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Client Report :

Accompanying Report for the BRE Environmental Profiles of NBT Thermoplan - fired clay masonry units

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Executive Summary

This report forms the output of the Environmental Profiling work done for Natural Building Technologies Ltd and the NBT Thermoplan - fired clay masonry units product produced by Ziegelwerk Klosterbeuren in Germany. The report provides a description of the Environmental Profiling process, provides the Environmental Profiles for NBT Thermoplan - fired clay masonry units and provides an analysis of the environmental performance of the product. Table 1 below shows the summary Ecopoint score for NBT Thermoplan - fired clay masonry units on a per tonne basis.

Table 1. Product Specification Ecopoint scores for the NBT Thermoplan - fired clay masonry units product.

Product Specification	Ecopoints Cradle to Gate
NBT Thermoplan - fired clay masonry units, 1 tonne	1.2 Ecopoints

The findings from this report have shown that the manufacturing process accounts for the most significant proportion of the environmental impact resulting from the production of NBT Thermoplan - fired clay masonry units.

The largest proportion of the environmental impact is through minerals extraction, which arises primarily from the. extraction of the clay. Additionally there are further impacts through climate change resulting from the manufacturing process.

The paper fibre included in the mix, a bi-product of paper manufacture, is burnt during the firing process in the kiln. The sequestered carbon and associated emissions released into the atmosphere from the burning of this paper is accounted for in the manufacturing process. The paper fibre therefore has a very low net overall climate change impact resulting from its transport to the factory.

Within a domestic external wall construction the NBT Thermoplan - fired clay masonry units with a lime:cement render and plasterboard achieve a Green Guide Rating of A..

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Introduction

This report forms the output from the Environmental Profiles of NBT Thermoplan - fired clay masonry units project undertaken for Natural Building Technologies Ltd.

The aim of this report is to provide explanatory information to accompany the NBT Thermoplan - fired clay masonry units Environmental Profiles. The report is divided into three sections:

- **Section 1: The Environmental Profiling Process –** this section of the report explains the principles of Life Cycle Assessment and the creation of an Environmental Profile.
- **Section 2**: **In depth analysis of the Environmental Profiles for NBT Thermoplan - fired clay masonry units –** this section of the report highlights the most important sources of the product's environmental impact and the relevant environmental issues.
- **Appendices –** this section contains the Environmental Profiles for NBT Thermoplan - fired clay masonry units.

Details of the Ziegelwerk Klosterbeuren production process were provided by Thomas Thater through the completion of a questionnaire, a site visit and subsequent telephone and e-mail correspondence.

Section 1 – The Environmental Profiling Process

This section of the report explains the principles of Life Cycle Assessment (LCA) and the creation of an Environmental Profile.

Environmental Profiles: Life Cycle Assessment scheme for construction products

Claims about the environmental performance of building products are easy to make, but difficult to substantiate without a universal measuring system. Environmental Profiles provide that measurement and enable manufacturers to independently demonstrate the performance of their products. They also help clients, designers and specifiers to identify products that will best fulfil a sustainability brief.

As well as underpinning claims of environmental performance, Environmental Profiles enable manufacturers to compare their products against others, to demonstrate improvements that have been made and help raise general awareness of life cycle issues.

Do Profiles relate to the full life cycle?

YES – Environmental Profiles measure environmental performance throughout a product's life:

- in manufacture (including impacts from virgin and recycled inputs)
- in use in a building (taken over a typical building life and including maintenance and replacement)
- in demolition (the waste produced, allowing for recycling and reuse).

Profiles provide key indicators of environmental sustainability:

- *Climate change* - from CO_2 and other greenhouse gases especially associated with energy use
- *Ozone depletion* - from gases affecting the ozone layer
- *Acidification* -contribution to the formation of acid rain
- Consumption of *minerals* and *water*
- Emission of *pollutants to air and water* – including toxicity to humans and ecosystems
- Quantity of *waste* sent to disposal.
- Ecopoint rating - a single measure of overall impact

Profiling individual materials, components and building elements

At its simplest level the profiling method is able to consider the impacts of a single building product, such as brick. However, to make valid comparisons designers need information about a building element, for example a wall. A building element is likely to be made up of several products and Environmental Profiling takes this into account by adding together the contribution of the component parts. This allows specifiers to compare one type of element with another. The comparison may be between product types or the same product from different manufacturers.

Credibility

The Life Cycle Assessment methodology used for Environmental Profiles has been peer reviewed and complies with ISO14041, an internationally established approach for analysing the environmental impacts of products and processes. The system fits well with the ISO14001 environmental management principles.

BRE devised the methodology in partnership with Government and 24 Trade Associations from the Construction Products sector to provide a single, consistent approach for applying LCA to all types of construction products. An Environmental Profile approved by BRE Certification is prepared according to Scheme Document SD028 (available from BRE Certification).

Environmental Profiles provide environmental information about construction products for different stages of their life cycle and can be used as both an environmental management tool by manufacturers and as an aid to environmental design and procurement by designers and specifiers.

Life Cycle Assessment of products

All construction products have a "life cycle":

Life cycle	**Scope of different Environmental Profiles**		
	Cradle to gate (1 tonne of product)	Cradle to site (1 square metre of product)	Cradle to grave (1 square metre of product)
Raw material extraction	↓	↓	↓
↓ Production	↓	↓	↓
↓ Construction		↓	↓
↓ Use			↓
↓ Reuse, recycling and/or disposal			↓

Each stage in the life cycle has its own inputs (e.g. materials and energy) and outputs (e.g. emissions and waste). There are also environmental impacts related to the transport of the product between life cycle stages.

The BRE Methodology allows Environmental Profiles to be created for different stages of the life cycle. These life cycle stages are illustrated in the diagram above and in Table 2. BRE do this to allow manufacturers and specifiers the greatest amount of flexibility from the data available to them.

