**Environmental** Product Declaration

# Westbond N9000 Carpet Tile

FORBO FLOORING SYSTEMS
TEXTILE FLOOR COVERING

FLOORING SYSTEMS

Westbond carpet tiles are synonymous with total flexibility and sophistication. Blending yarns to order and manufacturing premium quality fusion bonded tiles in an almost infinite number of colourways, with no minimum order quantity. Westbond allows customers to take control of the process of designing luxurious, bespoke carpet tiles with exceptionally heavy pile weights for the most prestigious installations.

Forbo was the first flooring manufacturer to publish a complete Life Cycle Assessment (LCA) report verified by CML in 2000. In addition, Forbo is now publishing Environmental Product Declarations (EPD) for all products including full LCA reports. This EPD uses recognized flooring Product Category Rules and includes additional information to show the impacts on human health and eco-toxicity. By offering the complete story, we hope that our stakeholders will be able to use this document as a tool that will translate the environmental performance of Westbond N9000 carpet tiles into true value and benefits for all our customers and stakeholders alike.

For more information visit:
www.forbo-flooring.com

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

FLOORING SYSTEMS

**Westbond N9000 Carpet Tile**
Textile Floor Covering

**According to ISO 14025 & EN 15804**

This declaration is an environmental product declaration in accordance with ISO 14025. This EPD does not guarantee that any performance benchmarks, including environmental performance benchmarks, are met. EPDs are intended to compliment Type I environmental performance labels. EPDs provide LCA-based information and additional information on the environmental aspects of products and assist purchasers and users to make informed comparisons between products. EPDs are not comparative assertions. EPDs encourage improvement of environmental performance and provide information for assessing the environmental impacts of products over their life cycle. EPDs not based on an LCA covering all life cycle stages, or based on a different PCR, are examples of declarations that have limited comparability. EPDs from different programs may not be comparable.

| | |
|---|---|
| PROGRAM OPERATOR | UL Environment<br>333 Pfingsten Road<br>Northbrook, IL 60611 |
| DECLARATION HOLDER | Forbo Flooring B.V.<br>Industrieweg 12<br>P.O. Box 13<br>NL-1560 AA Krommenie |
| DECLARATION NUMBER | 12CA64879.116.1 |
| DECLARED PRODUCT | Westbond N9000 |
| REFERENCE PCR | Flooring: Carpet, Resilient, Laminate, Ceramic, and Wood (NSF 2012) |

| | |
|---|---|
| DATE OF ISSUE | 23 July 2013 |
| PERIOD OF VALIDITY | 5 Years |

| | |
|---|---|
| CONTENTS OF THE DECLARATION | Product definition and information about building physics<br>Information about basic material and the material's origin<br>Description of the product's manufacture<br>Indication of product processing<br>Information about the in-use conditions<br>Life cycle assessment results<br>Testing results and verifications |

| | |
|---|---|
| The PCR review was conducted by: | NSF International |
| | Accepted by PCR Review Panel |
| | ncss@nsf.org |
| This declaration was independently verified in accordance with ISO 14025 and EN 15804 by Underwriters Laboratories<br>☐ INTERNAL ☒ EXTERNAL | Loretta Tam, ULE EPD Program Manager |
| This life cycle assessment was independently verified in accordance with ISO 14044, EN 15804 and the reference PCR by: | Trisha Montalbo, PE International |

FLOORING SYSTEMS

**Westbond N9000 Carpet Tile**
Textile Floor Covering

**According to ISO 14025 & EN 15804**

## Product Definition

### Product Classification and Description

This declaration covers Westbond N9000. Westbond N9000 is a fusion bonded textile floor covering complying with all the requirements of the EN1307 Class 33 Specification. Fusion bonding is a sophisticated method of carpet tile manufacture where individual yarn pile is bonded onto the backing material to make an extremely dense and luxurious product. Each tuft is individual and a high proportion of the yarn is in the wear surface providing a beautiful, rich, velour carpet tile which gives an excellent broadloom appearance.

All Westbond carpet tiles utilize a mixed vinyl waste backing which contains up to 74% pre-consumer recycled content, including PVC waste streams from our competitors, thereby decreasing the amount of waste going to landfill from the flooring industry as a whole. All Westbond N9000 is manufactured using renewable electricity.

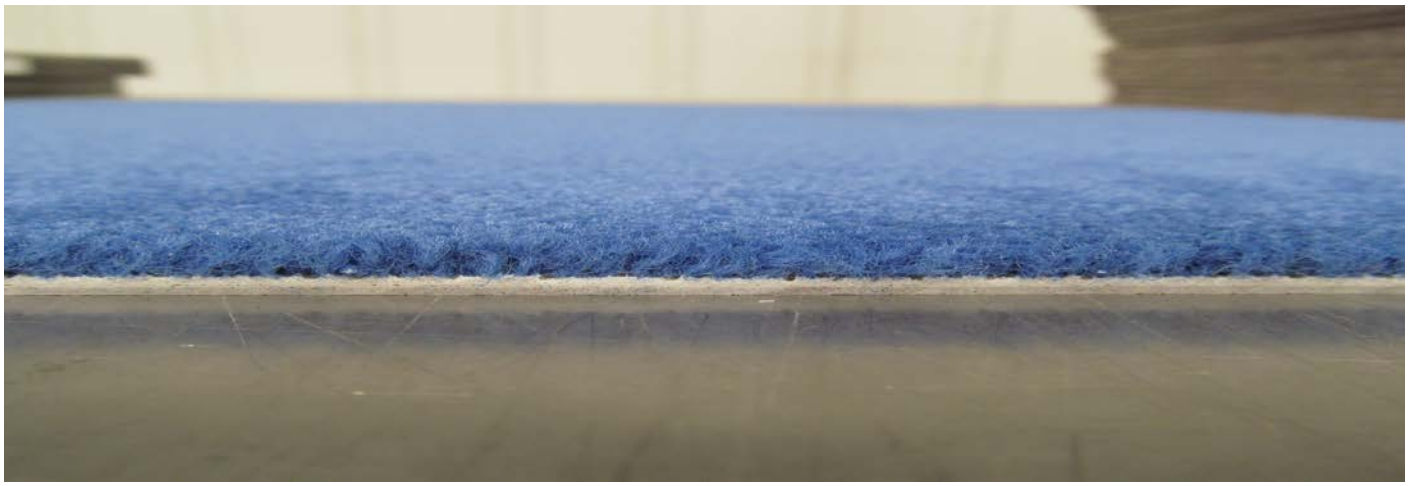


**Figure 1 : Illustration of Westbond N9000**

### Range of application

Westbond N9000 is classified in accordance with EN1307 to be installed in the following use areas defined in EN-ISO 10874:

forbo FLOORING SYSTEMS

**Westbond N9000 Carpet Tile**
Textile Floor Covering

According to ISO 14025 & EN 15804

## Product Standards

The products considered in this EPD have the following technical specifications:

