



SAINT-GOBAIN CONSTRUCTION PRODUCTS

Environmental Product Declaration for Glass Wool
manufactured by Saint-Gobain at its Isover SA plant

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TABLE OF CONTENTS

1 INTRODUCTION..... 1

2 METHODS AND DATA..... 1

2.1 Methodology 1

2.2 Data..... 2

2.2.1 Data limitations..... 5

3 RESULTS..... 6

3.1 Life cycle stage contributions..... 6

3.2 Comparison with Ecoinvent Glass Wool product..... 8

4 CONCLUSIONS..... 9

1 INTRODUCTION

Saint-Gobain South Africa has contracted The Green House (TGH) to compile the Environmental Product Declaration (EPD) of the Glass Wool Insulation product manufactured by Saint-Gobain at its Isover SA plant.

This report provides an account of the methods and data used in calculating the EPD. The EPD information is provided in the specific format required by the Saint-Gobain Product Category Rule (PCR) in an addendum to this report. A few graphical results are also presented, as these provide some insight into the results not immediately apparent in the PCR result presentation format.

2 METHODS AND DATA

2.1 Methodology

A cradle-to-grave life cycle assessment was conducted on the Glass Wool insulation product in accordance with the methodological guideline developed for Saint-Gobain by PwC-Ecobilan (PCR). The methodology followed is thus not described in detail here, as this is described in full in the PCR.

Included in the assessment are the production of the Glass Wool product, transport to the client, transport to the installation site, installation of the product, the use phase and end-of-life. The production stage includes raw material supply and transport to the production site, manufacturing of products and all upstream processes (manufacturing of raw materials). No emissions or resource use are associated with the installation phase for this product, as the Glass Wool product requires no energy or material inputs in its installation. Furthermore, it is assumed that there is no wasted product from installation. The use phase only considers the insulation function of the Glass Wool, and it is assumed no maintenance or replacement of the Glass Wool is required over the 50 year service life. There are also assumed to be no energy or material inputs into removal of the product at end of life.

As specified in the PCR for insulation products, the functional unit is taken as 1 m² of finished product with a thermal resistance coefficient R (determined based on local regulations regarding thermal insulation). This corresponds to a functional flow of 1.4 kg of Glass Wool product, based on a thickness of 100 mm and a density of 14 kg/m³. In accordance with the PCR, a typical lifetime (reference service life) of 50 years is used for the Glass Wool insulation.

Maintaining acceptable temperatures in buildings (through heating and cooling) uses a large proportion of energy; this is due to the inevitable heat flow from a warm body to a lower-temperature body. The thermal insulation reduces this heat flow, retaining heat during winter and reflecting heat during summer, thus avoiding the energy required for heating or cooling. To take into account the insulation function of the Glass Wool mat, the use phase is modelled using system expansion. This is a life cycle modelling technique to account for the energy that would have been needed to heat or cool the building had no Glass Wool been installed. This is done by “expanding” the life cycle system boundary to also include the production of the energy for heating and cooling (in this case assumed to be average grid electricity). The emissions and resource use from producing an equivalent amount of electricity that would have been required for heating or cooling (i.e. that is “saved” through the use of the insulation) are then subtracted from the Glass Wool system’s resources and emissions. An energy saving of 39 kWh electricity per month is applied in the EPD. This is the energy saving achieved by installing Glass Wool at

a home located in Johannesburg South (i.e. through avoiding heating and cooling). This data was based on climatic data for Johannesburg, heating/cooling degree days quoted by the South African Weather Service and an assumed ideal indoor temperature range of 20 - 23°C.

In accordance with the PCR, treatment of waste materials and wastewater is excluded from the system boundary, and only the quantity and type of waste recorded in the inventory. The end of life stage thus includes only emissions and resource use associated with transport to a waste disposal site. Infrastructure is also excluded from the system boundary.

SimaPro version 7.3 life cycle assessment software is used to carry out the assessment.

2.2 Data

Saint-Gobain factory-specific data is the source for production data. Saint-Gobain also provided specific data for the transport, installation and use phases, whereas data from the ecoinvent LCI database is the source for secondary data (raw materials, energy, transport etc.). All primary data is supplied by Saint-Gobain and no primary data collection has been undertaken by TGH.

The production data is for a single factory site, and is for the 2010 calendar year. It is understood that the production data supplied by Saint-Gobain meets the requirements of the PCR, and a thorough audit of this data is beyond the scope of this assessment. Nonetheless, the data were interrogated wherever possible by TGH, so as to be sure the data are applied correctly in the LCA model. Some specific points around how the supplied data are incorporated into the LCA model are given in the following section. The production data supplied were also compared to the ecoinvent data on a Glass Wool mat product, and were found to be reasonably consistent.

Where Saint-Gobain was only able to provide incomplete product information, but was able to provide the names of suppliers (e.g. as for dispersing agent, soap and starch), the suppliers were approached for material compositions, transport modes and, if imported, source countries. If no information on the supplier was provided, domestic production was assumed for the material.

Table 1 below provides a summary of the input data provided by Saint-Gobain, along with the dataset selected from the ecoinvent database to model the production of the raw materials. The geographical representativeness of the secondary data can also be determined from the tables by comparing the production location (actual location from which the raw material is supplied) with the geographical context of the ecoinvent dataset. The majority of the ecoinvent datasets are representative of European production, although the unit process structure of the database allows a dataset to be adjusted to approximate production in a different location. In most instances, where South African production data are required, the ecoinvent dataset is modified by replacing the European electricity production data with South African data compiled by TGH. For a raw material where electricity consumption is relatively high, this considerably improves the representativeness of the dataset.

TABLE 1: Input data for the annual production (2010) of 5,434 tonne (1,006,240 m²) of 135 mm Glass Wool Insulation, and the dataset selected from the ecoinvent database to model it. The geographical context of the dataset is also shown (ZA in brackets after the location indicates that the dataset was partially adjusted to better represent production in South Africa, e.g. by substituting European electricity data with South African data).