Table 2 Life cycle stages

Assessment	Life Cycle Stages considered
One tonne of product	"Cradle to gate" - Raw material extraction and manufacture through to the point the product leaves the factory gate.
One square metre of a building element	"Cradle to site" - Raw material extraction and manufacture through to installation at the construction site, including transport to the site. (Theoretically, impacts of construction would also be included here, but in practice are excluded due to their relatively small size).
One square metre of a building element	"Cradle to grave" - Raw material extraction, manufacture, installation and use in a building for a 60 year study period[1] including any associated maintenance and replacement, through to the point of removal for reuse, recycling or disposal.

"Cradle to gate" assessment

This type of assessment evaluates the environmental impact of the production of 1 tonne of product. The resulting BRE Environmental Profile is useful for both the comparison of identical products produced differently – e.g. in different locations or with different processes - and for the monitoring of production improvements over time. This Profile also provides the basic data to allow the impact of the whole life cycle to be considered.

"Cradle to site" assessment

This type of assessment evaluates the environmental impact on the basis of 1 m^2 of element (e.g. a wall with blocks, plasterboard and insulation).

A building element is likely to be made up of several products and Environmental Profiling takes this into account by adding together the contribution of the component parts. This allows specifiers to compare one type of element with another. The comparison may be between different product types or the same product from different manufacturers.

The “cradle to site” Profile allows the user to see the burden from the product in the context of different components in a specific function. However, they must apply their own life time factors for replacement, maintenance and disposal to achieve a true life cycle. This type of Profile is deliberately left free of replacement and maintenance data to allow the user to customise the data.

[1] The BRE Environmental Profiles methodology has been devised specifically for application to construction products in commercial buildings, hence a life cycle period of 60 years. However, it may also be applied to domestic buildings, infrastructure and other applications, where appropriate design lives may be applied.

“Cradle to grave” assessment

This type of assessment evaluates the environmental impact on the basis of 1 m² of a building element and takes into account the maintenance, replacement and disposal rates of the element for a sixty year life. The resulting BRE Environmental Profile can be compared to other elements which perform the same function in the building (eg. For a wall the thermal resistance, acoustics and damp proof properties will ideally be identical to make a comparison between different types of construction). To make comparisons, the building elements should be exposed to the same assumptions on construction impacts, maintenance, replacement, demolition and disposal.

Only this type of profile provides the results of a full life cycle assessment and is therefore the type of data on which it is most appropriate to make claims about your product compared to others.

Creation of the BRE Environmental Profiles: Procedures

The Life Cycle Assessment methodology used to produce the BRE Environmental Profiles is covered in detail in the BRE Environmental Profiles Methodology[2]. However, the steps below provide a brief outline of the procedure followed when creating an Environmental Profile.

For cradle to gate assessments

1. BRE process the data provided by manufacturers in the BRE questionnaire to produce a list of inputs and outputs to the process for 1 tonne of product. This is a "gate to gate" assessment.
2. BRE add to this data the upstream inputs and outputs associated with all the materials brought into the factory. In other words, they trace to the 'cradle'. For example if a site buys cement, the impact of making cement is included. BRE already has data on many materials but if required, specific data is collected from other databases or manufacturers.
3. The environmental impacts associated with all the inputs and outputs are then calculated using standard LCA impact assessment procedures (known as "classification", "characterisation" and "normalisation"). These are described briefly in the following section of this report and in more detail in the BRE Environmental Profiles Methodology.

For cradle to site assessments

In addition to steps 1-3:

4. The Environmental Profile product is assessed together with any other materials needed to produce 1 m^2 of element, e.g. if the main product is a roof tile, then felt and battens will be added to make a full roof element.
5. This assessment covers impacts due to transport from the factory to the site and subsequent installation. The mass of NBT Thermoplan - fired clay masonry units per m^2 Cavity Wall Construction is then used in a typical specification to allow the environmental impact of the NBT Thermoplan - fired clay masonry units to be reviewed in terms of 1 m^2 rather than 1 tonne. This allows the product to be compared with other products in a 'like for like' manner.

[2] Howard, N, Edwards, S, Anderson, J. 1999. *BRE Methodology for Environmental Profiles of Construction Materials, Components and Buildings*. CRC: London. www.bre.co.uk

For cradle to grave assessments

In addition to steps 1-5:

BRE add data on the maintenance, replacement and end of life scenario of the product and other materials allowing the environmental impacts of the element to be calculated for a 60 year building life element.

Creation of BRE Environmental Profiles: LCA methodology

BRE life cycle assessments can be divided into three distinct steps, although in practice, the life cycle assessment is an iterative process.

Step 1 – Goal and Scope Definition

The goal of the study defines the reason for carrying out the assessment, the target audience and the intended use of results. Defining the scope of the study entails the setting of system boundaries, which will include defining geographical and temporal limits, as well as deciding which life cycle stages are to be included in the assessment. For example, the BRE Environmental Profile in Annex 1 is for NBT Thermoplan - fired clay masonry units; in this case the scope has been defined as a Cradle to Gate assessment, using production data from the year April 2004 – March 2005.

Step 2 – Inventory Analysis

During this phase, data on all the inputs and outputs of the product system under study are calculated for all appropriate life cycle stages. This list of inputs and outputs is known as Inventory data. Once the process boundaries have been defined, and the data allocated to the relevant product, the inputs and outputs are processed to refer to 1 tonne of product.

Step 3 – Impact Assessment

The impact assessment phase is aimed at evaluating the data calculated in the inventory analysis in terms of their environmental impact. The BRE Methodology breaks this phase into a further 3 stages:

Stage 1: Classification

The impact categories are selected and the inputs and outputs from the inventory are then assigned to the appropriate impact category. Each input or output can contribute to one or more impact category (e.g. methane contributes to climate change *and* photochemical ozone creation). A list of the 13 impact categories considered in the BRE LCA methodology is shown below:

- Climate change
- Acid deposition
- Ozone depletion
- Pollution to air: Human toxicity
- Pollution to air: Low level ozone depletion
- Fossil fuel depletion and extraction
- Pollution to water: Human toxicity
- Pollution to water: Ecotoxicity
- Pollution to water: Eutrophication
- Minerals extraction
- Water extraction
- Waste disposal
- Transport pollution and congestion: Freight[3]

See Annex 4 for a more detailed list describing the impact categories currently considered in the BRE Environmental Profiles Methodology.

