost of landfill and for environmental reasons, for example, additives in plastics can seep into soil and groundwater, making recycling an attractive option.[26] However, as with embodied energy, the end use application and required thermal resistance of the insulation product must be the main consideration during product selection.

Further to recycling a number of alternative disposal options are available. Organic oil derived products can be recycled or have their energy recovered through incineration where facilities exist. Organic plant/animal derived products can also have their energy recovered or be disposed of to landfill, although the fire retardants in many of these products, e.g. cellulose fibres, make them unsuitable for incineration.

During refurbishment activities care should also be taken when handling old insulation materials like PUR, with blowing agents such as HFCKW or FCKW. Appropriate disposal options for these materials should be discussed with a local waste management operator. Products treated with boron may have to be disposed of as hazardous waste.[4]

[25] http://www.greenspec.co.uk/html/materials/recycledcontent.html
[26] Berge, B. (2000) Ecology of Building Materials. *Reed Educational and Professional Publishing Ltd.*

Table 5. Recycling options for a variety of insulation products if the product is not contaminated.

Type of insulation	Recycling
Expanded polystyrene	Can be melted and reformed, however fire retardants in the material may hinder the melting process
Rock mineral wool	Recycling possible.[4]
Cellular glass	Reclaimable on demolition.
Cellulose	Recycled and recyclable.
Flax Isovlas	Can be recycled.
Sheep's wool	Can be fully recycled.
Flexible melamine foam	Cannot be melted and reused.
Cork	Can be recycled.
Isonat Hemp and recycled cotton fibre batts	Yes.
Polyurethane (PUR)	Can be recycled. Alternatively its energy can be recovered.
Foil insulation products	The foil layer within foil products can typically be recycled.[4]
XPS	Easily melted and re-pelletised if the product is not contaminated. It can also be thermally recovered.
Wood fibre insulation	Can be composted or recovered via incineration.

5 Cost Considerations

As energy prices and landfill costs rise, manufacturers and building users are turning their attention to insulation materials as a solution to their rising bills. Table 6 outlines some costs for different types of insulation product. Please note that this table does not contain cost data for all insulation materials as it is quoted from a secondary source. It should also be noted that these costs are indicative and are subject to market fluctuations.

Table 6. Comparison of prices for a variety of insulation products.[3]

Type of insulation	Thermal performance (W/mK)	[(a)] Price/ m^2
Expanded polystyrene	0.033	50mm Board €3.14 100mm Board €6.28 65mm Cavity Fill €4.40 (including labour for installation)
Rock mineral wool	0.034-0.036	€4.40 - €7.80
Cellulose	0.033	€10.06
Flax Isovlas	50mm: 0.035	50mm €5.52 100mm €9.48
Sheep's wool	0.037	50mm €5.98 100mm €11.94
Flexible melamine foam	0.035	50mm €37.71
Cork	0.037	None given
Isonat Hemp and recycled cotton fibre batts	0.039	50mm €5.23 100mm €10.43

[(a)] Currency figures converted from UK pounds to Euros using http://www.xe.com on 07/07/08.

Although EPS has lower purchase costs than most other materials for very similar thermal performance, it has higher embodied energy in manufacture. For example, Table 2 shows that EPS has four times the embodied energy of manufacture compared to rock mineral wool. Similarly, although 100mm thick sheep's wool is approximately twice as expensive as 100mm EPS board for comparable thermal performances it has a fraction (~4%) of the embodied energy of manufacture. Consumers must consider the purchase and installation costs against the durability of the material and the thermal efficiency required for the building, so that it is in proportion. In other words, a greater thermal efficiency could be purchased and installed at greater cost, but might not be required for the intended purpose of the building, taking its location and climate into account.

In life-cycle terms the eco-cost of a building incorporates the following aspects[27]:

- Cost of controlling atmospheric emissions.
- Cost of resources during the extraction and production of the product. For example, the cost of energy, transport, packaging, waste and emissions.
- Cost of waste treatment and disposal.
- Cost of eco-taxes.
- Cost of pollution rehabilitation measures.
- Cost of environmental management.
- Cost of utilities, for example, water, electricity and gas.

Some of these costs, typically those from the production stages, are passed on to the final user in the price of the insulation product. Consumers must consider this cost against the increased heating and ventilation costs that they would experience if the insulation were not installed. This should consider any incentive schemes that are available from government or utility companies. For example, in the UK the Energy Saving Trust (EST) has calculated likely savings in this area for a gas centrally-heated semi-detached house with three bedrooms, where the insulation is installed by a professional and a discount is obtained on the price of the insulation materials from the local energy supplier.

[27] Boussabaine and Kirkham (2004) Whole Life-cycle costing: Risk and risk responses. *Blackwell Publishing.*

highlights some of the outputs from the EST study.

Table 7 Savings from Insulation

Product	Annual Savings per Year*	Installed Cost*	Payback Period
Cavity Wall Insulation[28]	Around €132	Around €300**	Around 2 years
Internal Wall Insulation[29]	Around €438	€6600 - €10200***	Around 15 to 23 years
External Wall Insulation[30]	Around €462	€12600 - €17400***	Around 27 to 37 years
Floor Insulation[31]	Around €60	Around €120****	Around 2 years****

Notes:
*All savings and costs in Euros converted from Pounds Sterling using an exchange rate of 1 Pound Sterling = 1.20037 EUR
**The installed cost includes the subsidy available from the major energy suppliers under the Carbon Emissions Reduction Target (CERT); the typical unsubsidised installed cost is around 600 EUR.
***Internal / External: The figures given above are for the whole installation however if you are going to be renovating the individual walls of your home; you can make some big savings by insulating them at the same time.
**** DIY Cost and Payback
.

It should also be noted that the payback period for insulation products may vary depending on whether the property is a new build or a refurbishment. As many older properties do not satisfy the same high level building standards as new builds today, there are greater energy saving benefits to be afforded through replacing/ topping up insulation levels. This therefore reducing the payback period as energy bills are reduced by a greater extent.

[28] http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Cavity-wall-insulation
[29] http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Solid-wall-insulation
[30] http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Solid-wall-insulation
[31] http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Floor-Insulation

6 Relevant EU Legislation and Policy

This section details EU legislation that is relevant to thermal insulation. This is important for setting the framework in which standards and labels have been developed. With respect to a particular product or service Contracting Authorities should be also aware of any additional local, regional or national legislation pertinent to their situation as well as the building, geographical and climate conditions in which the insulation would be used.