Saint-Gobain		Ecoinvent			
Process / input	Production location	Process / material input	Geographical context of dataset	Flow	Unit
Electricity	South Africa	Electricity, medium voltage	South Africa	16,995	MWh
Natural gas	South Africa	Natural gas, high pressure, at consumer	European average (ZA)	68,764	GJ
Natural gas burned in furnace	South Africa	Natural gas, burned in industrial furnace >100kW	European average/ site-specific data	68,765	GJ
Diesel fuel	South Africa	Diesel, at regional storage	European average (ZA)	3991	litre
Diesel fuel used in onsite forklifts	South Africa	Diesel, burned in building machine	Global average (ZA)	143	GJ
Water from city network (tap water)	South Africa	Tap water, at user	European average (ZA)	50341	tonne
Sand	South Africa	Silica sand, at plant	Switzerland (ZA)	1500	tonne
Soda ash	Egypt	Soda, powder, at plant	European average (ZA)	959	tonne
Limestone	South Africa	Limestone, milled, packed, at plant	European average (ZA)	412	tonne
Dolomite	South Africa	Dolomite, at plant	European average (ZA)	221	tonne
Sheet glass	South Africa	Glass, cullets, sorted, at sorting plant	European average (ZA)	3340	tonne
Andalusite	South Africa	Feldspar, at plant	European average (ZA)	234	tonne
Silane	South Africa	Silicone product, at plant	European average (ZA)	1.16	tonne
Ammonium Sulphate	South Africa	Ammonium sulphate, as N, at regional storehouse	European average (ZA)	7.25	tonne
Ammonium Hydroxide	South Africa	Ammonia, liquid, at regional storehouse	European average (ZA)	60	tonne
Glues	South Africa	Chemicals organic, at plant	Global average	91	tonne
Mulrex oil / Hydro wax	South Africa	Paraffin, at plant	European average (ZA)	17	tonne
R102 resin	South Africa	Phenolic resin, at plant	European average (ZA)	584	tonne
AQUASET	Egypt	Acrylic dispersion, 65% in H ₂ O, at plant; Tap water, at user	European average	122	tonne
Globe Glue	South Africa	5% Sodium borates, at plant; 40% Maize starch, at plant; Tap water, at user	California (ZA) Germany (ZA)	4.25	tonne
Plastic packaging	South Africa	Packaging film, LDPE, at plant	European average (ZA)	270	tonne

The South African datasets used are proprietary to TGH, and are based on modified ecoinvent unit process data and publically available statistical data (e.g. Eskom annual reports). The temporal representativeness of the secondary data is good, with the majority of the ecoinvent datasets representative of production in 2007.

Table 2 provides a summary of the input data used to model the transport of raw materials and product. Factory specific data were provided by Saint-Gobain on the delivery of the product (average transport distance and truck sizes in some cases), and on the delivery of raw materials (transport mode and distance to supplier). Imported products were assumed to be transported from Durban harbour via road. A nominal 100 km distance was assumed for transport of Glass Wool at end of life to waste disposal (landfill). A distance of 100 km was also assumed for the transport of the packaging waste generated during the installation stage. Glass Wool removed at end of building life is assumed to be transported by contractors to a disposal site and not in municipal waste collection trucks, i.e. average truck loading and fuel consumption is used, rather than mixed waste collection trucks, which have much higher fuel consumption due to the stop-start nature of municipal waste collection. Ecoinvent transport datasets were used to model the relevant transport processes.

TABLE 2: Data inputs and assumptions used to model transport process in the Glass Wool system.

Saint-Gobain				Ecoinvent	
Transport Step	Transport mode	Distance (km)	Fuel consumption (litres/km)	Transport process	Weighted fuel consumption (litres/tonne.km)
Glass Wool mat to client (factory to retail)	Road	150	0.48	Transport, truck 16-32 tonne, EURO3 (32 tonne truck)	0.015 (full)
Glass Wool mat to installation site (retail to building site)	Road	11	0.09	Transport, van <3.5 tonne (20% petrol; 80% diesel)	0.025
Waste wool end-of-life (building site to landfill site)	Road	100 ¹	0.09	Transport, van <3.5 tonne (20% petrol; 80% diesel)	0.025
Imported materials used in Glass Wool production (production country to SA)	Sea	3,520 - 9,900		Transport, transoceanic freight ship	0.0023
Imported materials used in production (port to factory)	Road	590	0.48	Transport, lorry >16 tonne (28 tonne truck)	0.017
Local materials used in Glass Wool production (production site to factory)	Road	50 - 200	0.48	Transport, lorry >16 tonne (28 tonne truck)	0.017

¹ Assumed value

2.2.1 Data limitations

All primary data were provided by the factory. There are however some important data gaps in the primary data. For almost all raw material inputs, a corresponding dataset was located in the Ecoinvent database or a dataset was compiled based on its composition. This was either provided by the Isover plant or it was extracted from the material safety data sheet (MSDS) provided by the supplier. This was not the case for the R102 Resin and Aquaset, which are both large in relation to the other inputs. How this was dealt with, including all assumptions made and the relevant data sources used, is explained below for these two material inputs.

AQUASET

The MSDS of the AQUASET product identifies it as an acrylic dispersing agent, but does not include any data on its exact composition. The Ecoinvent dataset “Glass wool mat, at plant” contains an acrylic dispersing agent, identified as, “Acrylic dispersion, 65% in H₂O, at plant”, which was used as a surrogate dataset for the Isover Glass Wool input. In this dataset the key components of “Acrylic dispersion” are an acrylic binder, titanium dioxide, ethylene glycol and butyl acrylate.

R102 Resin

Only the proprietary name of the resin product was provided. The Ecoinvent dataset “Glass wool mat, at plant”, includes a mixture of formaldehyde, urea and phenol resins. The Ecoinvent dataset “Phenolic resin, at plant” was thus selected to model the R102 Resin as it correlates with the emissions from the Isover plant, which include formaldehyde and phenol.

Other data limitations

In addition to the above, the following data limitations are identified, along with the modelling assumptions made:

- The quantity of plastic packaging used is an estimated value, and was provided by Saint-Gobain as a fraction (5%) of the mass of Glass Wool product;
- Only the proprietary names were provided for glues used in the Glass Wool manufacturing process. However the quantities used are very small, so it was assumed the effects would be negligible and a surrogate global dataset for the production of a mix of organic chemicals was used to model the glues;
- The data used to model the Hydrowax possibly underestimates the emissions associated with the production of paraffin wax (depending on the source of the wax), as the Ecoinvent dataset assumes the wax is manufactured from crude oil, whilst in South Africa, it is as likely to be produced by Sasol (i.e. the wax will be coal-based, which has much higher emissions associated with it than oil-based wax).

3 RESULTS

The EPD results are presented in an addendum to this report in the format required by the PCR. The results presented here are for the same impact categories required for consideration by the PCR, but in a graphical format. This allows for some insights into the major factors contributing to the environmental impacts. A comparison of the Isover plant to a Swiss operation is also provided.

3.1 Life cycle stage contributions

This section investigates more closely the profile of the life cycle. Figure 1 shows the contribution of the different stages over the life cycle of the Glass Wool mat, according to the stages defined in the PCR:

- Production of the Glass Wool mat;
- Transport of the Glass Wool mat from the production plant to the client (retail), and then from the client to the installation site;
- Installation of the Glass Wool mat;
- Use (energy savings during its service life); and
- End-of-life of the Glass Wool mat (removal of Glass Wool and transport to a landfill).