Stage 2: Characterisation

The characterisation step evaluates the relative importance of the different burdens under each impact category compared to a reference unit (e.g. for climate change the reference unit is “one kg of CO_2 equivalent emitted over 100 years”). The characterisation stage results in the contributions to each impact category being expressed as equivalent amounts of emitted reference unit; these contributions can then be summed to give a final category score. For example, for global warming, 1 tonne of CO_2 is considered to have an impact of 1 whereas 1 tonne of methane has 21 times more global warming potential than CO_2 (and therefore has an impact of 21).

Stage 3: Normalisation

A comparison between impact categories is still difficult because the data are represented in different units. One solution to this problem is "normalisation". In the BRE Environmental Methodology this relates the amount of environmental impact arising from the product to the impacts arising from activity associated with an average UK citizen over one year.

[3] It should be noted that due to European competition legislation, BRE are not able to include this as an impact in the final Ecopoint score. This means an aggregation of 12 Environmental impacts and not 13.

This expresses the environmental impact for each category as a dimensionless ratio because the different impacts become "dimensionless" they can be added together. This is useful to show how important the impacts of a product are compared to the reference point of one person (whose total impact is, therefore, "1"). Normalising the data may allow you to add the data but it does not allow you to distinguish the most important impacts from the least. To do this, it is necessary to weight the impacts. BRE has created a single score system for environmental impacts that takes into account the relative importance of different impacts. This is know as Ecopoints and is described in the next section.

Ecopoints: a single score environmental assessment

The environmental impacts of construction encompass a wide range of issues, including climate change, mineral extraction, ozone depletion and waste generation. Assessing such different issues in combination requires subjective judgements about their relative importance. For example, is a product with a high global warming impact that does not pollute water resources giving less overall environmental impact than a product that has a low global warming impact but produces significant water pollution? To enable such assessments, BRE has developed Ecopoints.

Normalised Environmental Impacts

Each environmental issue is measured using its own unit, for example BRE measure mineral extraction using tonnes of mineral extracted and climate change in mass of Carbon Dioxide equivalent. Using these "characterised" impacts, it is hard to make any useful comparisons. However, by comparing each environmental impact to a "norm", each impact can be measured on the same scale. BRE have taken as their norm the impacts of a typical UK citizen, calculated by dividing the impacts of the UK by its population.

Weightings

Expert panels from across the industry's stakeholder groups were asked to judge the importance of many sustainability issues, covering environmental, social and economic issues. The results showed a surprising degree of consensus about the relative importance of different environmental issues across a broad range of interest groups. These are used to weight the normalised environmental impacts to provide the Ecopoints score.

UK Ecopoints

A UK Ecopoint score is a measure of the overall environmental impact of a particular product or process covering the same environmental impacts described earlier.

UK Ecopoints are derived by adding together the score for each issue, calculated by multiplying the normalised impact with its percentage weighting. The annual environmental impact caused by a typical UK citizen therefore creates 100 Ecopoints. More Ecopoints indicate higher environmental impact[4].

[4] Assessing environmental impacts of construction - Industry consensus, BREEAM and UK Ecopoints, I Dickie, N Howard (2000).

The format of an Environmental Profile

The format of an Environmental Profile consists of:

1 Title

The title of the Profile contains a reference to the product as it is officially recognised. For elements, this will refer to the major products of which the element is comprised.

The title may also contain a reference to a generic product, such as glass wool, which contains the average available figures from a number of plants making a wide range of glass wool products.

2 Quality of data information

This is an abbreviated, user friendly format of the requirements proposed by, the Society for the Promotion of Life Cycle Development (SPOLD). Age, source, geography and the representativeness of the process are shown. For elements, this information will be referenced to the major products of which the element is comprised.

3 Characterised data

4 Normalised data

5 Ecopoint score

Environmental Profiles

Environmental Profile of characterised and normalised data (Annex 1)

Characterisation and normalisation are important steps towards increasing the understanding of the impacts from a product or element. This Profile allows the user to see the contribution towards each impact category (characterised data) and relate this to the impacts of one UK citizen over one year (normalised data). The Ecopoint score is also included in this Profile.

Elemental Profiles (Annex 2-3)

Two elemental Profiles have been generated using the site-specific NBT Thermoplan - fired clay masonry units data (one 'as installed' and one over a '60 year study period'); these have been based on the following specification:

Construction Element 1: Cavity Wall Construction.

NBT Thermoplan - fired clay masonry units 365mm, external lime: cement render, plasterboard and paint.

Environmental Profiles Generated for NBT Thermoplan - fired clay masonry units

Cradle to gate, cradle to site and cradle to grave Environmental Profiles have been generated for NBT Thermoplan - fired clay masonry units produced by Ziegelwerk Klosterbeuren. These Profiles contain characterised and normalised data as well as an Ecopoint score. This information is summarised in Table 3 below:

Table 3: Environmental Profiles Generated for NBT Thermoplan - fired clay masonry units.

Boundary	Data	Annex number
Cradle to gate (material)	Characterised and normalised data for 1 tonne of NBT Thermoplan - fired clay masonry units produced by Ziegelwerk Klosterbeuren.	1
Cradle to site (installed element)	Characterised and normalised data for 1 square metre of installed Cavity Wall.	2
Cradle to grave (60 year study period element)	Characterised and normalised data for 1 square metre of installed Cavity Wall over a 60 year study period.	3

Section 2 – Analysis of Environmental Profiles for NBT Thermoplan - fired clay masonry units

This section of the report highlights the most important sources of the product's environmental impact together with the relevant environmental issues.

Analysis approach

The aim of the study analysis is to inform on the product manufacturing process. BRE first analyses the process occurring in the factory (the ‘cradle to gate’ phase) to explore the relative impacts of different products and the process to manufacture 1 tonne of the product. Four charts are shown below. All of the breakdowns are provided on a per tonnes basis for the product NBT Thermoplan - fired clay masonry units. The first shows the inputs to the process by proportion of mass (tonnes/m^2). The next three graphs use Ecopoints and display environmental impact as follows:

§ Inputs into the process by proportion of environmental impact (Ecopoints/tonne NBT Thermoplan - fired clay masonry units);

§ Analysis of environmental impact by issue (Ecopoints/tonne NBT Thermoplan - fired clay masonry units);

§ Analysis by material and environmental issue (Ecopoints/tonne NBT Thermoplan - fired clay masonry units). Only environmentally ‘significant‘ materials have been included within this breakdown.