- Meets or exceeds all technical requirements EN1307 Class 33

CE

Westbond N9000 meet the requirements of

| | | |
|---|---|---|
| EN 14041 | Essential characteristics | |
| EN 13501-1 | Reaction to fire | Bfl - s1 |
| EN 13893 | Slip resistance | DS: ≥ 0.30 |
| ISO 10965 | Static dissipative | <1 x $10^9$ Ω |
| EN1815 | Body voltage | < 2 kV |
| EN 985 | Castor chair test | >2.4 |

## Accreditations

- ISO 9001 Quality Management System
- ISO 14001 Environmental Management System

DS CERTIFIED

QUALITY SYSTEM AND ENVIRON-MENTAL MANAGEMENT SYSTEM

DS/EN ISO 9001
DS/EN ISO 14001

## Delivery Status

**Table 1: Specification of delivered product**

| Characteristics | Nominal Value | Unit |
|---|---|---|
| Product thickness | 9mm | mm |
| Product Weight | 4000 | g/$m^2$ |
| Tile size | 50 x 50 | cm |

# Material Content

## Material Content of the Product

**Table 2: Composition of Westbond N9000**

| Component | Material | Availability | Amount [%] | Origin |
|---|---|---|---|---|
| **Carpet Pile** | Nylon 6.6 | Non renewable | 23.75% | UK |
| **Substrate** | Glass Tissue | Non renewable | 1.50% | Finland |
| **Plasticizer** | DINP | Non renewable | 6.28% | Europe |
| **Backing** | Mixed vinyl waste | Recycled material | 42.50% | Europe |
| **Polymer** | PVC | Non renewable | 14.80% | Europe |
| **Fire retardant** | Aluminium hydroxide | Non renewable | 5.88% | Europe |
| **Filler** | Calcium carbonate | Abundant mineral | 3.72% | Europe |
| **Antistat** | Antistatic agent | Non renewable | 1.37% | Europe |
| **Additives** | Various chemicals | Non Renewable | 0.20% | Europe |

## Production of Main Materials

**Nylon 6.6 :** Synthethic yarn made from the condensation reaction of hexamethylene diamibe and adipic acid. Forms the pile surface of N9000 and gives excellent aestheics combined with durability

**Glass Tissue :** A non woven sheet material comprising chopped glass fiber filaments bound together with a binder imparts dimensional stability and lay flat properties.

**DINP:** Plasticiser manufactured by the reaction of phthalic anhydride and alcohol. Placticiser is added to increase flexibility, durability and longevity of the floor covering.

**Mixed vinyl waste:** Blend of waste carpet and vinyl floor coverings, which gives approximately 42.5% recycled content by weight in the finished tile product.

**PVC:** Polymer which is manuafctured by the polymerisation of vinyl chloride monomer.

**Aluminium hydroxide**: Fire retardent filler obtained by extracting alumina hydroxide from Bauxite which is naturally occuring in the Earth's surface. Imparts fire retardence of Westbond N9000

**Calcium carbonate:** An abundant mineral found in all parts of the world as the chief substance in rocks (i.e., marble and limestone). It can be ground to varying particle sizes and is widely used as filler.

**Antistatic agent:** A low volatility product combining antistatic performance with effective viscosity depressing action.

**Various chemicals**: Minor components including, viscosity depressents, antstatic agents, heat stabilisers

## Production of the Floor Covering

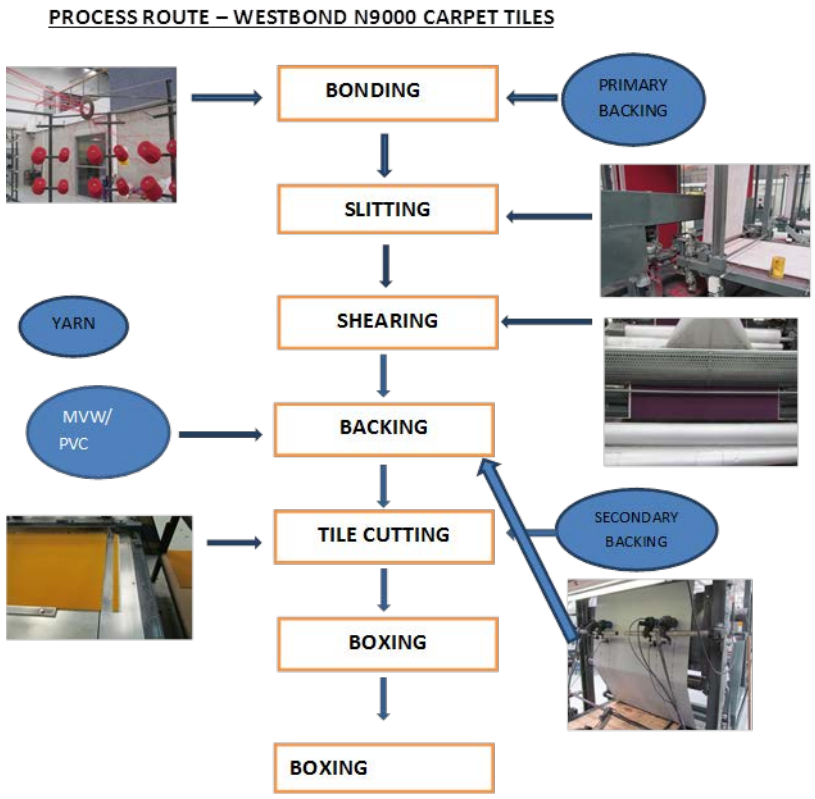



**Figure 2 : Production process of Westbond N9000**

Westbond N9000 is a cut pile product produced through our Fusion bonding process. The nylon yarn is cut into individual tufts, packed to stand vertically (this method ensures that a high proportion of the yarn is in the wear surface) before being joined with a primary backing and adhesive. This is then repeated prior to the roll being slit in the middle to form 2 rolls, tops and bottoms. The rolls are sheared to give a crisp surface appearance. Finally the recycled backing (mixed vinyl waste) is adhered on and the rolls are cut into tiles prior to boxing and dispatch.