It is clear that the production stage dominates all impact categories with the transport, installation and end-of-life all having negligible contributions. The avoided burdens (negative contributions) are a result of the electricity savings during the use phase. It is also clear from Figure 1 that a large proportion of the emissions associated with the manufacture of the Glass Wool, are balanced by emissions saved during its use phase. For certain impacts (photochemical oxidant formation, particulate matter formation, acidification and eutrophication), the impacts at the manufacturing stage are more than compensated by the savings during the use phase, whilst for others (e.g. carbon footprint and human toxicity) the overall life cycle impacts from the Glass Wool are close to neutral.

To provide some insight into the factors contributing the most to the environmental impacts, the production stage it is broken down further in Figure 2 according to the following activities:

- Manufacture of raw materials (inputs into the Glass Wool process);
- Transport of raw materials;
- Electricity used in the Glass Wool manufacturing process; and
- On-site factory emissions.

Almost all the impact categories, with the exception of Metal Depletion, are dominated by electricity use at the plant, followed by production of raw materials. The manufacture of the R102 resin contributes the most to the environmental impacts arising from the manufacture of raw materials, followed by natural gas production and soda powder. The Metal Depletion category is dominated by the production of raw materials, which is particularly due to the titanium chloride component of the AQUASET dispersing agent.

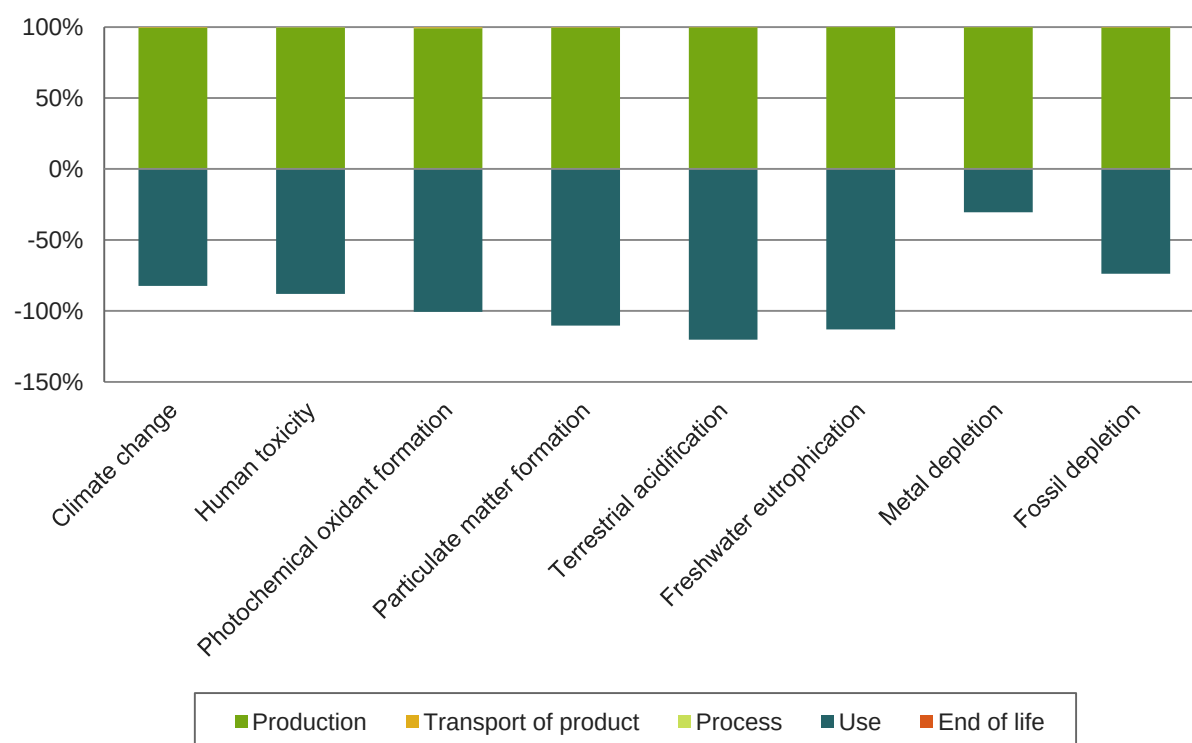


FIGURE 1: Contribution of the main life cycle stages of an Isover Glass Wool product to selected impact categories.

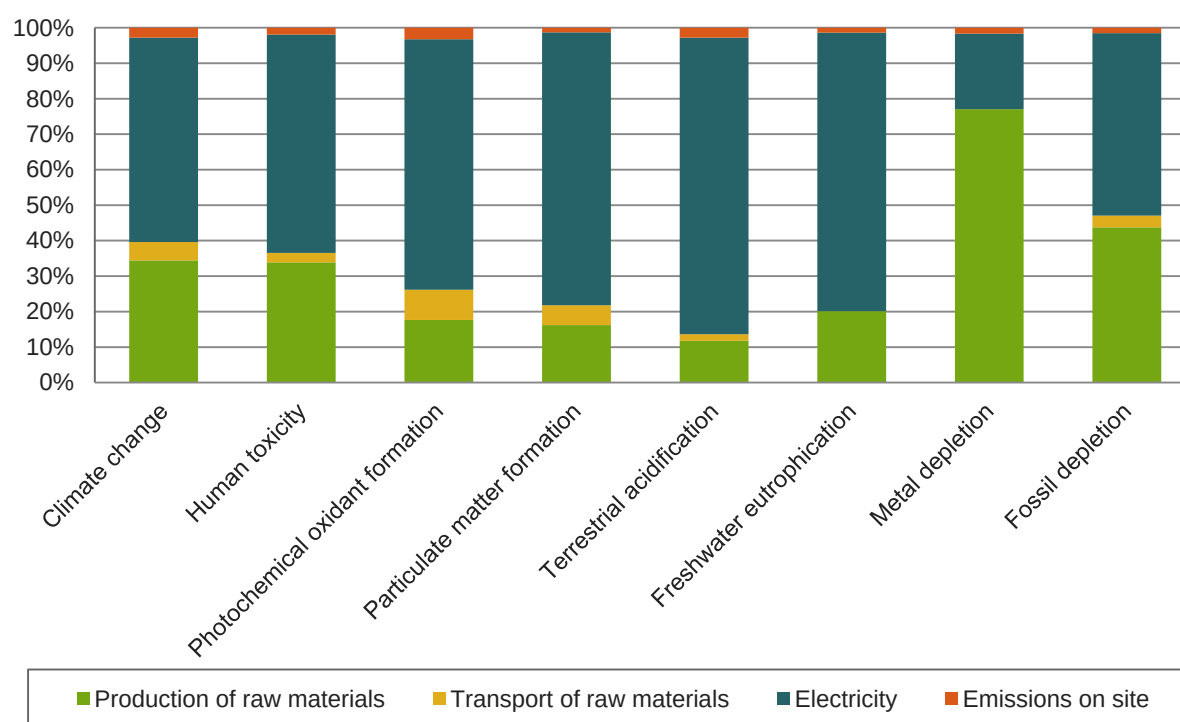


FIGURE 2: Contribution of the Glass Wool production process activities to selected impact categories

3.2 Comparison with Ecoinvent Glass Wool product

Table 3 shows the results of a comparison of the life cycle results obtained for the Isover Glass Wool with those of the Glass Wool product available in the ecoinvent database.