Preceding the graphical report, a short paragraph summarises the findings.

We then show how the product compares to other products and discuss the significance of the *Green Guide to Housing Specification*[5] rating received. For the comparison a full functional unit is compared over a 60-year life (the ‘cradle to grave’ profile).

[5] Anderson,J, Howard, N. 2000. *The Green Guide to Housing Specification.* BRE Bookshop, London.

Findings

Figures 1 – 4 provide analysis of 1 tonne of NBT Thermoplan - fired clay masonry units.

The clay accounts for the largest proportion (79%) of the inputs (by mass) going into the NBT Thermoplan - fired clay masonry units. Paper fibre, a bi-product of the paper manufacturing industry accounts for a further 20% and the remaining inputs collectively account for 1% (Figure 1).

The manufacturing process accounts for the most significant proportion of the environmental impact resulting from the production of NBT Thermoplan - fired clay masonry units with 1.02 Ecopoints overall (Figure 2).

The paper fibre included in the mix is burnt during the firing process in the kiln. The sequestered carbon, indicated on Figure 4; -0.44 Ecopoints, and associated emissions released into the atmosphere from the burning of this paper are accounted for in the manufacturing process. The net climate change impacts associated with the paper fibre relate to its transport to site, and are very close to zero.

The largest proportion of the environmental impact is through minerals extraction, 47% (Figure 3), which arises primarily from the extraction of the clay, 0.55 Ecopoints (Figure 4). An additional 0.37 Ecopoints arises through climate change; net Ecopoint score after accounting for sequestered carbon (Figure 3) results from the manufacturing process, 0.8 Ecopoints and the burning of fossil fuel (Figure 4).

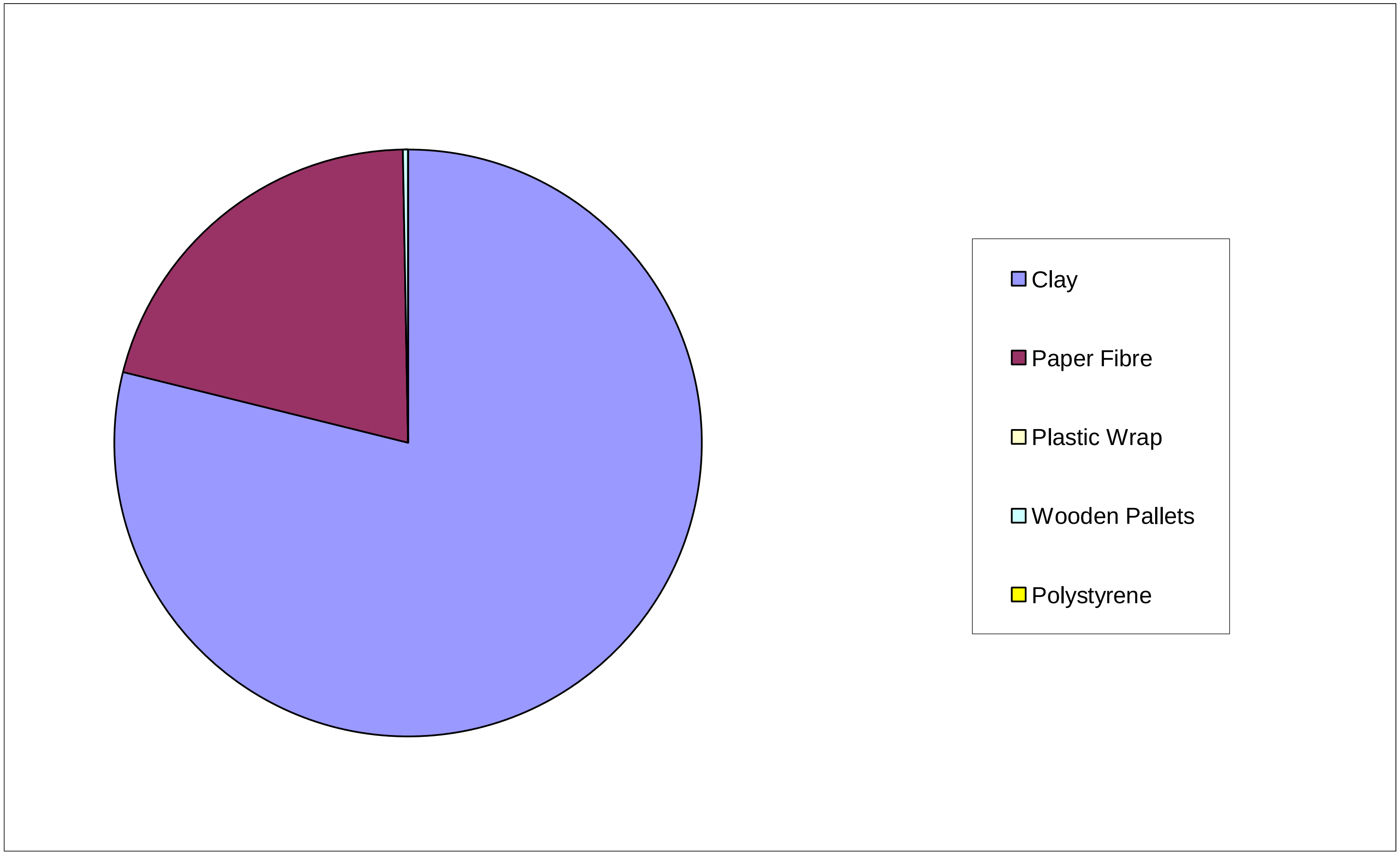

Figure 1: Inputs into process by proportion of mass (tonne).