### Health, Safety and Environmental Aspects during Production

- ISO 14001 Environmental Management System

### Production Waste

All product rejected at final inspection stage is either re-cycled through the manufacturing process or re-used externally. Incoming packaging materials are collected, separated and recycled.

## Delivery and Installation of the Floor Covering

### Delivery

A worldwide distribution by truck and container ship is utilized. On average every square meter of Westbond N9000 is transported as follows:

- Transport distance 40 t truck 290 km
- Transport distance 7.5 t truck 84 km
- Capacity utilization trucks (including empty runs) 85 %
- Transport distance Ocean ship 0km
- Capacity utilization Ocean ship 48%

Although a worldwide distribution is taken into account the average distance by Ocean ship is negligible.

### Installation

During the installation of Westbond N9000, an average of 4% of the material becomes installation waste. For the installation of Westbond N9000 tiles 0.25 kg/m$^2$ of adhesive is required. Waste during the installation process may be recycled as floor covering through the manufacturers' facilities or thermally recycled in a waste incineration plant. The majority of Westbond N9000 tile is sold in UK / Europe, the European electricity grid mix is used in the calculations for the energy recovery during incineration.

### Health, Safety and Environmental Aspects during Installation

Forbo flooring recommends the use of (low) zero emission adhesives for installing Westbond N9000.

### Waste

Waste during the installation process may be recycled as floor covering through the manufacturers' facilities or thermally recycled in a waste incineration plant. Since the major part of Westbond N9000 is sold in UK / Europe, the European electricity grid mix is used in the calculations for the energy recovery during incineration.

### Packaging

Cardboard tile boxes, wooden pallets and PE-film can be collected separately and should be used in a local recycling process. In the calculation model, 100% incineration is taken into account for which there is a credit received.

## Use Stage

The service lifetime of a floor covering for a certain application on a floor is too widespread to give one common number. For this EPD model the reference service lifetime (RSL) is set to one year. This means that all impacts for the use phase are based on the cleaning and maintenance model for one year. Depending on the area of use, the technical lifetime advised by the manufacturer and the estimated time on the floor by the customer, the service lifetime can be determined. The use phase impacts should be calculated with the foreseen service life to arrive at the total environmental impact.

## Cleaning and Maintenance

| Level of use | Cleaning Process | Cleaning Frequency | Consumption of energy and resources |
|---|---|---|---|
| Commercial/Residential/Industrial | Vacuuming | Daily | Electricity |
| | Spot/spill clean | As spill occcurs | Spotting agent |
| | Dry fusion clean<br>Hot water extraction | Four times each year | Hot water<br>Neutral detergent |

For the calculations the following cleaning regime is considered:

- Dry cleaning with a 1.5 kW vacuum cleaner for 0.21 min/$m^2$ every day. This equates to 1.92 kWh/$m^2$*year.
- Four times a year wet cleaning with 0.062 l/$m^2$ water and 0.0008 kg/$m^2$ detergent. This result in the use of 0.248 l/$m^2$*year water and 0.0032 kg/$m^2$*year detergent. The wet cleaning takes place without power machine usage. The waste water treatment of the arising waste water from cleaning is considered (Data source from Forbo GaBi model).

The cleaning regime that is recommended in practice will be highly dependent on the use of the premises where the floor covering is installed. In high traffic areas more frequent cleaning will be needed compared to areas where there is low traffic. The use of an entrance mat of at least four steps will reduce the cleaning frequency.

The cleaning regime used in the calculations is suitable for high traffic areas.

## Prevention of Structural Damage

All newly laid floor covering should be covered and protected with a suitable non-staining protective covering if other building activities are still in progress.

## Health Aspects during Usage

Westbond N9000 complies with:

- AgBB requirements

# End of Life

The deconstruction of installed Westbond N9000 from the floor is a manual process. For the end of life stage, 100% incineration is taken into account, since the vast majority of the countries in which Westbond N9000 are sold have a non landfill policy. The average distance to an incineration facility in the calculations is 200 km by truck.

## Life Cycle Assessment

A full Life Cycle Assessment has bee carried out according to ISO 14040 and ISO 14044.

The following Life Cycle Stages are assessed :

- Production Stage (Raw material acquisition, transportation to Manufacturing and Manufacturing)
- Transport Gate to User
- Installation Stage
- Use Stage
- End of Life Stage

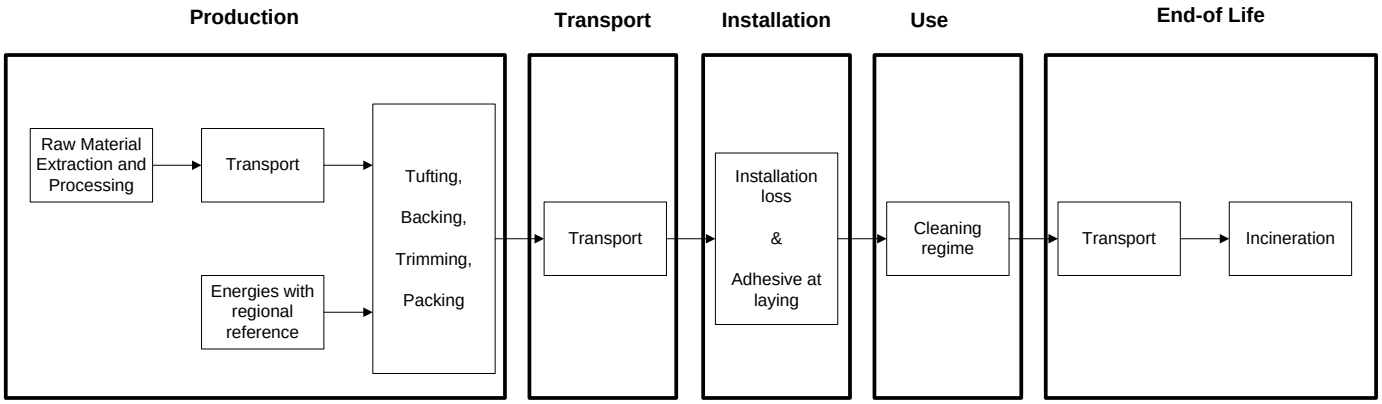



**Figure 3: Flow chart of the Life Cycle Assessment**

### Description of the Declared Functional Unit

The functional unit is one square meter of installed product and the use stage is considered for one year of service life.