TABLE 3: Comparison of 1 kg Isover Glass Wool product to 1 kg “Glass wool mat, at plant/CH” (Ecoinvent dataset) (results shown with the ReCiPe impact assessment method²).

Impact category	Unit	Difference
Climate change	kg CO ₂ e	74%
Ozone depletion	kg CFC-11 eq	-36%
Human toxicity	kg 1,4-DB eq	-144%
Photochemical oxidant formation	kg NMVOC	84%
Particulate matter formation	kg PM10 eq	84%
Ionising radiation	kg U235 eq	-596%
Terrestrial acidification	kg SO ₂ eq	82%
Freshwater eutrophication	kg P eq	-37%
Marine eutrophication	kg N eq	58%
Terrestrial ecotoxicity	kg 1,4-DB eq	-65%
Freshwater ecotoxicity	kg 1,4-DB eq	-8%
Marine ecotoxicity	kg 1,4-DB eq	-7%
Agricultural land occupation	m ² a	-100%
Urban land occupation	m ² a	69%
Natural land transformation	m ²	16%
Water depletion	m ³	23%
Metal depletion	kg Fe eq	-18,650%
Fossil depletion	kg oil eq	66%

The cells highlighted in the same colour represent impact categories whose differences can be explained by the same underlying factors.

The impact categories highlighted in dark orange are largely contributed to by fossil energy (i.e. Climate Change, Photochemical Oxidation, Particulate Formation, Acidification, Eutrophication) They thus display a similar percentage increase showing the higher coal-based component of South Africa's electricity relative to Swiss electricity. On the other hand, the Swiss electricity grid mix has a higher component of nuclear energy than the South African grid mix, which accounts for the large difference in Ionising Radiation.

The largest contributor to the Human Toxicity category is the factory emissions, particularly that of formaldehyde, which is much lower for the Isover plant than the Swiss plant resulting in its large percentage decrease in Human Toxicity potential.

² Goedkoop, M. et al., 2008. *ReCiPe 2008, A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level*. Available online: http://www.pre-sustainability.com/download/misc/ReCiPe_main_report_final_27-02-2009_web.pdf.

The Swiss plant performs poorly in the impact categories highlighted in yellow, which is largely due to the emissions associated with incineration of wet Glass Wool from filtering (i.e. Freshwater Eutrophication and Freshwater Ecotoxicity). The treatment of waste materials and wastewater is excluded from the system boundary of the Isover Glass Wool, in accordance with the PCR, and only the quantity and type of waste is recorded in the inventory. Therefore the Isover plant displays a lower impact in these categories.

With respect to the Swiss plant, the Terrestrial Ecotoxicity and Agricultural Land Use categories are both predominantly contributed to by emissions associated with agricultural activities. Palm fruit oil is used in the production of backing paper for the Glass Wool, however the Isover Glass Wool has no backing. Similarly, wood-based board is used to package the Glass Wool mat at the Swiss plant, whereas the Isover Glass Wool is packaged only in a plastic wrapping.

The Metal Depletion category in the Swiss dataset is largely contributed to by manganese that originates from a manganese oxide raw material input (80% manganese in manganese oxide). This appears to be a data gap or significant difference with the Isover Glass Wool mat process; therefore the percentage decrease shows the lower manganese quantity of the Isover plant relative to the Swiss plant.

4 CONCLUSIONS

The EPD results are produced in accordance with the PCR supplied by Saint-Gobain. Based on a comparison with the Ecoinvent dataset inventory, the primary data supplied by Saint-Gobain is judged to be complete and of good quality. The background data (Ecoinvent, and the proprietary TGH datasets based on the Ecoinvent database), are judged to be of a reasonable fit to the study and the best currently available. The results of the EPD are thus judged to be robust and of sufficient quality for the desired purpose of environmental communication.

ADDENDUM

Environmental product declaration for
Glass Wool in format supplied in St Gobain
Product Category Rule.

1 Product characterisation in accordance with SG PCR § 8.4

1.1 Definition of functional unit

1 m² of Glass Wool.

Typical lifetime (reference service life) of 50 years.

1.2 Product mass required for the functional unit

Quantity of product contained in the functional unit on the basis of a reference service life:

Product: 1.4 kg/m²

Additional product: N/A

Distribution packaging: 7.0 x 10⁻² kg/m² LDPE packaging film

Justification of quantities supplied:

Amounts relating to annual production at factory.

1.3 Useful technical characteristics not contained in the definition of the functional unit

Thermal resistance coefficient R. *St Gobain to supply value used in Home Insulation Saving calculation.*

The life cycle inventory data set out below have been calculated for the functional unit defined in 1.1 and 1.2

2 Inventory and other data in accordance with SG PCR § 9

Comments relating to the environmental effects of the product

2.1 Consumption of natural resources (SG PCR§9.3)

2.1.1 Consumption of natural energy resources and energy indicators

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Wood	kg	0	0	0	0	0	0	0
Coal	kg	3.17	2.20E-04	1.16E-03	-4.19	0	-0.02	-1.02
Lignite	kg	0.03	2.75E-05	2.23E-05	-1.07E-03	0	5.64E-04	0.03
Natural gas	kg	0.63	1.97E-04	7.75E-05	-1.97E-03	0	0.01	0.63
Oil	kg	0.39	5.90E-03	2.00E-03	-0.01	0	0.01	0.39
Uranium	kg	8.25E-06	1.46E-09	1.22E-09	-7.36E-06	0	1.77E-08	8.85E-07

Energy indicators

Total Primary Energy	MJ	115	0.29	0.12	-86.4	0	0.59	29.5
Renewable Energy	MJ	1.34	1.62E-04	1.57E-04	-1.25	0	2.00E-03	0.09
Non-renewable Energy	MJ	114	0.29	0.12	-85.2	0	0.59	29.4
Fuel Energy	MJ	95.7	0.29	0.12	-86.4	0	0.19	9.67
Feedstock Energy	MJ	19.8	0	0	0	0	0.40	19.8
Electricity	kWh	16.6	0	0	-24.0	0	-0.15	-7.38

Comments relating to consumption of energy resources

Total Primary energy is assumed to be the same as Cumulative Energy Demand, and is calculated according to the method published by ecoinvent (Frischknecht R., Jungbluth N., et.al. (2003). Implementation of Life Cycle Impact Assessment Methods. Final report ecoinvent 2000, Swiss Centre for LCI. Duebendorf, CH)

Feedstock energy is defined as in the PCR on page 52: “The part of the primary energy contained in the materials flowing into the system that are not used as fuel. This quantity of energy (net calorific value) can be recovered at end of life if the collection and recovery systems are available.” In Glass Wool Insulation production it arises from organic chemical inputs of benzene and propylene (in resin) and plastic for

packaging.