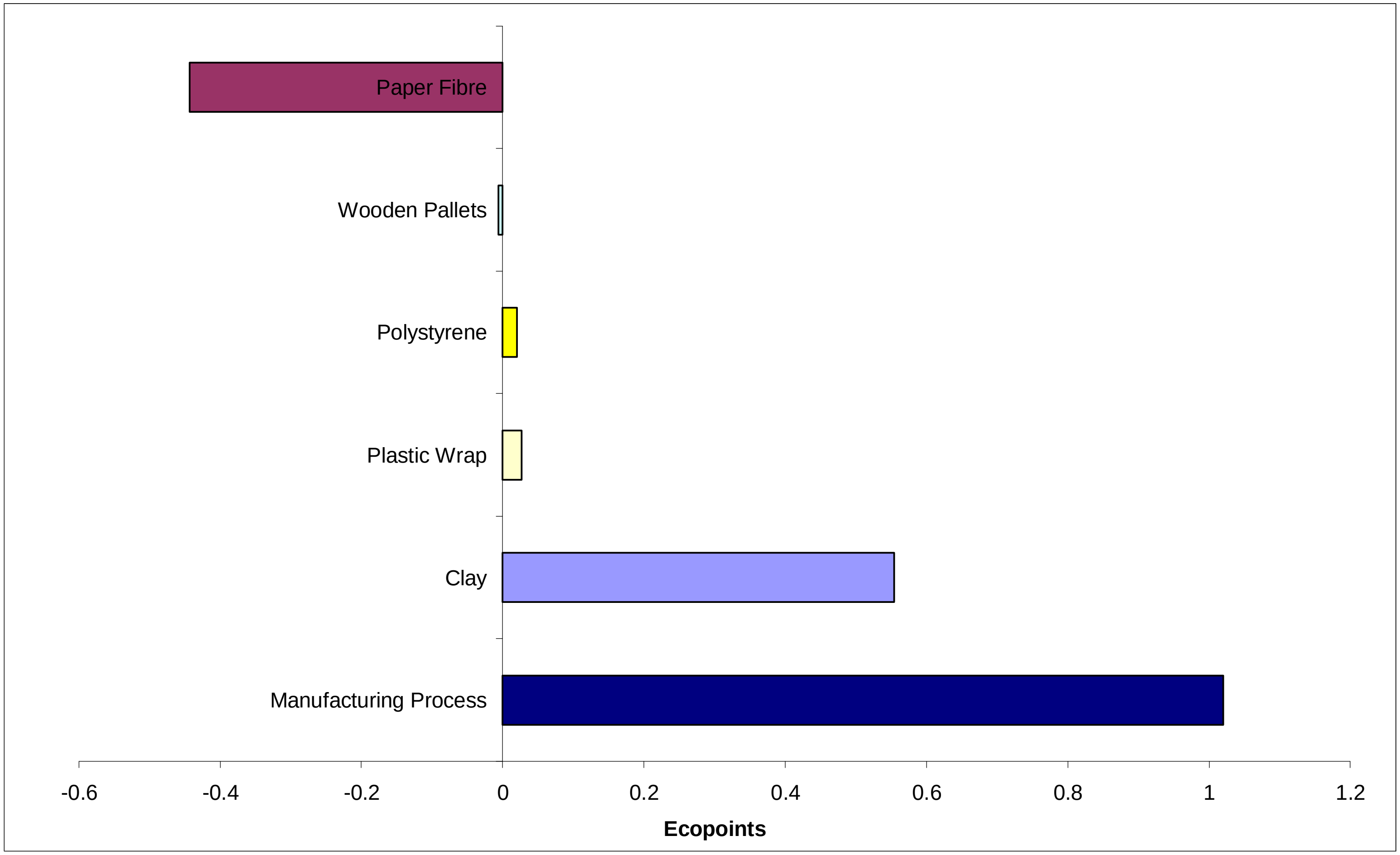

Figure 2: Inputs into process by proportion of impact (tonne).