### Cut off Criteria

The cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass of the unit process. The total neglected input flows per module shall be a maximum of 5% of energy usage and mass.

In practice, in this assessment, all data from the production data acquisition are considered, i.e. all raw materials used as per formulation, use of water, electricity and other fuels, the required packaging materials, and all direct production waste. Transport data on all considered inputs and output material are also considered.

### Allocations

In the present study some allocations have been made. Detailed explanations can be found in the chapters below.

### Co-product allocation

No co-product allocation occurs in the product system.

### Allocation of multi-input processes

The Production and End of Life stage include incineration plants. In these processes different products are treated together within a process. The allocation procedures followed in these cases are based on a physical classification of the mass flows or calorific values.

Credits from energy substitution are allocated to the production stage, because the gained energy from energy substitution is lower than the energy input in this stage. The same quality of energy is considered.

## Allocation procedure of reuse, recycling and recovery

The installation waste and end of life waste is fed into incineration processes. Incineration processes include cogeneration processes which give thermal and power energy as outputs. It is assumed that this recovered energy offsets that produced by the European average grid mix and thermal energy generation from natural gas.

## Description of the allocation processes in the LCA report

The description of allocation rules in of this LCA report meets the requirements of the PCR.

## LCA Data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes have been used as the first choice as a basis for calculating an EPD.

For life cycle modeling of the considered products, the GaBi 6 Software System for Life Cycle Engineering, developed by PE INTERNATIONAL AG has been used. All relevant LCA datasets are taken from the GaBi 6 software database. The datasets from the database GaBi are documented in the online documentation. To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

## Data Quality

The requirements for data quality and LCA data correspond to the specifications of the PCR.

Foreground data are based on 1 year averaged data (year 2012). The reference ages of LCA datasets vary but are given in the table in the Appendix. The time period over which inputs to and outputs from the system is accounted for is 100 years from the year for which the data set is deemed representative. The technological LCA of the collected data reflects the physical reality of the declared product. The datasets are complete, conform to the system boundaries and the criteria for the exclusion of inputs and outputs and are geographical representative for the supply chain of Forbo flooring.

For life cycle modeling of the considered products the GaBi 6 Software System for Life Cycle Engineering, developed by PE INTERNATIONAL AG, is used. All relevant LCA datasets are taken from the GaBi 6 software database. The last revision of the used data sets took place within the last 10 years.

## System Boundaries

Production Stage includes provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues during the product stage.

Transport and Installation Stage includes provision of all materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during the construction stage. These information modules also include all impacts and aspects related to any losses during this construction stage (i.e. production, transport, and waste processing and disposal of the lost products and materials). For the transportation a worldwide distribution is considered.

Use Stage includes provision and transport of all materials, products and related energy and water use, as well as waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage. These information modules also include all impacts and aspects related to the losses during this part of the use stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

End of Life Stage includes provision and all transports, provision of all materials, products and related energy and water use. It also includes any declared benefits and loads from net flows leaving the product system that have not been allocated as co-products and that have passed the end-of-waste state in the form of reuse, recovery and/or recycling potentials.

### Power mix

The selection of LCA data for the electricity generation is in line with the PCR.

The products are manufactured in Cortonwood, the United Kingdom. The GaBi 6 Hydropower, Wind power and Biomass datasets have therefore been used (reference year 2009). The energy supplier is providing Forbo with a certificate every year.

### $CO_2$-Certificates

No $CO_2$-certificates are considered in this study.

## Life Cycle Inventory Analysis

The total primary energy for one square meter installed Westbond N9000 is presented in table 3 with their specific energy resources.

**Table 3: Primary energy for all life cycle stages for Westbond N9000 for one year**

| Non-renewable primary energy by resources | Unit | Total Life cycle (MJ) | Total Life cycle (%) | Production | Transport | Installation | Use (1 yr) | End of Life |
|---|---|---|---|---|---|---|---|---|
| Total non-renewable primary energy | MJ | 450.48 | 100% | 448.71 | 0.74 | 7.17 | 5.84 | -11.99 |
| Crude oil | MJ | 179.37 | 39.8% | 169.77 | 0.68 | 2.94 | 0.63 | 5.34 |
| Hard coal | MJ | 20.79 | 4.6% | 17.86 | 0 | 0.23 | 0.98 | 1.72 |
| Lignite | MJ | 19.99 | 4.4% | 18.07 | 0 | 0.22 | 0.74 | 0.95 |
| Natural gas | MJ | 202.63 | 45.0% | 217.46 | 0.06 | 3.62 | 1.74 | -20.24 |
| Uranium | MJ | 27.7 | 6.1% | 25.55 | 0 | 0.16 | 1.74 | 0.25 |
| **Renewable primary energy by resources** | **Unit** | **Total Life cycle (MJ)** | **Total Life cycle (%)** | **Production** | **Transport** | **Installation** | **Use (1 yr)** | **End of Life** |
| Total renewable primary energy | MJ | 8.12 | 100% | 7.7 | 0.03 | 0.1 | 0.79 | -0.5 |
| Geothermical | MJ | 0.22 | 2.7% | 0.23 | 0 | 0 | 0.01 | -0.01 |
| Hydro power | MJ | 2.75 | 33.9% | 2.63 | 0 | 0 | 0.32 | -0.2 |
| Solar energy | MJ | 2.51 | 30.9% | 2.37 | 0.03 | 0.06 | 0.23 | -0.17 |
| Wind power | MJ | 2.64 | 32.5% | 2.48 | 0 | 0.04 | 0.23 | -0.11 |

The renewable and non-renewable primary energy is mainly determined by the production stage for a one year usage; within the production stage the main contributors are the raw material production and energy generation.