Fuel energy is assumed to be the difference between Total Primary Energy and Feedstock Energy, as defined in the PCR on page 74:

“Total primary energy = non-renewable energy + renewable energy = process energy + feedstock energy”

(Process Energy is assumed to be synonymous with Fuel Energy). However, the definitions in the PCR appear to be contradictory, as on page 54, it defines Process energy (fuel energy) as the “Energy input required for a unit process to operate the process or equipment within the process excluding energy inputs for production and delivery of this energy”. Following this definition, the sum of Process Energy and Feedstock Energy would not equal Total primary energy.

The electricity figure included in the table is for South African electricity consumption only.

2.1.2 Consumption of non-energy and natural resources

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Antimony (Sb)	kg	0	0	0	0	0	0	0
Silver (Ag)	kg	-	-	-	-	0	-	-
Clay	kg	6.86E-04	-	1.15E-06	-1.47E-05	0	1.34E-05	6.72E-04
Arsenic (As)	kg	0	0	0	0	0	0	0
Bauxite (Al ₂ O ₃)	kg	2.54E-04	-	-	-3.03E-04	0	-	-4.84E-05
Bentonite	kg	5.93E-05	-	-	-3.23E-05	0	-	2.72E-05
Bismuth (Bi)	kg	0	0	0	0	0	0	0
Boron (B)	kg	0	0	0	0	0	0	0
Cadmium (Cd)	kg	-	-	-	-	0	-	-
Limestone	kg	0.21	1.50E-06	4.00E-06	-2.18E-04	0	4.2E-03	0.21
Sodium Carbonate (Na ₂ CO ₃)	kg	0	0	0	0	0	0	0
Potassium Chloride (KCl)	kg	2.02E-06	-	-	-	0	-	1.19E-06
Sodium Chloride (NaCl)	kg	0.129	1.78E-06	8.43E-07	-6.27E-04	0	2.56E-03	0.13
Chrome (Cr)	kg	8.66E-06	-	-	-2.75E-06	0	-	5.93E-06
Cobalt (Co)	kg	-	-	-	-	0	-	-
Copper (Cu)	kg	1.22E-05	-	-	-	0	-	1.15E-05
Dolomite	kg	0.057	-	-	-	0	1.14E-03	0.057
Tin (Sn)	kg	-	-	-	-	0	-	-
Feldspar	kg	-	-	-	-	0	-	-
Iron (Fe)	kg	6.95E-04	-	3.58E-06	-7.95E-06	0	1.38E-05	6.91E-04
Fluorite (CaF ₂)	kg	1.57E-05	-	-	-1.11E-05	0	-	4.76E-06
Gravel	kg	0.50	-	1.83E-05	-2.28E-04	0	-	0.496
Gypsum (CaSO ₄)	kg	1.63E-06	-	-	-	0	-	1.63E-06
Lithium (Li)	kg	-	0	-	-	0	-	-
Kaolin (Al ₂ O ₃ , 2SiO ₂ , 2H ₂ O)	kg	3.29E-05	-	-	-3.70E-05	0	-	-4.04E-06
Magnesium (Mg)	kg	6.47E-06	-	-	-	0	-	6.36E-06
Manganese (Mn)	kg	1.31E-06	-	-	-	0	-	1.30E-06
Mercury (Hg)	kg	0	0	0	0	0	0	0
Molybdenum (Mo)	kg	2.33E-06	-	-	-	0	-	2.31E-06
Nickel (Ni)	kg	3.24E-05	-	-	-4.88E-06	0	-	2.76E-05
Gold (Au)	kg	-	-	-	-	0	-	-
Palladium (Pd)	kg	-	-	-	-	0	-	-
Silica (SiO ₂)	kg	0	0	0	0	0	0	0
Platinum (Pt)	kg	-	-	-	-	0	-	-
Lead (Pb)	kg	-	-	-	-	0	-	-
Rhodium (Rh)	kg	-	-	-	-	0	-	-
Rutile (TiO ₂)	kg	7.24E-03	-	-	-	0	1.45E-04	7.24E-03
Sand	kg	2.94E-05	-	-	-	0	-	2.94E-05
Sulphur (S)	kg	2.77E-05	-	-	-	0	-	2.77E-05
Barium Sulphate (BaSO ₄)	kg	5.21E-05	-	2.21E-06	-1.51E-06	0	1.06E-06	5.28E-05
Titanium (Ti)	kg	0	0	0	0	0	0	0
Tungsten (W)	kg	0	0	0	0	0	0	0

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Vanadium (V)	kg	0	0	0	0	0	0	0
Zinc (Zn)	kg	3.07E-05	-	-	-3.11E-06	0	-	2.76E-05
Zirconium (Zr)	kg	-	-	-	-	0	-	-
Vegetal raw materials not specified above	kg	2.27E-04	-	-	-	0	4.52E-06	2.26E-04
Animal raw materials not specified above	kg	0	0	0	0	0	0	0
Intermediate products not integrated ups	kg	0	0	0	0	0	0	0
Calcareous clay	kg	0	0	0	0	0	0	0

Comments relating to consumption of non-energy resources

A zero in the table reflects no consumption of that resource, whilst a “-“ reflects amounts less than 10^{-6} kg.

2.1.3 Consumption of water

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Water : Lake	litre	2.78	3.82E-05	5.00E-05	0	-0.14	0.05	2.64
Water : Sea	litre	1.05	2.70E-03	1.25E-03	0	-0.50	0.01	0.56
Water : Water table	litre	6.62	2.63E-04	5.45E-04	0	-1.48	0.10	5.14
Water : Unspecified source	litre	14.6	0.02	6.54E-03	0	-0.07	0.29	14.5
Water: River	litre	16.9	7.67E-03	4.79E-03	0	-12.89	0.08	4.00
Drinking Water (network)	litre	13.5	1.86E-04	2.28E-04	-0.69	0	0.26	12.9
Consumed Water (total)	litre	41.9	0.03	0.01	0	-15.08	0.54	26.8

Comments relating to the consumption of water

Water sources are not representative of South Africa as they are taken from the ecoinvent database.

Consumed water is the sum of the first five rows, whilst drinking water draws from the various sources (i.e. is water that undergoes treatment before it is used). Only consumed water is included in the table, i.e. once-through cooling water and turbine water are excluded.

2.1.4 Consumption of recovered energy, recovered material

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Recovered Energy (stock)	MJ							
Recovered Material (stock) : Total	kg							
Recovered Material (stock) : Steel	kg							
Recovered Material (stock) : Aluminium	kg							
Recovered Material (stock) : Metal (unspecified)	kg							
Recovered Material (stock) : Paper-Cardboard	kg							
Recovered Material (stock) : Plastic	kg							
Recovered Material (stock) : Cullet	kg							
Recovered Material (stock) : Biomass	kg							
Recovered Material (stock): Mineral	kg							
Recovered Material (stock) : Unspecified	kg							

Comments relating to the consumption of recovered energy and materials:

This table has been left blank since as far as could be inferred from the data provided by Saint-Gobain, no recovered energy or materials are used in the production process.