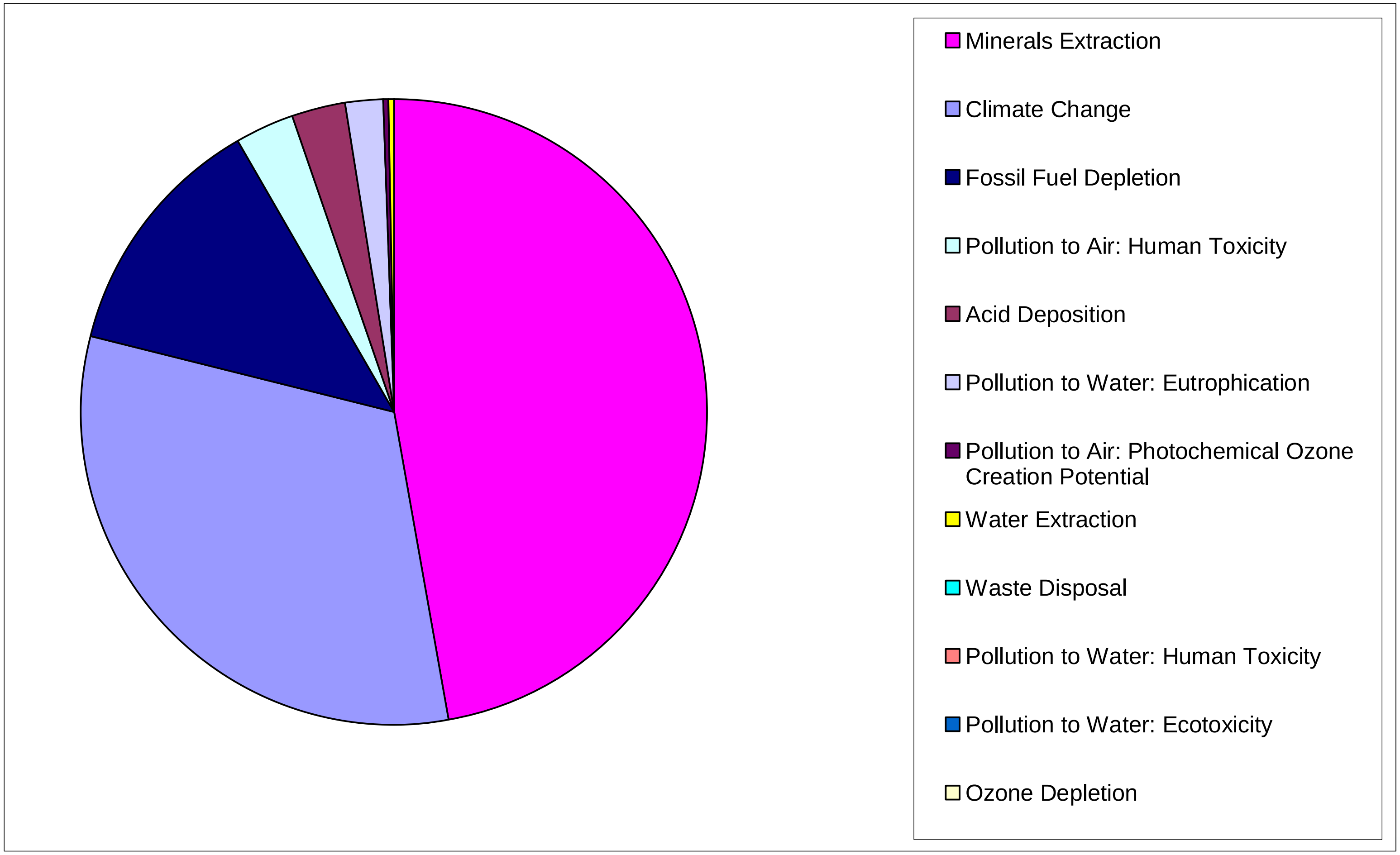

Figure 3: Breakdown of environmental impact by issue (Ecopoint/tonne).

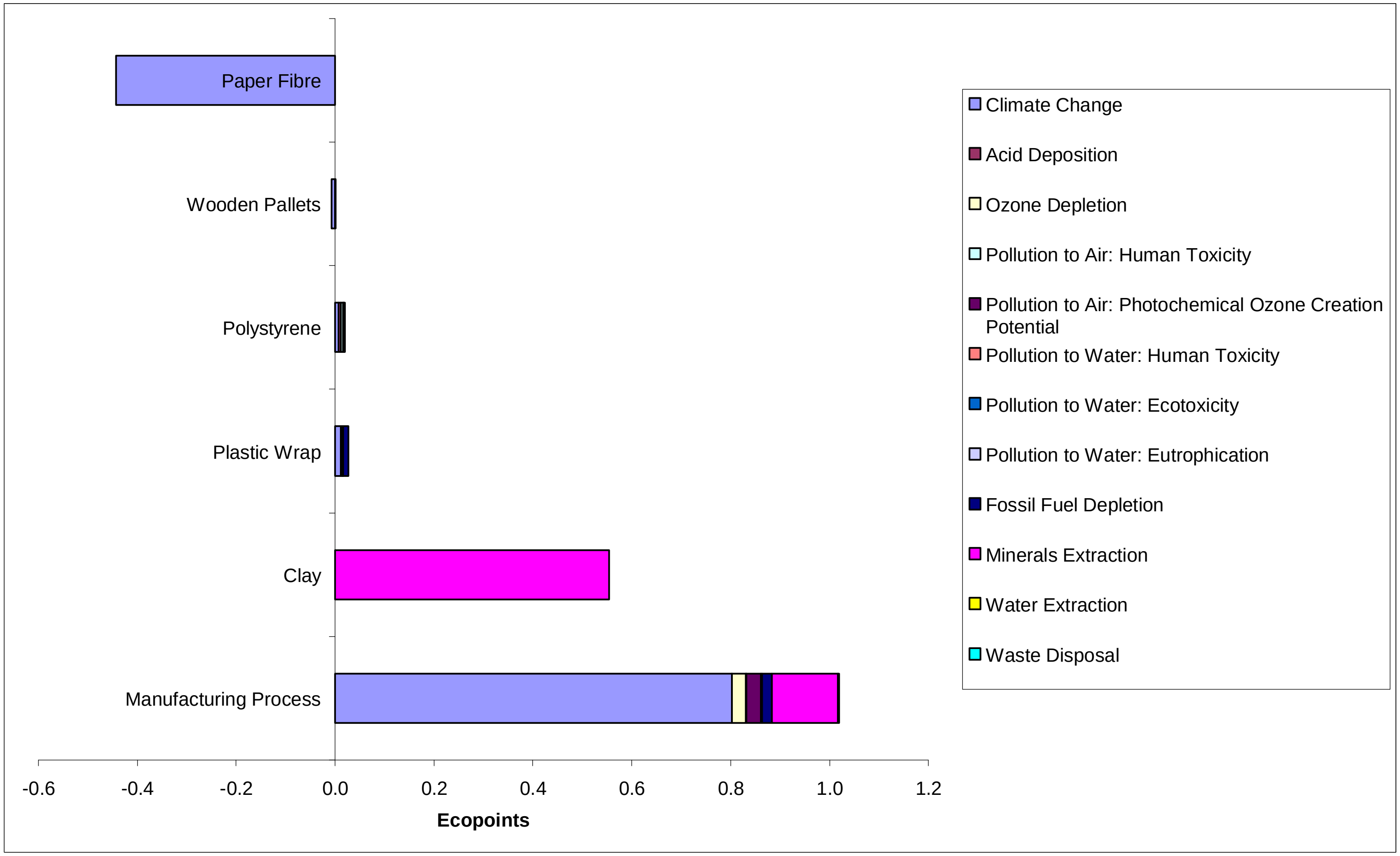

Figure 4: Breakdown by material and environmental issue (Ecopoint/tonne).

Linking Environmental Profiles to other Sustainable Construction Tools

BREEAM

Construction products are of course only one part of the sustainable construction story. BRE[6] also manages and promotes the use of the most widely used whole building assessment tool in the UK, which has an international reputation as the leading tool of its type. This is BREEAM.