### Waste and non-renewable resource consumption

In table 4 the non-renewable resource consumption and waste production are shown for all life cycle stages for a one year usage.

*Table 4: Waste categories and non-renewable resources for Westbond N9000 (one year)*

| Wastes | Unit | Total Life cycle | Production | Transport | Installation | Use (1yr) | End of Life |
|---|---|---|---|---|---|---|---|
| Hazardous waste | [kg] | 2.30E-03 | 1.29E-03 | 0.00E+00 | 1.01E-03 | 0.00E+00 | 0.00E+00 |
| Non-hazardous waste | [kg] | 2.90E+01 | 2.55E+01 | 2.63E-03 | 4.57E-01 | 1.12E+00 | 1.97E+00 |
| Radioactive waste | [kg] | 1.02E-02 | 9.40E-03 | 1.03E-06 | 1.29E-04 | 7.12E-04 | -7.09E-05 |
| **Resources** | **Unit** | **Total Life cycle** | **Production** | **Transport** | **Installation** | **Use (1yr)** | **End of Life** |
| Nonrenewable resources | [kg] | 33.08 | 27.19 | 0 | 0.5 | 1.13 | 4.26 |

## Life Cycle Assessment

In table 5 the environmental impacts for one lifecycle are presented for Westbond N9000. In table 6 the environmental impacts are presented for all the lifecycle stages.

**Table 5: Results of the LCA – Environmental impacts one lifecycle (one year) – Westbond N9000**

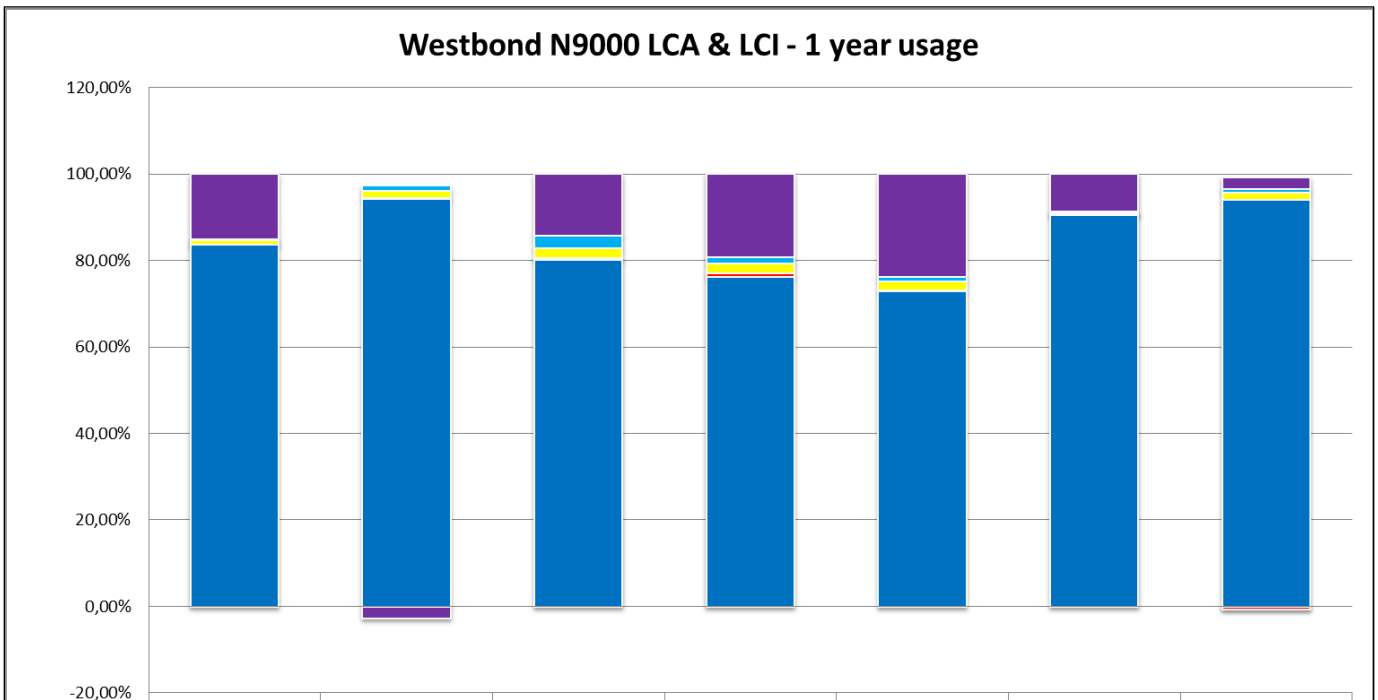
| Impact Category : CML 2001 – Nov. 2010 | Westbond N9000 | Unit |
|---|---|---|
| Global Warming Potential (GWP 100 years) | 3.43E+01 | kg CO2-Equiv. |
| Ozone Layer Depletion Potential (ODP. steady state) | 6.55E-07 | kg R11-Equiv. |
| Acidification Potential (AP) | 4.76E-02 | kg SO2-Equiv. |
| Eutrophication Potential (EP) | 6.07E-03 | kg Phosphate-Equiv. |
| Photochem. Ozone Creation Potential (POCP) | 1.14E-02 | kg Ethene-Equiv. |
| Abiotic Depletion Potential Elements (ADPE) | 2.16E-05 | kg Sb-Equiv. |
| Abiotic Depletion Potential Fossil (ADPF) | 4.37E+02 | [MJ] |