6.1 The Energy Performance of Buildings Directive (EPBD) 2010/31/EU

This Directive[32] is a recast of Directive 2002/91/EC and is concerned with promoting energy efficiency in buildings across Europe using cost effective measures, whilst at the same time harmonising standards across Europe to those of the more ambitious Member States. The original Directive has been recast for the purposes of clarity in light of previous amendments and further substantive amendments to be made.

It is widely recognised as important to tackle the construction sector as energy use in buildings, for space heating, cooling and lighting accounts for around 40 % of total energy use in Europe.

This Directive centres around four key strands:

- Providing a methodology framework for calculating the energy performance of buildings, taking into account local climatic conditions;
- Applying energy performance requirements to both new buildings and existing building stock;
- Providing a certification scheme for all buildings together with;
- Regular assessments of any heating and cooling equipment installed.

The recast Directive ensures that all new buildings must comply with high energy-performance standards as well as generating a significant proportion of their own energy through renewables after 2020. The intention is that the public sector will lead the way through using buildings with "nearly zero" energy standards two years earlier, from January 2019. However the definition of "nearly zero" was left vague, and this will allow member states to define their own standards.

Buildings with a useful floor area over 500m^2 that are occupied by public authorities and frequently visited by the public will be required to display the energy performance certificate in a prominent place, where one has been issued. The 500m^2 threshold will be lowered to 250m^2 on 9 July 2015.

The provision for existing buildings states that where major renovations are carried out these must increase energy-savings if doing so is “technically, functionally and economically feasible”. In addition Member States will have to develop national plans that encourage owners to install smart meters, heat pumps and heating and cooling systems using renewables energy sources, as well as listing incentives from technical assistance and subsidies to low-interest loans by mid-2011 for the transition to near zero-energy buildings.

[32] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF

6.2 Directive on the indication by labelling and standard product information of the consumption of energy and other resources by energy related products 2010/30/EU

This Directive[33] is a recast of the original Energy Labelling Directive (92/75/EEC). The recast has been undertaken to clarify the Directive in light of the number of changes, and further changes that have been made to the original directive.

Directive 92/75/EEC was only applicable to household appliances. The recast Directive (2010/30/EU) aims to improve the overall environmental performance of products and to help consumers buy more eco-friendly products, through its application to 'energy related products', including construction products, that have a significant direct or indirect impact on the consumption of energy.

This extension of the scope to energy related products could reinforce potential synergies between existing legislation, and in particular Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy related products.

The recast Directive for the labelling of energy related products forms part of the broader legal framework to bring about energy savings and environmental gains.

6.3 The Construction Products Directive (CPD) 89/106/EEC

The Construction Products Directive[34] (CPD) is aimed at creating a single market for construction products, through the use of CE Marking. It defines the Essential Requirements of construction works (buildings, civil engineering works) which indirectly determines the requirements for construction products (in function of the works design and the climatic and geological conditions in the place where the construction works are situated).

Construction products must declare their performance for mechanical strength and stability, fire safety, health and environment effects, safety of use, sound nuisance and energy economy if EU or national regulatory requirements exist. Under the Directive the Commission may give a mandate to standardisation organisations such as CEN to develop standards in consultation with industry. A list of the adopted standards can be found on the European Commission's website[35]. Where harmonised standards are not available, existing national standards apply.

In relation to insulation, the harmonised European product standards developed under the CPD introduced a specific approach on how thermal conductivity is measured and declared; the results of thermal conductivity tests are now analysed using a statistical procedure called lambda 90/90. This change makes insulation one of the most tightly controlled materials in the building market.[36] It should be noted also that Directive 93/68/EEC[37] amended the CPD 89/106/EEC on the approximation of laws, regulations and administrative provisions of the Member States relating to Construction Products.

The Commission has adopted a proposal to replace Council Directive 89/106/EEC by a Regulation (CPR) with the aim to better define the objectives of Community legislation and make its implementation easier[38]. It now includes a specific essential requirement related to the sustainable use of natural resources, stating that:

[33] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0001:0012:EN:PDF
[34] OJ L 40, 11.2.1989, p. 12–26 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0106:EN:HTML
[35] http://ec.europa.eu/enterprise/newapproach/standardization/harmstds/reflist/construc.html
[36] TIMSA Brief: New European Legislation and lambda 90/90.
[37] OJ L 220, 30.8.1993, p. 1–22 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0068:EN:HTML
[38] http://ec.europa.eu/enterprise/construction/index_en.htm

"The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the following:

(a) Recyclability of the construction works, their materials and parts after demolition.
(b) Durability of the construction works.
(c) Use of environmentally compatible raw and secondary materials in the construction works."

6.3.1 CEN TC 350

Based on mandate 350 European technical standards are currently under development in CEN and will provide a methodology for the voluntary delivery of environmental information for construction products, in a similar way to an environmental product declaration (EPD). It will provide information to allow purchasers to compare the technical and environmental performance of products.

The European standardisation approach is based on a lifecycle assessment methodology covering production (mandatory), construction, use (including maintenance) and end of life stages (all optional). The standardisation work will also consider social and economic aspects of sustainability.

The following diagram demonstrates the various stages considered.

Product			**Construction**		**Use**					**End of life**			
Raw materials supply	Transport	Manufacturing	Transport	Construction/ installation	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction/ demolition	Transport	Reuse/recycling	Disposal

Within these stages the following environmental indicators are being developed:

1. Life Cycle Impact Assessment (LCIA) emission indicators (output):
   - Climate change
   - Destruction of the stratospheric ozone layer
   - Acidification of land and water resources
   - Eutrophication
   - Formation of ground level ozone

2. Resource use indicators (input):
   - Use of non-renewable materials
   - Use of renewable materials
   - Use of secondary materials
   - Use of non-renewable primary energy
   - Use of renewable primary energy
   - Use of freshwater resources

3. Waste indicators
   - Construction and demolition waste to recycling
   - Construction and demolition waste to energy recovery
   - Non-hazardous waste to disposal
   - Hazardous waste to disposal
   - Radioactive waste to disposal

CEN TC 350 is working on a standardised voluntary approach across Europe for the delivery of environmental information on construction products, and to assess the environmental performance of building products and new and existing buildings. It will specify what information should be declared on the labels of construction products, however, the declarations will not specify benchmarks or standards that products should aspire to, which will be done by other instruments like GPP. Until the CEN TC 350 work is complete the EU GPP criteria have been developed using the current evidence base available that is provided by the existing ecolabels.