The BRE's Environmental Assessment Method (BREEAM) is a voluntary scheme for the environmental labelling of buildings, developed by BRE with private sector partners and sponsors. The basis of the scheme is a certificate awarded to the individual buildings stating clearly – and in a way that can be made *visible* to clients and users alike – the performance of the building against a set of defined environmental criteria. BREEAM is now required for all Government office buildings[7] – representing over 40% of construction in the UK. One of the aims of BREEAM is to encourage the use of materials that have lower impact on the environment, taking account of the full life cycle of the materials in question. Credits are awarded for selecting high performance specifications for key building elements using the *Green Guide to Specification*, for walls, floors, roofs and windows.

Manufacturers should actively promote their Ecopoint scores to registered BREEAM assessors and designers working on buildings which are to be assessed.

EcoHomes

EcoHomes, sponsored by the NHBC, is the homes version of BREEAM. It is a voluntary scheme for the environmental labelling of new and renovated homes. It rewards developers who improve environmental performance through good design. The Housing Corporation now requires an EcoHomes rating to award grants for social housing and several developers have committed to achieving the standard. EcoHomes includes credits for selecting high performance specifications for key building elements using the *Green Guide to Housing Specification,* for walls, floors, roofs and windows.

The Green Guide to Housing Specification

Linked to EcoHomes, the Green Guide to Housing Specification provides guidance to designers and specifiers on the environmental impacts of common specifications used in housing. The guide uses the same format as the Green Guide to Specification.

[6] More information on these tools can be found at www.bre.co.uk/sustainable

[7] Office of Government Commerce. Sustainability Action Plan - a*chieving sustainability in construction procurement.* www.hm-treasury.gov.uk/gccp

Green Guide to Specification

The *Green Guide to Specification (*Anderson, Shiers and Sinclair*,* Blackwells, 2002), contains tables showing summary ratings, measured in Ecopoints per m^2, for all the common building elements*.*

The Green Guide to Specification ratings are based on a 60 year study period (including transport to site, replacement and disposal data). Green Guide ratings are obtained by calculating the environmental impacts associated with all the common construction specifications for a particular element, for example roofing. The range of impacts, from lowest to highest, is then divided into three, and any specification with an impact in the lowest (best) third of the range gets an A rating, in the mid part of the range, a B rating, and in the part with the highest impact, a C rating.

The table below lists the Green Guide to Housing rating obtained by NBT Thermoplan – fired clay masonry units in an external cavity wall construction.

Table 4. Element Specification Green Guide To Housing Rating for the NBT Thermoplan - fired clay masonry units product.

Element Specification	Green Guide Rating
Cavity Wall Construction: NBT Thermoplan - fired clay masonry units 365mm, external lime:cement render, plasterboard and paint.	A

Conclusion and Recommendations

Table 5 shows the Ecopoints Score for the Environmental Profile calculated by BRE for NBT Thermoplan - fired clay masonry units.

Table 5. Product Specification Ecopoint scores for the NBT Thermoplan - fired clay masonry units product.

Product Specification	Ecopoints Cradle to Gate
NBT Thermoplan - fired clay masonry units, 1 tonne	1.2 Ecopoints

The Ecopoint score for the NBT Thermoplan – fired clay masonry units within a domestic external cavity wall specification means that they achieve a Green Guide rating of A.

The findings from this report have shown that the extraction of clay accounts for the most significant proportion of the environmental impact resulting from the production of NBT Thermoplan - fired clay masonry units.

The paper input has sequestered carbon, which is stored within the structure of the fibre. This is released back to the atmosphere when the paper is incinerated during the firing process in the kiln.

As plants and trees grow, they absorb carbon dioxide from the atmosphere as part of photosynthesis. This carbon then remains locked in the wood during use, for example as timber or paper, providing a positive environmental benefit. On disposal, the carbon can be:

- released back into the atmosphere as carbon dioxide if it is burnt, rebalancing the environmental impact;
- released as methane if it rots in an enclosed atmosphere such as landfill, causing a much greater environmental impact because methane is a strong greenhouse gas, or;
- the carbon can remain sequestered in the timber if it is reused or recycled, passing the environmental benefit on to the new product.

BRE models the impact of disposal for timber products based on a mix of the above scenarios and applies these impacts to the Environmental Profile of a product within a building element and is disposed of at the end of life.

The largest proportion of the environmental impact is through minerals extraction, which arises primarily from the extraction of the clay. Additionally there are further impacts through climate change resulting from the manufacturing process and the burning of fossil fuel

BRE are able to model modifications in the production process, (both raw material inputs and the process itself) for NBT Thermoplan - fired clay masonry units, to indicate potential improvements in the

Environmental Profiles. For example, the use of a substitution, or recyclate for some of the clay input or a more energy efficient manufacturing process could be considered to further improve the products environmental performance.

Annex 1 – Environmental Profile: Characterised and normalised data for 1 tonne of NBT Thermoplan - fired clay masonry units

Annex 2 – Environmental Profile: Characterised and normalised data for 1 m^2 of installed NBT Thermoplan - fired clay masonry units

Annex 3 – Environmental Profile: Characterised and normalised data for 1 m^2 NBT Thermoplan - fired clay masonry units over a 60-year life

Annex 4 - Impact categories considered in BRE LCA methodology

Climate change (kg CO_2 eq.)

"Global warming" is associated with problems of increased desertification, rising sea levels, climatic disturbance and spread in disease. It has been the subject of major international activity, and methods for measuring it have been presented by the Intergovernmental Panel on Climate Change (IPCC).

Gases recognised as having a "greenhouse" or radiative forcing effect include CFCs, HFCs, N_2O and methane. Their relative global warming potential (GWP) has been calculated by comparing their direct and indirect radiative forcing to the emission of the same mass of CO_2 after 100 years. E.g. CFC-11 is 3400 times more powerful as a greenhouse gas than CO_2 and therefore one tonne of CFC-11 is equivalent to 3400 tonnes CO_2. Global warming potential is measured in CO_2 equivalents for each emission, which can be added and entered into the Profile under “Climate change” as CO_2 equivalents (100yrs).