**Table 6: Results of the LCA – Environmental impact for Westbond N9000 (one year)**

| Impact Category : CML 2001 – Nov. 2010 | Unit | Production | Transport | Installation | Use (1yr) | End of Life |
|---|---|---|---|---|---|---|
| Global Warming Potential | kg CO2-Equiv. | 2.50E+01 | 1.02E-01 | 7.03E-01 | 3.22E-01 | 8.15E+00 |
| Ozone Layer Depletion Potential | kg R11-Equiv. | 5.94E-07 | 9.31E-13 | 2.67E-09 | 2.30E-09 | 5.66E-08 |
| Acidification Potential | kg SO2-Equiv. | 3.81E-02 | 2.22E-04 | 1.13E-03 | 1.35E-03 | 6.76E-03 |
| Eutrophication Potential | kg PSO4-Equiv. | 4.63E-03 | 5.07E-05 | 1.44E-04 | 8.29E-05 | 1.17E-03 |
| Photochem. Ozone Creation Potential | kg Ethene-Equiv. | 1.09E-02 | -7.67E-05 | 1.84E-04 | 9.17E-05 | 3.24E-04 |
| Abiotic Depletion Elements | kg Sb-Equiv. | 1.81E-05 | 1.99E-09 | 2.42E-07 | 6.36E-08 | 3.23E-06 |
| Abiotic Depletion Fossil | MJ | 4.35E+02 | 7.38E-01 | 7.16E+00 | 5.78E+00 | -1.23E+01 |

The relative contribution of each process stage to each impact category for Westbond N9000 is shown in the figure 4.

**Figure 4: Relative contribution of each process stage to each impact category for Westbond N9000 for a one year usage.**




| | Abiotic Depletion (Elements) | Abiotic Depletion (Fossil) | Acidification Potential | Eutrophication Potential | Global Warming Potential | Ozone Layer Depletion Potential | Photochem. Ozone Creation Potential |
|---|---|---|---|---|---|---|---|
| End of Life | 14,95% | -2,68% | 14,21% | 19,22% | 23,79% | 8,63% | 2,79% |
| Use | 0,29% | 1,25% | 2,83% | 1,36% | 0,94% | 0,35% | 0,79% |
| Installation | 1,12% | 1,55% | 2,37% | 2,38% | 2,05% | 0,41% | 1,59% |
| Transport | 0,01% | 0,16% | 0,47% | 0,84% | 0,30% | 0,00% | -0,66% |
| Production | 83,63% | 94,36% | 80,12% | 76,20% | 72,92% | 90,61% | 94,16% |

## Interpretation

The interpretation of the results has been carried out considering the assumptions and limitations declared in the EPD, both methodology- and data-related for a one year usage.

In all of the impact categories the production stage has the main contribution to the overall impact with the raw material supply as the key contributor with a share of 95 – 99%, except for POCP where the raw materials account for 57% of the total. In all cases this contribution is caused by the manufacturing of Polyamide 6, PVC and to a lesser extent DINP. For POCP the share of the Forbo manufacturing stage is 43%, caused by the use of energy during the manufacturing of Westbond N9000.

The transport, installation and use phase are contribute little to the overall impact, for all categories every single measurement is to a greater or lesser extent below 3%.

Except for ADPF every category has got a significant share in the impacts at the End of Life stage. This is caused by the incineration of 100% of the deconstructed floor that is considered in the calculations. For ADPF there is a credit for the waste to energy conversion.

## Additional Environmental Information

To be fully transparant Forbo Flooring does not only want to declare the environmental impacts required in the PCR, but also the impacts on human health and eco-toxicity. Furthermore the outcome of the calculations according to the european Standard EN15804 are published in this section.

### Toxicity

For this calculations the USEtoxTM model is used as being the globally recommended preferred model for characterization modelling of human and eco-toxic impacts in LCIA by the United Nations Environment Programme SETAC Life Cycle Initiative.

According to the "ILCD Handbook: Recommendations for Life Cycle Impact Assessment in the European context" the recommended characterization models and associated characterization factors are classified according to their quality into three levels:

- Level I (recommended and satisfactory),
- Level II (recommended but in need of some improvements)
- Level III (recommended, but to be applied with caution).

A mixed classification sometimes is related to the application of the classified method to different types of substances. USEtoxTM is classified as Level II / III, unlike for example the CML impact categories which are classified as Level I.

**Table 7: Results of the LCA – Environmental impacts one lifecycle (one year) – Westbond N9000**

| Impact Category : USEtox | Westbond N9000 | Unit |
|---|---|---|
| Eco toxicity | 6.01E-01 | PAF m3.day |
| Human toxicity, cancer | 9.01E-09 | Cases |
| Human toxicity, non-canc. | 4.92E-07 | Cases |

In the following table the impacts are subdivided into the lifecycle stages.

**Table 8: Results of the LCA – Environmental impact for Westbond N9000 (one year)**

| Impact Category : USEtox | Unit | Production | Transport | Installation | Use (1yr) | End of Life |
|---|---|---|---|---|---|---|
| Eco toxicity | PAF m3.day | 5.18E-01 | 6.66E-03 | 1.09E-02 | 2.78E-02 | 3.76E-02 |
| Human toxicity, cancer | cases | 7.97E-09 | 2.78E-11 | 1.75E-10 | 2.66E-10 | 5.72E-10 |
| Human toxicity, non-canc. | cases | 3.24E-07 | 1.30E-08 | 1.75E-08 | 5.50E-08 | 8.22E-08 |

### Interpretation

The interpretation of the results has been carried out considering the assumptions and limitations declared in the EPD, both methodology- and data-related for a one year usage.

All the Toxicity categories are dominated by the production stage in which the raw materials are having a big impact with a share of around 93-99%. The raw materials with the highest impact are Polyamide 6 and PVC.

The transport and installation stage are both having a minor impact on the total impact compared to the other life cycle stages. For the transport life cycle the contribution comes completely from the Diesel that is used for the trucks. In the installation stage the adhesive is the main contributor.

The use stage is contributing 3 – 11% of the total, mainly caused by the use of electricity needed for vacuuming the floor. The cleaning regime considered in the calculation is an assumption, in practice this will be dependent on the use of the premises where the floor covering is installed.

At the End of Life stage the main contributor is the 100% of the floor that is incinerated after it is deconstructed. The

possibility to recycle the post-consumer waste is not taken into account for these calculations, because this is not yet widely practiced.

## EN15804 Results

In this section the calculations have been conducted and verified according to the requirements of the European Standard EN 15804. In addition, calculations followed the document "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report", however, Part A was not included as a part of the verification.