2.2 Emissions in the environment (water, air and soil) (SG PCR§ 9.4)

2.2.1 Emissions in the air

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Hydrocarbons (unspecified)	g							
Hydrocarbons (unspecified, except methane)	g							
PAHs (unspecified)	g	2.82E-04	-	-	-1.02E-04	0	3.60E-06	1.80E-04
Methane (CH ₄)	g	17.8	0.02	0.02	-11.5	0	0.13	6.38
Volatile organic compounds (e.g. acetone, acetate...)	g	3.27	0.01	0.02	-0.45	0	0.06	2.84
Carbon Dioxide (CO ₂)	kg	7.02	0.03	0.01	-5.87	0	0.02	1.20
Carbon Monoxide (CO)	g	3.14	0.04	0.08	-0.98	0	0.05	2.29
Nitrogen oxides (NO _x in NO ₂)	g	24.9	0.18	0.05	-26.9	0	-0.04	-1.76
Nitrous Oxide (N ₂ O)	g	0.21	8.40E-04	3.75E-04	-0.25	0	-7.28E-04	-0.04
Ammonium Hydroxide (NH ₃)	g	0.40	1.82E-04	2.81E-04	-0.29	0	2.28E-03	0.11
Dust (unspecified)	g	2.92	7.80E-03	6.26E-03	-2.20	0	1.45E-02	0.73
Sulphur oxides (SO _x in SO ₂)	g	40	0.03	0.01	-50.4	0	-0.21	-0.10
Hydrogen Sulphide (H ₂ S)	g	0.02	-	1.38E-03	-5.87E-05	0	4.78E-04	0.24
Hydrocyanic Acid (HCN)	g	5.26E-05	-	-	-	0	1.04E-06	5.21E-05
Organic chlorine compounds (in Cl)	g	2.90E-04	-	-	-1.08E-05	0	5.59E-06	2.80E-04
Hydrochloric Acid (HCl)	g	0.14	2.78E-05	1.64E-05	-0.08	0	1.33E-03	0.07
Inorganic chlorine compounds (in Cl)	g	0.14	2.87E-05	1.68E-05	-0.08	0	1.33E-03	0.07
Unspecified chlorine compounds (in Cl)	g	0	0	0	0	0	0	0
Organic fluorine compounds (in F)	g	0.06	6.48E-06	4.70E-06	-0.07	0	-3.18E-04	-0.02
Inorganic fluorine compounds (in F)	g	2.14E-04	6.12E-05	-	-8.03E-05	0	3.90E-06	1.95E-04
Unspecified halogen compounds	g	3.94E-03	-	-	-5.19E-03	0	-2.51E-05	-1.25E-03
Unspecified fluorine compounds (in F)	g	0	0	0	0	0	0	0
Metals (unspecified)	g	0.59	4.87E-05	2.06E-04	-0.73	0	-2.81E-03	-0.14
Antimony and its compounds (in Sb)	g	4.68E-06	-	-	-1.45E-06	0	-	3.24E-06
Arsenic and its compounds (in As)	g	8.57E-05	-	-	-3.92E-05	0	-	4.67E-05
Cadmium and its	g	2.11E-05	-	-	-2.47E-06	0	-	1.92E-05

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
compounds (in Cd)								
Chrome and its compounds (in Cr)	g	5.49E-04	1.11E-06	-	-3.43E-05	0	1.03E-05	5.17E-04
Cobalt and its compounds (in Co)	g	3.48E-05	-	-	-6.76E-06	0	-	2.86E-05
Copper and its compounds (in Cu)	g	6.07E-04	5.44E-05	2.73E-05	-4.17E-05	0	1.29E-05	6.47E-04
Tin and its compounds (in Sn)	g	3.31E-06	-	-	-1.53E-06	0	-	1.78E-06
Manganese and its compounds (in Mn)	g	7.73E-05	-	-	-3.37E-05	0	-	4.37E-05
Mercury and its compounds (in Hg)	g	1.03E-04	-	-	-1.17E-04	0	-	-1.38E-05
Nickel and its compounds (in Ni)	g	1.25E-03	5.90E-06	2.13E-06	-6.58E-05	0	2.38E-05	1.19E-03
Lead and its compounds (in Pb)	g	2.47E-04	3.40E-06	1.69E-06	-6.92E-05	0	3.66E-06	1.83E-04
Selenium and its compounds (in Se)	g	3.47E-04	-	-	-4.35E-04	0	-1.75E-06	-8.75E-05
Tellurium and its compounds (in Te)	g	0	0	0	0	0	0	0
Zinc and its compounds (in Zn)	g	4.98E-04	2.30E-05	1.15E-05	-7.89E-05	0	9.08E-06	4.54E-04
Vanadium and its compounds (in V)	g	9.51E-04	8.84E-06	3.00E-06	-6.94E-05	0	1.79E-05	8.93E-04
Silicon and its compounds (in Si)	g	0.03	-	1.20E-06	-3.57E-03	0	5.40E-04	0.03
Boron and its compounds	g	0.01	1.29E-06	1.10E-06	-0.01	0	-3.41E-05	-1.71E-03
Micro-organisms...acarids...legionnaire's disease	g	0	0	0	0	0	0	0

NOTE 1 : With regards to radioactive emissions, this table will be completed as soon as the transposition of the Euratom European Directive on radioactive emissions is issued.

Comments relating to emissions in the air:

A zero in the table reflects no emissions in that category, whilst a “-“ reflects an emission less than 10^{-6} g.

Each emission appears in only one category, even if it does fit into more than one, e.g. “Ethane, 1,2-dichloro-“ is captured under “Organic chlorine compounds”, even though it could equally have been put under “Volatile organic compounds” or “Hydrocarbons”. For that reason the first two categories (“Hydrocarbons (unspecified)” and “Hydrocarbons (unspecified, except methane)”) are empty, even though that does not imply there are no hydrocarbons emitted.