A timescale is applied to the GWP figure because the GWP of different gases is related to the amount of time they will spend in the atmosphere and the amount of radiative forcing they will induce over that period. It is important to recognise how long the gases will last in the atmosphere. For example, both carbon dioxide and CFC-11 are greenhouse gases but they have different half lives in the atmosphere and they will thus have a different relative effect over different timescales. Three different scenarios are available for GWP: 20 years, 100 years and 500 years. The 100 year scenario is most commonly used and has been applied in the BRE Environmental Profiles.

Fossil fuel depletion (toe)

This unit reflects the total quantity of fossil fuel energy depleted by consumption. It is measured in *tonnes of oil equivalents* - (toes), which is a unit of energy. The characterisation method assumes that the energy content of all fossil fuels is equally valuable to total fossil fuel resources. This is measured from the perspective of their depletion with a characterisation factor of 1 per tonne of oil equivalent for all fossil fuels. The characterisation factor for all fossil fuels will then be the primary energy value of the fuel in toe.

Acid deposition (kg SO_2 eq.)

Acid deposition on landscapes causes ecosystem impairment of varying degree, depending upon the nature of the landscape ecosystems.

Gases are related to the acidification of one tonne of Sulphur Dioxide (SO_2). They include Ammonia, Hydrochloric acid, Hydrogen Fluoride, Nitrous Oxides and Sulphur Oxides. The equivalents are calculated by dividing the contribution of protons (H+) to the ecosystem from a compound with the contribution from SO_2.

Ozone depletion (kg CFC11 eq.)

Ozone depleting gases cause damage to stratospheric ozone or the "ozone layer". There is great uncertainty about the combined effects of different gases in the stratosphere and all chlorinated and brominated compounds that are stable enough to reach the stratosphere can have an effect. CFC manufacture was banned from the year 2000 and HCFCs will be phased out by 2015. In the characterisation method, gases are related to the ozone depletion potential (ODP) of one kilogram CFC-11.

Human toxic air pollution and water pollution and ecotoxic water pollution (Kg. toxicity and m³. toxicity)

The subject of toxicity is a particularly complex area within impact assessment and a variety of different techniques have been developed. The four categories proposed by Heijungs (1992) at the University of Leiden for the CML method is the most widely accepted method and BRE therefore advocate the use of this technique in the absence of more definitive works. CML developed a provisional method of toxicological weighting factors. For human toxicity these are then calculated as (human toxicological classification factor) x (kg body weight/kg substance). The factors are based on tolerable concentrations in air, air quality guidelines, tolerable daily intakes and acceptable daily intake.

BRE are paying close attention to developments in the field and are particularly interested in the work of the World Health Organisation to develop Disability Adjusted Life years (DALYs) and Percentage Affected Fractions (PAFs) for human and ecotoxic effects respectively.

Photochemical ozone creation (kg ethene eq.)

In atmospheres containing nitrogen oxides, ozone creation occurs under the influence of radiation from the sun. Different hydrocarbons react to form ozone at different rates and both NO_x and volatile organic compounds (VOCs) can control the rate of this photo-oxidation process. Increased ozone in the lower part of the atmosphere is important at a local, regional and global scale but impact assessment methods concentrate on the local and regional impacts. The formation of ozone and other oxidants, such as nitrogen dioxide, hydrogen peroxide and aldehydes, are implicated in impacts as diverse as crop damage and increased incidence of asthma and other respiratory complaints. The method used for characterisation in the Profile comes from CML and compares the photochemical ozone creation potential of VOCs to that of ethene.

Eutrophication (kgPO_4)

Phosphate is the unit against which a number of emissions to air and water are measured for their equivalent eutrophication or “nutrification” potential, leading to loss of biodiversity through over-enrichment of water supplies. Species dependent on low-nutrient environments are lost and algal blooms occur in water, increasing mortality of aquatic fauna and flora. Ammonia, Nitrates, Nitrous Oxides and total Nitrogen and Phosphorous are included within this part of the Profile. This characterisation factor is derived from the Dutch CML method.

Minerals extraction (tonnes)

This unit was selected to reflect the total quantity of mineral resource extracted. This applies to all minerals, including metal ore, and applies to both UK and overseas extraction. The extraction of minerals for building in the UK is a high Profile environmental topic but the minerals themselves are not considered to be scarce. This unit is not currently used to make such a distinction. The assumption is that this unit is a proxy for levels of local environmental impact from mineral extraction. The characterisation method assumes that all mineral extractions are equally disruptive of the local environment and a characterisation factor of 1 is used per tonne of material extracted.

Water extraction (litres)

This unit was selected to reflect the depletion, disruption or pollution of aquifers or disruption or pollution of rivers and their ecosystems due to over abstraction. The characterisation factor is 1 per cubic metre and assumes that all abstractions are equally damaging. This is a significant area of impact which warrants further research.

Waste disposal (tonnes)

At the present time, it is most practical to use a tonne of waste as a proxy for the impacts arising from waste disposal. This unit was selected to reflect the depletion of landfill capacity, the noise, dust and odour from landfill (and other disposal) sites, the gaseous emissions and leachate pollution from incineration and landfill, the loss of resources from economic use and risk of underground fires etc. The characterisation factor is 1 assuming that 1 tonne of any waste is equally deleterious. In practice, wastes will vary in their putrescible content, combustibility, leachability of toxic substances etc. The exception to the "proxy" status of the associated impacts is for greenhouse gases. The greenhouse emissions from landfill and incineration are included in the sixty year life element Profile.

Transport pollution & congestion (tonne.km)

This unit was chosen to reflect the impacts arising from the transport of freight world wide, including ocean travel. It is particularly useful because it provides a figure for an impact over which producers have direct control. Tonne.km reflect the local transport pollution, congestion, noise, dust and discomfort to travellers and to those local transport routes especially roads. The characterisation factor used is 1, implying that all modes of tonne.km are equally damaging. This characterisation factor will be the subject of future refinement. It is recognised that transport associated with the production and construction of buildings is also converted to emissions to atmosphere from the combustion of the fuel used and primary energy figures reflect the production of the fuel itself. Tonnes.km is not displayed to reflect these impacts, which are accurately accounted for within the other categories and therefore does not produce a double counting effect.