**Table 9: Results of the LCA – Environmental impact for Westbond N9000 (one year)**

| | | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **A1-3** | **A4** | **A5** | **B2** | **C1** | **C2** | **C3** | **D** |
| GWP | [kg $CO_2$-Equiv.] | 2.50E+01 | 1.02E-01 | 8.07E-01 | 3.22E-01 | 0.00E+00 | 1.09E-01 | 9.77E+00 | -1.83E+00 |
| ODP | [kg CFC11-Equiv.] | 5.94E-07 | 9.31E-13 | 2.69E-09 | 2.30E-09 | 0.00E+00 | 1.90E-12 | 5.68E-08 | -2.78E-10 |
| AP | [kg $SO_2$-Equiv.] | 3.81E-02 | 2.22E-04 | 1.31E-03 | 1.35E-03 | 0.00E+00 | 5.46E-04 | 8.58E-03 | -2.54E-03 |
| EP | [kg $PO_4^{3-}$- Equiv.] | 4.63E-03 | 5.07E-05 | 1.59E-04 | 8.29E-05 | 0.00E+00 | 1.26E-04 | 1.26E-03 | -2.30E-04 |
| POCP | [kg Ethen Equiv.] | 1.09E-02 | -7.67E-05 | 2.02E-04 | 9.17E-05 | 0.00E+00 | 6.08E-05 | 5.45E-04 | -3.00E-04 |
| ADPE | [kg Sb Equiv.] | 1.81E-05 | 1.99E-09 | 2.48E-07 | 6.36E-08 | 0.00E+00 | 4.05E-09 | 3.32E-06 | -9.70E-08 |
| ADPF | [MJ] | 4.35E+02 | 7.38E-01 | 8.89E+00 | 5.78E+00 | 0.00E+00 | 1.51E+00 | 1.47E+01 | -3.03E+01 |

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non fossil resources; ADPF = Abiotic depletion potential for fossil resources

**Table 10: Results of the LCA – Resource use for Westbond N9000 (one year)**

| | | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **A1-3** | **A4** | **A5** | **B2** | **C1** | **C2** | **C3** | **D** |
| PERE | [MJ] | - | - | - | - | - | - | - | - |
| PERM | [MJ] | - | - | - | - | - | - | - | - |
| PERT | [MJ] | 8.46E+00 | 6.88E-02 | 1.67E-01 | 7.88E-01 | 4.24E-02 | 6.87E-02 | 2.44E-01 | -8.31E-01 |
| PENRE | [MJ] | - | - | - | - | - | - | - | - |
| PENRM | [MJ] | - | - | - | - | - | - | - | - |
| PENRT | [MJ] | 4.71E+02 | 1.75E+00 | 8.42E+00 | 5.84E+00 | 2.55E-01 | 1.75E+00 | 1.40E+01 | -2.73E+01 |
| SM | [kg] | 0.00E+00 | - | - | - | - | - | - | - |
| RSF | [MJ] | 1.61E-03 | 1.11E-05 | 2.22E-04 | 9.54E-05 | 5.20E-06 | 1.11E-05 | 0.00E+00 | -3.04E-04 |
| NRSF | [MJ] | 1.68E-02 | 1.16E-04 | 1.48E-03 | 9.99E-04 | 5.45E-05 | 1.16E-04 | 0.00E+00 | -3.19E-03 |
| FW | [kg] | 6.98E+01 | 7.63E-02 | 1.47E+00 | 5.28E+00 | 1.14E-01 | 7.62E-02 | -1.64E+00 | -2.58E+00 |

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials; PENRM = Use of non renewable primary energy resources used as raw materials; PENRT = Total use of non renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non renewable secondary fuels; FW = Use of net fresh water

**Table 11: Results of the LCA – Output flows and Waste categories for Westbond N9000 (one year)**

| | | Manufacturing | Transport | Installation | Use (1yr) | End of Life/credits | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **A1-3** | **A4** | **A5** | **B2** | **C1** | **C2** | **C3** | **D** |
| HWD | [kg] | 1.29E-03 | 0.00E+00 | 1.01E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NHWD | [kg] | 2.55E+01 | 2.63E-03 | 4.57E-01 | 1.12E+00 | 0.00E+00 | 5.36E-03 | 3.18E+00 | -1.22E+00 |
| RWD | [kg] | 9.40E-03 | 1.03E-06 | 1.29E-04 | 7.12E-04 | 0.00E+00 | 2.09E-06 | 7.12E-04 | -7.85E-04 |
| CRU | [kg] | - | - | - | - | - | - | - | - |
| MFR | [kg] | - | - | - | - | - | - | - | - |
| MER | [kg] | - | - | - | - | - | - | 4.09E+00 | - |
| EE Power | [MJ] | - | - | 1.16E-01 | - | - | - | 2.78E+00 | - |
| EE Thermal energy | [MJ] | - | - | 1.43E+00 | - | - | - | 3.42E+01 | - |

HWD = Hazardous waste disposed; NHWD = Non hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Exported energy per energy carrier

## Interpretation

The interpretation of the environmental impacts calculated according to EN 15804 are similar to the interpretation according to ISO 14025. A more detailed interpretation is published in the appendix.

## References


| | |
|---|---|
| GABI 6 2012 | PE INTERNATIONAL AG; GaBi 6: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2012. |
| GABI 6 2012D | GaBi 6: Documentation of GaBi 6: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2012. http://documentation.gabi-software.com/ |
| NSF International<br>May 22, 2012 | Product Category Rule for Environmental Product Declarations<br>*Flooring: Carpet, Resilient, Laminate, Ceramic, Wood* |
| UL ENVIRONMENT | UL Environment's Program Operator Rules |
| ERFMI 2008 | Final report: LCA, Environmental Information Sheet and Eco design Model of Resilient Flooring by order of ERFMI, PE International, 2008 |
| IBU 2011 | PCR - Part A: Calculation rules for the Life Cycle Assessment and Requirements on the Background Report, Institut Bauen und Umwelt e.V. |
| PE 2012 | Description of Selected Impact Categories, PE International AG, 2012 |
| ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance | European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010 |
| **STANDARDS AND LAWS** | |
| DIN EN ISO 14044 | Environmental management - Life cycle assessment - Requirements and guidelines (ISO 14044:2006); German and English version EN ISO 14044 |
| ISO 14025 2006 | DIN EN ISO 14025: Environmental labels and declarations — Type III environmental declarations — Principles and procedures |
| ISO 14040 2006 | Environmental management - Life cycle assessment - Principles and framework (ISO 14040); German and English version EN ISO 14040 |
| CEN/TR 15941 | Sustainability of construction works - Environmental product declarations - Methodology for selection and use of generic data; German version CEN/TR 15941 |
| EN 15804 | EN 15804: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products |
| ISO 24011 | Resilient floor coverings - Specification for plain and decorative linoleum |
| CPR | REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2011 laying down harmonized conditions for the marketing of construction products and repealing Council Directive 89/106/EEC |
| EN-ISO 10874 | Resilient, textile and laminate floor coverings - Classification |