The following timetable for CEN 350 has been provided by EURIMA:

WI	Standard	Title of standard	Comment
	prEN 15643-2	Sustainability of construction works- Framework for Environmental Performance	**Enquiry September 2008**
WI 350002	EN	Sustainability of construction works – Assessment of environmental performance of buildings – Calculation methods	**Enquiry Nov 08**
WI 350003	EN	Sustainability of construction works - Assessment of environmental performance of buildings - Use of the EPD	**Enquiry June 09**
WI 350004	prEN 15804	Sustainability of construction works - Assessment of environmental performance of buildings- Product category rules	**Enquiry September 2008**
WI 350005	EN	Sustainability of construction works – Environmental product declarations Communications format	**Enquiry January 2009**
WI 350006	TR	Sustainability of construction works – Environmental product declarations – Methodology and data for generic data	**Vote January 2009**

ISO standards exist for determining life cycle impacts. The interested reader is guided towards EN ISO 14040: 2006, EN ISO 14044: 2006, EN ISO 14025: 2005 and EN ISO 21930:2007 for further details.

6.3.2 CEN TC 351

Mandate 351 was established in 2005 under the framework of the Construction Products Directive (89/106/EEC - CPD with the title "Construction products: Assessment of release of dangerous substances". It deals with the emission of dangerous substances from construction products that may have harmful impacts on human health and the environment (Essential Requirements 3 (ER3) of the CPD). Horizontal standardised assessment methods for harmonised approaches relating to dangerous substances are developed under the CPD and relates to emissions to indoor air and release to soil, surface water and ground water. These horizontal assessment methods will be used in product specific harmonised European standards under the framework of the CPD. Technical reports for CEN 351 were due in April 2009.[39] By January 2010, despite a number of documents having been reviewed, no TC 351 documents were approved for enquiry/ formal vote.[40]

6.4 The CLP Regulation (EC) No 1272/2008

The Regulation of 16 December 2008[41] on classification, labelling and packaging of substances and mixtures entered into force on 20 January 2009 and will ultimately replace the current rules on classification, labelling and packaging of substances (Directive 67/548/EEC) and preparations (Directive 1999/45/EC). Substance classification and labelling must all be consistent with the new rules by 1 December 2010 and for mixtures 1 June 2015.

The Regulation aims to ensure a high level of protection of human health and the environment, as well as the free movement of chemical substances, mixtures and certain specific articles, whilst enhancing competitiveness and innovation. This should be achieved by ensuring that the same hazards will be described and labelled in the same way all around the world.

39 http://www2.nen.nl/cmsprod/groups/public/documents/bestand/249543.pdf
40 http://www.normapme.com/docs/expertsmeeting/presentations/experts/
41 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF

6.5 The REACH Regulation 1907/2006

The REACH Regulation[42] came into force on 1 June 2007 and deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. It provides an improved and streamlined legislative framework for chemicals in the EU, with the aim of improving protection of human health and the environment and enhancing competitiveness of the chemicals industry in Europe.

REACH places the responsibility for assessing and managing the risks posed by chemicals and providing safety information to users in industry instead of public authorities, promotes competition across the internal market and innovation.

Manufactures are required to register the details of the properties of their chemical substances on a central database**,** which is run by the European Chemicals Agency in Helsinki. The Regulation also requires the most dangerous chemicals to be progressively replaced as suitable alternatives develop.

This legislation will provide further controls on the chemicals used in the manufacture of blowing agents used in thermal insulation.

6.6 The Montreal Protocol on Substances That Deplete the Ozone Layer

The Montreal Protocol[43] was a landmark international agreement designed to protect the stratospheric ozone layer. The treaty was originally signed in 1987 and substantially amended in 1990 and 1992, it stipulated that the production and consumption of compounds that deplete ozone in the stratosphere, including chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform, were to be phased out by 2000 (2005 for methyl chloroform).

The Vienna Convention (1985) outlined Member States' responsibilities for protecting human health and the environment against the adverse effects of ozone depletion and established the framework under which the Montreal Protocol was negotiated.

6.7 Regulation on Substances that Deplete the Ozone Layer EC 1005/2009

This Regulation[44] applies to organisations that produce, import, export, sell and recover/recycle or destroy substances such as CFCs and HCFCs, which are classified as ozone depleting substances (ODSs). One difference to the Montreal protocol is that it specifies an accelerated HCFC phase-out schedule.

Certain polymer based insulation materials that require blowing agents use ODSs in their manufacture, therefore these insulation materials must be recovered and destroyed by an environmentally acceptable technology such as incineration at the end of their life.[45]

Regulation 1005/2009 is a recast of original Regulation 2037/2000. A recast was deemed appropriate due to the large number of amendments that had been made to the original regulation and further amendments that needed to be made.

The original regulation phased out a large proportion of ODS previously produced in the European Community, with others still to be phased out between 2010 and 2015. This means that further environmental benefits from production controls will be limited, therefore the new regulation addresses issues such as identifying measures to prevent ODS in existing products and equipment from escaping into the atmosphere.

[42] OJ L 396, 30.12.2006, p. 1–849 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF
[43] http://www.ciesin.org/TG/PI/POLICY/montpro.html
[44] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:286:0001:0030:EN:PDF

[45] UK Market Transformation Progarmme BNIW03: Insulation legislation and policy drivers, v1, www.mtprog.com

6.8 Directive on Packaging and Packaging Waste 94/62/EC and the Directive amending Directive 94/62/EC on packaging and packaging waste 2004/12/EC

The EC Packaging Directive[46] seeks to reduce the impact of packaging and packaging waste on the environment by introducing recovery and recycling targets for packaging waste, and by encouraging minimisation and reuse of packaging[47]. A scheme of symbols, currently voluntary, has been prepared through Commission Decision 97/129/EC[48]. These can be used by manufacturers on their packaging so that different materials can be identified to assist end-of-life recycling.

The Packaging Directive (94/62/EC) was amended in 2004 by Directive 2004/12/EC[49]. This amendment included a number a key revisions. These included further clarification regarding the definition of packaging, amendments to the provisions relating to prevention and revised targets for the recovery and recycling of packaging materials.

6.9 Hazardous Waste Directive (HWD) 91/689/EC

The European HWD[50] sets out requirements for the controlled management and movement of hazardous (special) waste within Member States of the European Community. The aim of the Directive is to provide a consistent European definition of hazardous waste, which it has done by identifying the properties of hazardous waste and using these to identify which wastes in the European Waste Catalogue (EWC) are hazardous. The original list of wastes resulting from this methodology was called the Hazardous Waste List (HWL), however this has since been updated and combined with the EWC.

This Directive is due to be repealed in December 2010 by the revised Waste Framework Directive.