2.2.2 Emissions in water

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
COD (Chemical Oxygen Demand)	g	9.39	0.02	0.01	-0.11	0	0.19	9.30
5-day BOD (Biochemical Oxygen Demand)	g	7.73	0.01	9.90E-03	-0.10	0	0.15	7.66
Matter in Suspension (MIS)	g	8.73	5.07E-03	3.74E-03	-0.26	0	0.17	8.48
Cyanide (CN ⁻)	g	3.03E-05	-	-	-1.29E-06	0	6.11E-07	3.05E-05
AOX (Adsorbable organic halogen compounds)	g	6.63E-05	-	-	-1.371E-05	0	1.05E-06	5.27E-05
Hydrocarbons (unspecified)	g	2.26	1.31E-03	5.09E-04	-2.76E-03	0	0.05	2.26
Nitrogen compounds (in N)	g	0.11	1.46E-04	9.32E-05	-0.01	0	1.94E-03	0.10
Phosphorous compounds (in P)	g	0.21	1.81E-05	2.03E-04	-0.25	0	-7.73E-04	-0.04
Organic fluorine compounds (in F)	g	0	0	0	0	0	0	0
Inorganic fluorine compounds (in F)	g	0.04	3.44E-05	2.68E-05	-0.04	0	-9.73E-05	-4.87E-03
Unspecified fluorine compounds (in F)	g	0	0	0	0	0	0	0
Organic chlorine compounds (in Cl)	g	1.79E-05	-	-	-	0	3.46E-07	1.73E-05
Inorganic chlorine compounds (in Cl)	g	0.44	0.13	0.06	-0.27	0	0.33	0.17
Unspecified chlorine compounds (in Cl)	g	0	0	0	0	0	0	0
PAHs (unspecified)	g	3.29E-05	1.30E-06	-	-2.66E-06	0	6.42E-07	3.21E-05
Metals (unspecified)	g	103	0.02	0.04	-120	0	-0.33	-16.2
Aluminium and its compounds (in Al)	g	0	0	0	0	0	0	0
Arsenic and its compounds (in As)	g	3.00E-04	-	-	-2.70E-05	0	5.47E-06	2.74E-04
Cadmium and its compounds (in Cd)	g	6.24E-05	-	-	-1.14E-05	0	1.02E-06	5.12E-05
Chrome and its compounds (in Cr)	g	0.01	2.50E-06	4.98E-06	-0.01	0	-4.26E-05	-2.13E-03
Copper and its compounds (in Cu)	g	7.30E-03	4.84E-06	2.43E-06	-3.68E-03	0	7.25E-05	3.63E-03
Tin and its compounds (in Sn)	g	2.78E-03	-	-	-3.43E-03	0	-1.29E-05	-6.46E-04

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Sn)								
Iron and its compounds (in Fe)	g	0.28	1.30E-04	2.06E-04	-0.20	0	1.57E-03	0.08
Mercury and its compounds (in Hg)	g	1.30E-05	-	-	-2.56E-06	0	-	1.04E-05
Nickel and its compounds (in Ni)	g	0.02	3.08E-06	1.15E-05	-0.03	0	-1.23E-04	-6.15E-03
Lead and its compounds (in Pb)	g	2.70E-03	5.08E-06	1.34E-06	-4.98E-04	0	4.42E-05	2.21E-03
Zinc and its compounds (in Zn)	g	7.51E-03	1.56E-04	2.83E-05	-2.82E-03	0	9.76E-05	4.88E-03
Unspecified dissolved organic compounds	g	2.73	5.56E-03	3.31E-03	-0.04	0	0.05	2.71
Unspecified inorganic compounds	g	6.39	2.36E-03	5.85E-03	-7.26	0	-0.02	-0.86
Alkaline metals (Na ⁺ , K ⁺)	g	6.70	0.08	0.03	-6.25	0	0.02	0.57

Comments relating to discharges in water:

A zero in the table reflects no emissions in that category, whilst a “-“ reflects an emission less than 10⁻⁶ g.

DOC (dissolved organic carbon) is included in the category “Unspecified dissolved organic compounds”.

TOC (total organic carbon) is not included in the table, and amounts to 2.71 g.

The category “Unspecified inorganic compounds” is used as a catch-all for those emissions that do not fit into any other category. The relatively high value is due to sulphate emissions.

2.2.3 Emissions in the soil

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Arsenic and its compounds (in As)	g	-	-	-	-	0	-	-
Biocides a	g	1.82E-04	-	-	-4.48E-05	0	2.75E-06	1.38E-04
Cadmium and its compounds (in Cd)	g	-	-	-	-	0	-	-
Chrome and its compounds (in Cr)	g	1.39E-05	-	-	-	0	-	1.41E-05
Copper and its compounds (in Cu)	g	8.46E-05	3.18E-06	-	-	0	1.74E-06	8.72E-05
Tin and its compounds (in Sn)	g	-	-	-	-	0	-	-
Iron and its compounds (in Fe)	g	0.44	5.16E-05	4.19E-05	-2.09E-03	0	8.29E-04	0.42
Lead and its compounds (in Pb)	g	2.83E-05	1.94E-06	-	-	0	-	3.02E-05
Mercury and its compounds (in Hg)	g	-	-	-	-	0	-	-
Nickel and its compounds (in Ni)	g	9.98E-06	-	-	-	0	-	1.05E-05
Zinc and its compounds (in Zn)	g	1.77E-03	1.35E-04	9.55E-06	-5.56E-06	0	3.82E-05	1.91E-03
Heavy metals (unspecified)	g	1.04E-03	-	2.01E-05	-2.63E-05	0	2.07E-05	1.03E-03
a Biocides: e.g. pesticides, herbicides, fungicides, insecticides, bactericides etc.								

Comments relating to emissions in the soil:

A zero in the table reflects no emissions in that category, whilst a “-“ reflects an emission less than 10^{-6} g.

Emissions of Oils (1.42×10^{-4} g) is not reflected in the table.

2.3 Waste production (SG PCR§9.4)

2.3.1 Recovered matter

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Recovered Energy (stock)	MJ							
Recovered Material (stock) : Total	kg							
Recovered Material (stock) : Steel	kg							
Recovered Material (stock) : Aluminium	kg							
Recovered Material (stock) : Metal (unspecified)	kg							
Recovered Material (stock) : Paper-Cardboard	kg							
Recovered Material (stock) : Plastic	kg							
Recovered Material (stock): Cullet	kg							
Recovered Material (stock): Biomass	kg							
Recovered Material (stock): Mineral	kg							
Recovered Material (stock): Unspecified	kg							

2.3.2 Eliminated waste

Flow	Units	Production	Transport	Process	Use	End of life	Total life cycle	
							Per year	Reference service life
Hazardous waste	kg	0.03	0	-	-	0	5.98E-04	0.03
Non-hazardous waste	kg	0.09	0	-	-	0	1.82E-03	0.09
Inert waste	kg	0.06	0	-	-	0	1.11E-03	0.06

Comments relating to waste production and management methods

Waste figures are only available in these categories for the primary process (i.e. the totals in the table for production reflect only the Glass Wool factory and not the production of raw materials).

3 Contribution of the product to environmental impacts in accordance with SG PCR §9.6

All these impacts are entered or calculated in compliance with indications of § 9.6 of the SG PCR.