6.9.1 Waste Framework Directive 2008/98/EC

The revised Waste Framework Directive[51] was signed on behalf of the European Parliament and the Council on 19 November 2008. The revised Directive replaces the existing Waste Framework Directive (2006/12/EC), the Hazardous Waste Directive and the Waste Oil Directive. These Directives will all be repealed in December 2010, once the requirements of the revised Waste Framework Directive have been transposed by Member States into national legislation.

The revised Waste Framework Directive sets the basic concepts and definitions related to waste management and lays down waste management principles such as the "polluter pays principle" and the "waste hierarchy". In relation to construction waste recycling targets of 70% are to be achieved by 2020:

“b) by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material … shall be increased to a minimum of 70% by weight”

It also provides clarification regarding the definition of waste and other concepts such as recycling and recovery.

6.9.2 European Waste Catalogue (EWC)

The EWC was developed through the Waste Framework Directive and, as mentioned previously, has been amended since its original version to include classifications for hazardous and non-hazardous

[46] OJ L 365, 31.12.1994, p. 10–23 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994L0062:EN:HTML
[47] http://www.defra.gov.uk/environment/waste/topics/packaging/index.htm
[48] OJ L 050, 20.02.1997 P. 28 – 31
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997D0129:EN:HTML
[49] OJ L 47, 18.2.2004, p. 26–32
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:047:0026:0031:EN:PDF

[50] OJ L 377, 31.12.1991, p. 20–27 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML
[51] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0003:EN:PDF

wastes. Each waste is assigned a six-digit code, which has to be used on Duty of Care documentation, such as transfer notes.

Insulation is categorised as a construction waste within Chapter 17 'Construction and Demolition' of the EWC. In the following list an asterisk * denotes a hazardous waste:

- 17 06 – Insulation materials and asbestos-containing construction materials.
- 17 06 03* - Other insulation materials consisting of or containing dangerous substances.
- 17 06 04 – Insulation materials other than those mentioned in 17 06 01 and 17 06 03.

Some insulation products may also fall within Chapter 14 of the EWC due to the polymer based materials used as blowing agents[52]:

- 14 06* - Waste organic solvents, refrigerants and foam/aerosol propellants, including CFCs, HCFCs and HFCs.

6.9.3 The Landfill Directive 1999/31/EC

This Directive[53] aims to encourage waste minimisation and increased levels of recycling and recovery of waste and thus reduce the negative effects of landfiling on the environment. One requirement of the legislation, which is relevant to insulation, is the ban on the co-disposal of hazardous with non-hazardous waste in landfills.

6.10 Directive on Energy End-use Efficiency and Energy Services 2006/32/EC

The aim of this Directive[54] is to improve energy efficiency, manage demand and reduce energy consumption across Europe. Member States will be required to save at least an additional 1% of their final energy consumption each year from 2008 for nine years. Within these targets are savings targets for the public sector of 1.5%[55] as it is expected that a particular contribution will have to be made by this sector, a large part of which will be as a result of public procurement.

Installing insulation is one way of doing this and the Directive particularly encourages the public sector in each Member State to set a good example regarding investments, maintenance and other expenditure for energy-using equipment, energy services and other energy efficiency measures.

6.11 Directive establishing a framework for the setting of ecodesign requirements for Energy-related Products 2009/125/EC

The original Directive (2005/32/EC) on the ecodesign of energy using products was adopted in July 2005 and focused on energy using products. This Directive has subsequently been repealed by Directive 2009/125/EC[56], which is a recast and increases the scope from energy using product to energy related products.

It provides clear EU wide rules for ecodesign, aimed at avoiding disparities in regulation amongst individual Member States, which could impede the free movement of products within the internal market.

The Ecodesign Directive does not in itself set binding requirements for specific products, however it does define conditions and criteria for setting, through subsequent implementing measures, minimum

[52] BNIW03: Insulation legislation and policy drivers, v1, www.mtprog.com
[53] OJ L182, 16.07.1999, p. 1-9 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:HTML
[54] OJ L 114, 27.4.2006, p. 64–85 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0085:EN:PDF
[55] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/03/1687&format=HTML&aged=0&language=EN&guiLanguage=en
[56] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:en:PDF

requirements regarding environmentally relevant product characteristics and allows them to be improved quickly and efficiently.

The framework provided by the Directive aims to encourage manufacturers to develop products where they have taken into account the environmental impact of the product throughout its entire life cycle.

Regulations setting binding requirements for specific product groups are gradually been developed, and would only be set for those energy related products which meet certain criteria, for example, key environmental impact and volume of trade across the internal market and only if there is clear potential for improvement of a product. Under the Ecodesign Directive, self-regulation, including voluntary agreements offered as unilateral commitments by the industry can, under certain conditions, be recognised as a valid alternative to implementing measures.

7 Existing Standards & Ecolabels relevant to Thermal Insulation

There are a number of existing standards/labels for thermal insulation products and a number of Type 1 ecolabel criteria[57] do exist for this product group. An outline of these different standards is provided below.

7.1 Thermal insulation standards

There are seven sets of ecolabel criteria currently available for thermal insulation: the New Zealand, Canada and Australia Environmental Choice Labels, the Korean Ecolabel, the Taiwan GreenMark, the UK Energy Saving Recommended Logo and the US Energy Star.

The **German Blue Angel** label does not have criteria for insulation products specifically, however it does have criteria for building materials made of waste glass and building materials made of waste paper which can be used for several applications including heat insulation, as given in the scope of each criteria document.

All of the labels mentioned below look at a variety of lifecycle impacts, as discussed in Section 7.2. The **UK Energy Saving Recommended (ESR) logo**, managed by the Energy Saving Trust, and the **US ENERGY STAR** program, however, consider energy use only. Also, the Global Eco-labelling Network website indicates that the Ukraine and Czech Republic have standards for insulation products; however the criteria documents for these labels are unavailable.

The EU Ecolabel does not currently have criteria for insulation, however insulation is listed as a priority product for development in the future.[58] The task of creating criteria for the eco-labelling of thermal insulation product was given to the Danish government by the European Commission in the early nineties. The work was abandoned because it became evident that the benefit from use of insulation products overwhelmed the deficit created during their manufacture.

Some very recent examples of developments in the construction sector include the British government recently announcing new resource efficiency targets to be met by construction firms by 2012. The landfilling of construction, demolition and excavation waste going to landfill must be halved.[59] The strategy promotes green public procurement, design and innovation, also EU priorities. The global standardisation body ISO has set a new sustainability standard for the building construction sector, ISO 15392:2008 [60] which covers the general principles to be followed for sustainable construction:

"ISO 15392 is based on the concept of sustainable development as it applies to buildings and other construction works, from "the cradle to the grave". [sic]

The foundations elaborated [sic] form the basis for a suite of standards intended to address specific issues and aspects of sustainability. They are applicable to buildings and other construction works individually and collectively, as well as to building materials, products, services and processes."

The **Good Environmental Choice Australia (GECA)** Standard is a voluntary standard that was launched in 2007. The standard is valid for three years and is applicable to bulk insulation materials, including boards, blankets, batts, loose-fill and spray-on thermal insulation. It does not include foil-type insulation or lagging for pipe work or ducts. The standard does not cover the installation of the materials, as this is out of the control of the manufacturer and it does not specify R-ratings or thermal conductivities as these are already specified under the Building Codes; it merely asks that evidence be provided to prove the product has been tested and R-values can be defined. All products must

[57] Type 1 Ecolabel criteria are independently verified and set in accordance with ISO14024
[58] http://ec.europa.eu/environment/ecolabel/pdf/prioritisation/prioritisationlist.pdf
[59] ENDS Europe DAILY 2562, 12/06/08, http://nds.coi.gov.uk/environment/fullDetail.asp?ReleaseID=370253&NewsAreaID=2&NavigatedFromDepartment=True and http://www.berr.gov.uk/files/file46535.pdf
[60] International Organisation for Standardisation, Ref 1131, http://www.iso.org/iso/pressrelease.htm?refid=Ref1131

satisfy the relevant Australian standard (AS4859.1:2006 in the case of insulation) before GECA certification can be granted.

The Australian Ecolabel Program is also planning a Specialist Insulation Materials label for 2008. This will cover pipe lagging and other specialist materials. Expressions of interest are currently being sought for the establishment of these criteria.

The criteria for the **Environmental Choice New Zealand Label** was published in 2004 and is valid for five years. It sets out the environmental and product criteria that products must satisfy and also specifies the testing required to demonstrate conformance. All products must be able to demonstrate basic regulatory compliance in the form of a letter and evidence from the organisations Chief Executive Officer before it can be considered for certification. As part of the licensing process a monitoring plan will be put in place that allows Environmental Choice access to relevant quality control and production records and access to production facilities to check ongoing compliance with the criteria. Similar to the GECA, the New Zealand Label covers all bulk, resistive-type insulation materials and excludes foil-type insulants and lagging for pipe work and ducts.

Environment Canada's Environmental Choice Program first published criteria for thermal insulation products in 1997. The last review of the criteria took place in 2005 and another is scheduled for 2008.The criteria cover board-type thermal insulation; loose-fill and spray-on thermal insulation; as well as batt/blanket-type thermal insulation. Products must satisfy all applicable government and industrial safety and performance standards, including legislation for the disposal of waste arising from the manufacturing process. Similar to the New Zealand scheme, verification requires access to quality control and production records and access to production facilities.

The **Taiwan GreenMark Logo** was launched in 1992 and now covers 104 products, including thermal insulation materials. It is less detailed than the other specifications, however it provides heat conductivity requirements, material restrictions and packaging guidelines.

The **Korean Ecolabel** has also been in existence since 1992. It is a voluntary standard run by the Ministry of Environment. Since 1995 Korean public services have been obliged to buy products with the eco-label in compliance with the Act on the Promotion of the Purchase of Environmentally-Friendly Products. The criteria include requirements for waste content within insulation products, restrictions on materials to be used and quality specifications.

7.2 Thermal insulation criteria

7.2.1 Product characteristics

The Canadian and Australian criteria and the ESR label do not specify thermal resistance levels but refer to existing standards within their own countries. These documents outline the methodologies to be used in testing and verifying standards. Manufacturers must satisfy these standards before their application for ecolabel status can be considered. A table of the standards is provided in Appendix 1.

Further to the British Standards and Building Regulations, the recommended levels of thermal conductivity, for loft insulation work that is not captured by the Building Regulations, varies between 0.044 W/mK and 0.037 W/mK.

Table 7[61] demonstrates the thickness of insulation required for a material of given thermal conductivity to achieve a U-value of 0.16 W/m^2K.

[61] ESR Schedule B – Product Specification. Apr 2008

Table 7. Required thermal insulation thicknesses for a given thermal conductivity.

Thermal conductivity (W/mK)	Required thickness (mm)
0.044	270
0.040	250
0.039	240
0.037	230
0.024	ca. 150

Further to the Korea Industrial Standards, where a product is not covered the thermal conductivity must be less than 0.044W/mK. Similarly the Taiwan GreenMark specifies that thermal conductivity of insulation materials must be less than 0.044 W/mK.[62] Due to a lack of limit values in European schemes, these reference values have been taken over for the EU GPP.

Within the New Zealand Environmental Choice criteria, wall products must have an R-value of 2.5 and ceiling products an R-value of 3. All thermal insulant products must have a stated thermal resistance which has an appropriate statistical basis, derived from independent laboratory testing. Testing must determine the mean thermal performance of the product, the standard deviation and variations between batches of product. All thermal insulant products must have reports from independent sampling and testing demonstrating the product's stated thermal resistance achieved and must be reasonably expected to retain 90% of thermal performance for the service life.

7.2.2 Material requirements

7.2.2.1 Recycled content

The existing labels differ in their approach to specifications for recycled content. The New Zealand label does not specify a specific level, stating that there is insufficient information available to do so. Instead they state that manufacturers should use recycled content where practicable and require manufacturers to specify levels on packaging to allow consumers to make informed purchasing decisions.

Canada and Australia both specify minimum recycled content requirements within their criteria. These are compared in Table 8.

Table 8. Minimum recycled content for a variety of insulation products.

Product	Korea Ecolabel	GECA specification (a)	Canadian specification (b)		
(% by weight)			Board-type	Loose-fill/spray applied	Batt or blanket type
Glass wool	≥50%	≥65%	≥45%	≥45%	≥45%
Rock/slag wool (Mineral wool)	≥40%	≥25%	≥35%	≥50%	≥35%
Cellulose		≥80%		≥80%	
Wool		≥80%			
Plastics or synthetic polymers	≥50%	≥85%			
Extruded polystyrene			≥20%		
Polyisocyanurate (plastic component only, e.g. not including facing)			≥15%		
Closed-cell spray polyurethane foam	≥20% (C)			≥5%	
Aluminium reflective insulation (plastic layer content)					≥15%

[62] Converted from 0.038 Kcal/m2h^{o}C using http://www.unitconversion.org/power/watts-to-kilocalories-it--per-hour-conversion.html

[(a)] If two or more products are used together, the whole use rate of recycled content shall satisfy the requirement for the main raw material.
[(b)] Products must meet the minimum recycled content requirements, calculated on a 12-month rolling basis and measured as weight of final product. For expanded polystyrene manufacturers must implement a program to recover and reintroduce pre- and post-consumer waste into the manufacturing process.
[(c)] Foam-processing synthetic resin.