No.	Environmental impact		Value - Unit
1	Consumption of energy resources		
	Total primary energy		29.5 MJ/FU
	Renewable energy resources		0.09 MJ/FU
	Process energy resources		29.4 MJ/FU
2	Depletion of natural resources (ADP)		9.13E-03 kg SB eq./FU
3	Water Consumption		26.8 litres/FU
4	Solid waste	Recovered	0.07 kg/FU
		Disposed of	
		Hazardous waste	0.0299 kg/FU
		Non-hazardous waste	0.0912 kg/FU
		Inert waste	0.0557 kg/FU
5	Climatic change		1.32 kg CO ₂ eq./FU
6	Atmospheric acidification		-0.013 kg SO ₂ eq./FU
7	Eutrophication		5.24E-06 kg PO ₄ 3eq./FU
8	Stratospheric ozone layer depletion		2.40E-07 kg CFC eq. R11/FU
9	Formation of photochemical oxidants		1.21E-04 kg ethylene eq./FU

Comments relating to calculation of environmental impacts

Process energy is understood to be the same as fuel energy, and is derived from the relationship between the energy indicators given in the PCR on page 55:

Total primary energy = non-renewable energy + renewable energy = process energy + feedstock energy
(and not per the definition given in the PCR for Process Energy on page 54).

Depletion of abiotic resources (Abiotic depletion potential) is calculated according the CML LCIA method, which has units in kg antimony equivalents (units in the table have been adjusted). This is

believed to be more meaningful than merely summing the resource inputs, but if that is what is desired for the table, the total for mineral resource inputs is 0.91 kg/FU (excluding fuel resources), and 0.95 kg/FU if non-renewable fuel resources (i.e. crude oil, gas and coal) are included.

The CML method is similarly used to calculate potential impacts arising from acidification, eutrophication, ozone depletion and formation of photochemical oxidants.

Global warming factors are taken from the IPCC (2007) for the 100 year time-frame.

REFERENCES:

CML LCIA METHOD: Guinée, J.B., Gorée, M., Heijungs, R., Huppes, G., Kleijn, R., Koning, A. de, Oers, L. van, Wegener Sleeswijk, A., Suh, S., Udo de Haes, H.A., Bruijn, H. de, Duin, R. van, Huijbregts, M.A.J. (2002) Handbook on life cycle assessment. Operational guide to the ISO standards. I: LCA in perspective. IIa: Guide. IIb: Operational annex. III: Scientific background. Kluwer Academic Publishers, ISBN 1-4020-0228-9, Dordrecht, 2002.

GLOBAL WARMING FACTORS: IPCC (2007) Climate Change 2007. IPCC Fourth Assessment Report. The Physical Science Basis. <http://www.ipcc.ch/ipccreports/ar4-wg1.htm>

4 Annex I: Characterisation of data for calculating the life cycle inventory

4.1 Definition of LCA system

4.1.1 Stages included

Production

The production stage includes raw material supply and transport to the production site, manufacturing of products and all upstream processes (manufacturing of raw materials).

Transport from factory to building site inclusive

This includes the transport of the packaged Glass Wool mats in 30 ton trucks to the client and the further transport of the Glass Wool mat to the installation site in a “bakkie” (which has been modelled as a van of <3.5 tonne capacity).

Installation of the Glass Wool inclusive

No emissions or resource use are associated with the installation phase for this product, as the Glass Wool product requires no energy or material inputs in its installation. Furthermore, it is assumed that there is no wasted product from installation.

Use phase of the Glass Wool inclusive

The use phase only considers the insulation function of the Glass Wool, and it is assumed no maintenance or replacement of the Glass Wool is required over the 50 year service life. There are also assumed to be no energy or material inputs into removal of the product at end of life.

To take into account the insulation function of the Glass Wool mat, the use phase is modelled using system expansion. This is a life cycle modelling technique to account for the energy that would have been needed to heat or cool the building had no Glass Wool been installed. This is done by “expanding” the life cycle system boundary to also include the production of the energy for heating and cooling (in this case assumed to be average grid electricity). The emissions and resource use from producing an equivalent amount of electricity that would have been required for heating or cooling (i.e. that is “saved” through the use of the insulation) are then subtracted from the Glass Wool system’s resources and emissions. An

energy saving of 39 kWh electricity per month is applied in the EPD. This is the energy saving achieved by installing Glass Wool at a home located in Johannesburg South (i.e. through avoiding heating and cooling). This data was based on climatic data for Johannesburg, heating/cooling degree days quoted by the South African Weather Service and an assumed ideal indoor temperature range of 20 - 23°C.

End-of-life (transport to final disposal)

In accordance with the PCR, treatment of waste materials and wastewater is excluded from the system boundary, and only the quantity and type of waste recorded in the inventory. The end of life stage thus includes only emissions and resource use associated with transport to a waste disposal site. Infrastructure is also excluded from the system boundary.

4.1.2 Flows excluded

4.1.3 System boundaries

The system boundary is up to final disposal (Cradle-to-Grave) and thus includes production and transportation of raw materials, fuels and energy, manufacture of product onsite, transport of product, installation of product, use phase and transport to waste disposal. Excluded from the system boundaries are wastewater and waste material treatment processes.

Data sources

4.1.4 Characterisation of primary data

Fabrication

- Year : 2010
- Geographical coverage: South Africa (Saint-Gobain)
- Technology coverage: Saint-Gobain single site (Isover SA plant)
- Sources: Saint-Gobain (Isover plant data and relevant reports), suppliers.

Transport

- Year : 2010
- Geographical coverage: South Africa
- Technology coverage: Truck sizes, distances and truck emissions

- Source: Saint-Gobain (truck sizes) and reasonable estimates and ecoinvent database (distances and truck emissions)

Implementation

- Year: 2010
- Geographical coverage: South Africa
- Technology coverage: Saint-Gobain
- Source: Saint-Gobain

Utilization

- Year: Not applicable
- Geographical coverage: Johannesburg South, South Africa
- Technology coverage: assumed ideal indoor temperature range (20 - 23°C)
- Source: South African Weather Service (heating/cooling degree days)

End of life

- Year: Not applicable
- Geographical coverage: South Africa
- Technology coverage: transport distance of waste Glass Wool from site to landfill
- Source: Rough estimate

4.1.4 Characterisation of secondary data³

Fabrication

- Year : 2007
- Geographical coverage: South Africa / Europe / Other
- Technology coverage: South Africa / Europe / Other
- Sources: TGH, ecoinvent

Transport

- Year : 2007
- Geographical coverage: South Africa / Europe

³Secondary data sources are listed in full in Tables 1 - 3 in the accompanying report.

- Technology coverage: South Africa / Europe
- Sources: TGH, ecoinvent

Implementation

- Year: 2007
- Geographical coverage: South Africa / Europe
- Technology coverage: South Africa / Europe
- Source: TGH, ecoinvent

End of life (transport only)

- Year: 2007
- Geographical coverage: South Africa / Europe
- Technology coverage: South Africa / Europe
- Source: TGH, ecoinvent

End of life (transport only)

- Year: 2007
- Geographical coverage: South Africa / Europe
- Technology coverage: South Africa / Europe
- Source: TGH, ecoinvent