7.2.2.2 Production waste management

Further to the Canadian requirement for expanded polystyrene, the Australian GECA and New Zealand criteria require that manufacturers put effective policies and procedures in place to minimise waste and recycle waste materials from the production process.

7.2.2.3 Energy and water use

Only two of the eco-labels mention energy and water use. The New Zealand Environmental Choice label requires that manufacturers have energy management policies and procedures in place and/ or an energy management programme. The Australian GECA specification is voluntary and requests that manufacturers provide information on energy and water use during the manufacturing process.

7.2.3 Raw materials

The GECA specifies the following criteria for raw materials[63]. None of the other labels have raw material specifications.

Sand and rock
Where non-recycled sand and rock are used as a raw material in mineral wools they must come from an operation with a registered environmental remediation program, not be located in a National Park or within an endangered community as defined by the Environment Protection and Biodiversity Conservation Act 1999 List of Threatened Ecological Communities.

Petrochemical raw materials
Non-recycled monomer or other petrochemical products for use as raw materials in insulation must be sourced from a production facility that complies with environmental legislation.

Timber and natural fibre sources
Virgin fibre may be sourced from any combination of FSC or AFS certified fibre, plantation wood fibre, cellulose fibre, return fibre, cotton fibre, crop residue or other waste fibre. Any sources that are not certified under a recognised certification scheme as being sustainably managed shall not originate from illegal harvesting, genetically modified organisms or uncertified high conservation value communities.

7.2.4 Hazardous substances

7.2.4.1 Prohibited substances

For the four Ecolabel standards listed in

[63] The Australian Ecolabel Program Good Environmental Choice Australia Standard: Thermal Building Insulation Materials. Standard No: GECA 33-2007. Issued 29 June 2007.

Table 9 the following substances must not be used at any stage in the production process or be present in the final product.

Table 9. Prohibited substances.

Product	GECA	Canadian Standard	Korea Eco-label	Taiwan GreenMark
Polybrominated diphenyl flame retardants	X	X	X	
Brominated paraffin flame retardants	X			
Short-chain chlorinated paraffin flame retardants	X			
CFCs, HCFCs or HFCs	X			X
Tin, lead, mercury, cadmium or chromium-containing catalysts or additives	X			
Asbestos			X	X
Formaldehyde containing binders [(a)]	X [(b)]	X		
Polybrominated biphenyls			X	
Short-chain chlorinated paraffins that have more than 50% of chlorine as fire retardancy in the manufacturing process			X	

[(a)] If batt or blanket type insulation made of low density fibreglass or mineral wool.
[(b)] The GECA criteria states that formaldehyde may be exempt if the measured release of formaldehyde from the new product is less than 0.2 mg/m^2h, measured by ASTM D5116 or ASTM 5197.

The Canadian criteria also state that substances should not be used if they are labelled as "toxic, corrosive or flammable under the Consumer Chemical and Container Regulations (SOR/SOR/2001-269) of the Hazardous Products Act".

The GECA has a similar requirement that the product must not "contain more than 0.1% by weight (in total) of substances classified by the International Agency for Research on Cancer (IARC) as Class 1 or 2A, or carry the following risk phrases:

- R26 – Very toxic by inhalation.
- R27 – Very toxic in contact with skin.
- R39 – Danger of very serious irreversible effects.
- R40 – Limited evidence of a carcinogenic effect.
- R45 – May cause cancer.
- R46 – May cause heritable genetic damage.
- R47 – May cause birth defects
- R48 – Danger of serious damage to health by prolonged exposure.
- R49 – May cause cancer by inhalation.

7.2.4.2 Blowing agents

The following table outlines the existing ecolabel criteria for the global warming potential (GWP) and ozone depletion potential (ODP) of blowing agents for different insulation materials.

Table 10. Blowing agents.

Product	Canadian Standard		GECA		New Zealand Standard	
	GWP	ODP	GWP	ODP	GWP	ODP
Foam products			Not more than 140 over 100 years	0		
Insulants	-	0			Not more than 140 over 100 years	-
EPS, PIR, or open-cell PUR type insulation	Less than 15	0				

The Canadian criteria also specify that the blowing agent content be less than 6% by weight if the insulation is manufactured using expandable polystyrene resin. It also requires that lead catalysts not be used in the manufacturing of foam that is to be sprayed.

The Korean Eco-label also specifies that the foaming agent used must have zero ODP.

7.2.5 Packaging requirements

Further to requirements on the product itself, two of the ecolabels specify restrictions on the types of packaging to be used.

The GECA specifies that the packaging for insulation materials should not contain chlorinated or halogenated plastics. It also requires that the packaging be durable enough to withstand normal transport and storage without compromising the performance of the product in any way and must be able to be recycled by local recycling systems.

The Canadian Environmental Choice label takes this recycling requirement further by requiring that manufacturers be able to demonstrate that efforts have been made to ensure the packaging contains post-consumer recycled content.

7.2.6 Product information

Product labelling was a key criterion, with four of the labels including some reference to the topic. The GECA and New Zealand label specify that the products be labelled according to the AS/NZ 4859.1 – 2006 standard. This requires the following items to be specified on the label:

- Manufacturer and date of manufacture/batch no.
- Product R-values.
- The material that the product is manufactured from.
- Weight and thickness.
- Percentage recycled content: for composite materials, the percentage of each material must be clearly labelled by mass or volume.
- Maximum storage time or install-by date.
- Time after installation at which the product will have re-lofted to its nominal thickness.
- Transportation and installation instructions.
- Written storage instructions.

The GECA states: "*If there is insufficient space for this information on the product label, it may be provided as a separate document provided to suppliers, distributors and consumers, and be made available on the manufacturer's website.*"

The Canadian label also requires detailed instructions for proper handling and installation to be included to minimise health concerns. And the Taiwan GreenMark requires the insulation manufacturers name and address to be clearly printed on the product or on the packaging material.

For non-manufacturing Logo users, the manufacturer's name and address shall also be shown. The GreenMark also specifies that the products or the packaging material bear a label reading "Energy conservation”.

7.2.7 Warranty

Two of the existing eco-labels made reference to providing a guarantee with the insulation materials.

The GECA specified a minimum warranty period 20 years and the UK ESR scheme requires an independent 25-year guarantee against defects in workmanship and materials

8 Conclusions and Summary

During the life cycle of thermal insulation, hazardous materials are a key environmental impact, especially in the chemical makeup of some blowing agents. This can impact on air and water quality, as well as human health. The hazardous properties of these substances make many of them unsuitable for landfill in non-hazardous sites. Some can be recycled thus reducing the impact on the environment.

Energy consumption is another key impact, especially during manufacture and transportation. However, the reduction in energy use in buildings, by choosing highly efficient insulation, with good thermal resistance, will significantly reduce energy consumption in the in-use phase by lessening the need for fuel for space heating Nevertheless there is still scope to reduce the overall consumption by reducing energy use during manufacture. Furthermore extending the lifetime of the product will naturally reduce resource consumption and disposal burdens.

The ecolabel standards for thermal insulation, in particular the Australian, New Zealand and Canadian Environmental Choice logos cover the key issues and it is therefore proposed that they form the basis of the criteria.

The core criteria represent the key environmental issues associated with thermal insulation

- The thermal insulating properties of the material
- Use of certain hazardous materials

The comprehensive criteria cover all environmental impact criteria and will include the core criteria as well as additional issues related to:

- Waste management.
- Product labelling – information to the user
- Recycled content.

In addition to the recommended core and comprehensive technical specifications (which are criteria that have to be met by all products offered for purchase), award criteria are proposed where applicable. These are additional criteria on which the contracting authority will base its award decision. Award criteria are not pass/fall criteria, meaning that offers of products that don't comply with the criteria may still be withheld for the final decision, depending on their score on the other award criteria, including the price. To stimulate further market uptake of ever improved environmental products, award criteria should be considered depending on the specific circumstances of each case.

Insulation is just one element, albeit a key one, of the overall energy performance of buildings. A wider holistic approach is necessary. Such wider approach forms the basis of the EPBD (Energy Performance of Buildings Directive). Its implementation by the Members States and the integration of the different aspects will be key to improving the overall energy performance of buildings in the future. The recommended GPP criteria for insulation and the development of GPP criteria for other construction elements such as boilers, climate control and windows will provide key information to contracting authorities.

9 Proposal for core and comprehensive criteria

It is proposed to set core and comprehensive criteria for thermal insulation.

The proposed GPP criteria are designed to reflect the key environmental impacts. This approach is summarised in the following table. Please note that the order of impacts does not necessarily translate to the order of their importance.

Key Environmental Impacts	GPP Approach
• Energy consumption, especially in manufacturing and transportation. • Energy consumption in the building due to less efficient insulation. • Pollution of air, land and water due to the use of hazardous materials e.g. blowing agents. • Use / extraction of raw materials. • Production of hazardous waste. ▪ Generation of waste material, including hazardous wastes and packaging and its disposal.	• Purchase most energy efficient insulation. • Purchase insulation appropriate for your situation to ensure maximum benefit. • Purchase insulation that restricts the use of hazardous materials. • Promote effective maintenance of insulation to extend its useful life. • Promote end of life management e.g. take back schemes / re-use / recycling. • Purchase products designed to be easily dismantled and recycled. • Promote the use of environmentally sound materials. • Promote use of recycled materials in insulation and packaging, either directly or in the case of packaging through participation in an accredited recycling scheme.

A comparison of the main ecolabels for thermal insulation highlights a number of key similarities that focus on the main environmental impacts identified in Section 6.11. These include thermal conductivity standards, the use of hazardous materials, and packaging requirements.

Thermal conductivity is a measure of the insulations effectiveness. Specifying a minimum level of effectiveness therefore leads to greater insulation within buildings and therefore energy savings within those buildings through reduced heating and air conditioning costs.

Limiting the use of hazardous materials is key to reducing the environmental impact of thermal insulation materials, especially blowing agents. Criteria in relation to these are included due to the potential environmental impact discussed in Section 7.The proposed GPP criteria are built upon legislation but go beyond the mandatory requirements, for example, by restricting the use of HCFC blowing agents ahead of the 2015 ban specified in the ODS Regulation.

A number of the hazardous substances currently used can have an impact on human health, especially on breathing conditions, such as asthma, or have been shown to have cancerous properties. As such, the hazardous content of insulation products is a key issue that should be considered in the criteria. Through time this should be linked to the standards being developed through CEN TC 351, however while this is in development ecolabel criteria has been used. The GECA sets the most stringent criteria of all the ecolabels.

Packaging has an impact on the environment in terms of waste but also has a vital role to play in terms of labelling. Communication to suppliers, distributors and consumers is essential to ensure the correct handling and installation of the materials – incorrectly installed insulation is less effective.

Labelling also provides buyers with more information on recycled content, u-vales, etc to allow them to make educated decisions when choosing between insulation products.

It is noted that a number of the ecolabels, for example the GECA and New Zealand labels have included requirements that manufacturers demonstrate that they have environmental policies in place to minimise energy use and waste production, In line with this the EU GPP criteria include Selection Criteria in this area.

Full details of the proposed purchasing criteria are provided in the associated Product Sheet for this product group.

10 Relevant EU legislation and information sources

10.1 EU Legislation

- The Energy Performance in Buildings Directive (EPBD) 2010/31/EU: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF

- Directive on the indication by labelling and standard product information of the consumption of energy and other resources by energy related products 2010/30/EU http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0001:0012:EN:PDF

- The Construction Products Directive (CPD) 89/106/EEC: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0106:en:HTML

- Council Directive 93/68/EEC amending many Directives including 89/106/EEC (construction products) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0068:EN:HTML

- The CLP Regulation (EC) No 1272/2008. The Regulation of 16 December 2008 on classification, labelling and packaging of substances and mixtures http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF

- The REACH Regulation 1907/2006: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF

- The Montreal Protocol on Substances That Deplete the Ozone Layer: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:22001A0718(01):EN:HTML

- Regulation on Substances that Deplete the Ozone Layer EC Regulation No. 1005/2009: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:286:0001:0030:EN:PDF

- Directive on Packaging and Packaging Waste 94/62/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994L0062:EN:HTML

- Commission Decision (97/129/EC) of 28 January 1997 establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and waste packaging http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997D0129:EN:HTML

- Directive amending Directive 94/62/EC on packaging and packaging waste 2004/12/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:047:0026:0031:EN:PDF

- Hazardous Waste Directive (HWD) 91/689/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML

- Waste Framework Directive 2008/98/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0003:EN:PDF

- European Waste Catalogue (EWC) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000D0532:EN:HTML

- Landfill Directive 1999/31/EC: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:HTML

- Directive on Energy End-use Efficiency and Energy Services 2006/32/EC

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006L0032:EN:HTML

- Directive establishing a framework for the setting of Ecodesign Requirements for Energy-related Products 2009/125/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:en:PDF

10.2 Ecolabels and Standards

- Blue Angel - http://www.blauer-engel.de
- ESR Schedule B – Product Specification. Apr 2008 - http://www.energysavingtrust.org.uk/energy_saving_products
- Good Environmental Choice Australia - http://www.aela.org.au/StandardsRegister.htm
- Good Environmental Choice Canada - http://www.environmentalchoice.com/guidelines/guide.cfm?content=Guidelines&Name=
- Good Environmental Choice New Zealand - http://www.enviro-choice.org.nz/
- Korea Ecolabel - http://www.koeco.or.kr/eng/business/business01_03.asp?search=1_3
- Taiwan Green Mark - http://greenmark.epa.gov.tw/english/criteria.asp
- US Energy Star logo - http://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_sealing

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- TIMSA Brief: New European Legislation and lambda 90/90.

- UK Building Regulations (1990 edition) Approved Document L: Conservation of fuel and power.

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- http://www.chem.unep.ch/irptc/sids/OECDSIDS/FORMALDEHYDE.pdf

- http://www.ciesin.org/TG/PI/POLICY/montpro.html

- Information on renewable raw materials and bio-based products: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/biobased-products/index_en.htm

- http://www.energysavingtrust.org.uk/home_improvements/home_insulation_glazing/cavity_wall_insulation/

- http://www.eurima.org/mineral_wool/composition.html

- http://www.icis.com/v2/chemicals/9076008/polystyrene-expandable/uses.html

- http://www.lime.org.uk/building_materials/Woodfibre_Insulation.asp

- http://www.nnfcc.co.uk/metadot/index.pl?id=7866;isa=DBRow;op=show;dbview_id=2457

- http://www.nnfcc.co.uk/metadot/index.pl?id=9162;isa=DBRow;op=show;dbview_id=2457

- http://www.nnfcc.co.uk/metadot/index.pl?id=5970;isa=DBRow;op=show;dbview_id=2457
- http://www.nnfcc.co.uk/metadot/index.pl?id=5969;isa=DBRow;op=show;dbview_id=2457
- http://www.unitconversion.org/power/watts-to-kilocalories-it--per-hour-conversion.html
- http://www.xe.com/ucc/

Appendices

Appendix 1 – International Standards for Insulation

The following harmonised European standards apply to thermal insulation products: hEN 13162-13171, 13950, 14063-1, 14316-1, 14317-1, 14496, 14933, 14934.

The following table outlines the standards referred to by each of the ecolabels.

Australian GECA Standard	Canadian Environmental Choice Program	Korea Eco-label	UK ESR scheme
AS 4859.1-2006. Materials for the thermal insulation of buildings – General criteria and technical provisions.	ASTM C547 Specification for Mineral Fiber Pipe Insulation.	KS F 4708 Basic carbonic acid magnesium thermal insulation material.	BS 5628-3:2001 Code of Practice for Use of Masonry: Materials and Components, Design and Workmanship.
	ASTM C1497 Specification for Cellulosic Fiber Stabilized Thermal Insulation.	KS F 6304 Rock wool insulator for house.	BS 8208-1:1985 Guide to Assessment of Suitability of External Cavity Walls for Filling with Thermal Insulants: Existing Traditional Cavity Construction.
	ASTM C 1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.	KS F 4714 Water repellency pearlite heat insulator.	BS 8000-3:2001 Workmanship on Building Sites: Code of Practice for Masonry.
	ASTM C1224 Standard Specification for Reflective Insulation for Building Applications.	KS F 6305 Glass fibre heat insulator for house.	BS 476-4: 1970 Fire tests on building materials and structures: Non-combustibility test for materials.
	ASTM C1149 Standard Specification for Self-Supported Spray Applied Cellulosic Thermal/Acoustical Insulation.	KS F 6306 Rock wool heat insulator for purchase.	BS EN 13162:2001 Thermal insulation products for buildings – Factory made mineral wool (MW) product – Specification.
	ASTM C739 Standard Specification for Cellulosic Fiber (wood-base) Loose-Fill Thermal Insulation.	KS L 9101 Calcium silicate heat insulator.	BS 5803:1985 pt 2 Thermal insulation for use in pitched roof spaces in dwellings. Specification for man-made mineral fibre thermal insulation in pelleted or granular form for application by blowing.
	ASTM C655 Specification Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.	KS L 9102 Artificial mineral fibre heat insulator.	BS 5803:1985 pt 3 Thermal insulation for use in pitched roof spaces in dwellings. Specification for cellulose fibre thermal insulation for application by blowing.
	ASTM C612 Specification for Mineral Fiber Block and Board Thermal Insulation.	KS M 3807 Recycled foaming polystyrene heat insulator.	BS 5803:1985 pt 4 Thermal insulation for use in pitched roof spaces in dwellings. Methods for determining flammability and resistance to smouldering

Australian GECA Standard	Canadian Environmental Choice Program	Korea Eco-label	UK ESR scheme
	ASTM C553 Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.	KS M 3808 Foaming polystyrene heat insulator.	BS 5803:1985 pt 5 Thermal insulation for use in pitched roof spaces in dwellings. Specification for installation of man-made mineral fibre and cellulose fibre insulation.
	CAN/CGSB 92.2 Trowel or Spray Applied Acoustical Material.	KS M 3809 Hard urethane form heat insulator.	BS EN 13164:2001 Thermal insulation products for buildings – Factory made products of extruded polystyrene foam (XPS) – Specification. Applicants must demonstrate how their product conforms to the relevant sections of the Building Regulations with regard to fire spread, protection and retardance.
	CAN/ULC-S701 Thermal Insulation, Polystyrene, Boards and Pipe Covering.	KS M 3862 Foaming polyethylene heat insulator.	BR443 Conventions for U-value calculations.
	CAN/ULC-S702 Thermal Insulation, Mineral Fibre for Buildings (proof of compliance to the optional corrosion test is also required).		Approved Document L1B (Conservation of Fuel and Power in Existing Dwellings) of the UK Building Regulations.
	CAN/ULC S703 Standard for Cellulose Fibre Insulation (CFI) for Buildings.		
	CAN/ULC S705.1 Thermal Insulation-Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specifications.		
	Gradually being replaced but still in use:		
	CAN/CGSB-51.26 Thermal Insulation.		
	CAN/CGSB-51.11 Mineral Fibre Thermal Insulation Blanket.		
	CAN/CGSB-51.10 Mineral Fibre Board Thermal Insulation.		
	CAN/CGSB-51.9 Mineral Fibre Thermal Insulation for Piping and Round Ducting.		