## Appendix

The following life cycle assessment study of the company Forbo Flooring, a manufacturer of resilient floor coverings, has been performed by Forbo Flooring under support of PE International and has been conducted according to the requirements of the European Standard /EN 15804/ following the document “Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report” /IBU 2011/.

# LCA Report for Environmental Product Declarations (EPD)

## Westbond N9000 Carpet Tile

PE INTERNATIONAL
EXPERTS IN SUSTAINABILITY

FLOORING SYSTEMS

## Forbo Flooring

Title of the study:

Environmental product declarations of Westbond N9000 Carpet Tile

Part of the project: Life Cycle assessment (LCA)

LCA study conducted by:

Forbo Flooring

Industrieweg 12

1566 JP Assendelft

The Netherlands

July 2013

Supported by:

PE INTERNATIONAL AG

Environment

FLOORING SYSTEMS

**Westbond N9000 Carpet Tile**
Textile Floor Covering

According to ISO 14025 & EN 15804

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## Nomenclature

| Abbreviation | Explanation |
|---|---|
| ADP | Abiotic Depletion Potential |
| AP | Acidification Potential |
| BLBSB | Benefits and Loads Beyond the System Boundary |
| CRU | Components for re-use |
| EE | Exported energy per energy carrier |
| EP | Eutrophication Potential |
| EPD | Environmental Product Declaration |
| FW | Use of net fresh water |
| GWP | Global Warming Potential |
| HWD | Hazardous waste disposed |
| LCA | Life Cycle Assessment |
| MER | Materials for energy recovery |
| MFR | Materials for recycling |
| NRSF | Use of non-renewable secondary fuels |
| ODP | Ozone Layer Depletion Potential |
| PENRE | Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials |
| PENRM | Use of non-renewable primary energy resources used as raw materials |
| PENRT | Total use of non-renewable primary energy resources |
| PERE | Use of renewable primary energy excluding renewable primary energy resources used as raw materials |
| PERM | Use of renewable primary energy resources used as raw materials |
| PERT | Total use of renewable primary energy resources |
| PCR | Product Category Rules |
| POCP | Photochemical Ozone Creation Potential |
| RSF | Use of renewable secondary fuels |
| RSL | Reference Service Life |
| RWD | Radioactive waste disposed |
| SM | Use of secondary material |

## General

The present LCA study of the company Forbo Flooring, a manufacturer of resilient floor coverings, has been performed by Forbo Flooring under support of PE International and has been conducted according to the requirements of the European Standard EN15804 following the document “Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report”. The LCA report was sent to verification on 07/22/13.

### Scope

This document is the LCA report for the “Environmental Product Declaration” (EPD) of "Westbond N9000 Carpet Tile".

The provision of an LCA report is required for each EPD of the EPD-program holder (UL Environment). This document shows how the calculation rules were applied and describes additional LCA information on the Life Cycle Assessment in accordance with the requirements of ISO 14040 series.

### Content, Structure and Accessibility of the LCA report

The LCA report provides a systematic and comprehensive summary of the project documentation supporting the verification of an EPD.

The report documents the information on which the Life Cycle Assessment is based, while also ensuring the additional information contained within the EPD complies with the requirements of ISO 14040 series.

The LCA report contains all of the data and information of importance for the details published in the EPD. Care is been given to all explanations as to how the data and information declared in the EPD arises from the Life Cycle Assessment.

The verification of the EPD is aligned towards the structure of the rule document based on ISO 14025 and EN15804.

### Goal of the Study

The reason for performing this LCA study is to publish an EPD based on EN 15804 and ISO 14025.

This study contains the calculation and interpretation of the LCA results for Westbond N9000 Carpet Tile complying with EN 1307.

Manufactured by:

Forbo Flooring UK Ltd.
Cortonwood Drive
Cortonwood Business Park
Brampton, Barnsley
S73 0UF
Uinted Kingdom

The following life cycle stages were considered:

- Product stage
- Transport stage
- Installation stage
- Use stage
- End-of-life stage
- Benefits and loads beyond the product system boundary

The main purpose of EPD is for use in business-to-business communication. As all EPD are publicly available on the website of UL Environment and therefore are accessible to the end consumer they can also be used in business-to-consumer communication.

The intended use of the EPD is to communicate environmentally related information and LCA results to support the assessment of the sustainable use of resources and of the impact of construction works on the environment.

FLOORING SYSTEMS

**Westbond N9000 Carpet Tile**
Textile Floor Covering

According to ISO 14025 & EN 15804

## Scope of the study

### Declared / Functional Unit

The declaration refers to the declared/functional unit of 1m² installed flooring product.

### Declaration of Construction Products Classes

The LCA report refers to a manufacturer declaration of type 1a): Declaration of a specific product from a manufacturer's plant. Westbond N9000 Carpet Tile is produced at the following manufacturing site:

Forbo Flooring UK Ltd.
Cortonwood Drive
Cortonwood Business Park
Brampton, Barnsley
S73 0UF
Uinted Kingdom

## Product Definition

### Product Classification and Description

This declaration covers Westbond N9000. Westbond N9000 is a fusion bonded textile floor covering complying with all the requirements of the EN1307 Class 33 Specification. Fusion bonding is a sophisticated method of carpet tile manufacture where individual yarn pile is bonded onto the backing material to make an extremely dense and luxurious product. Each tuft is individual and a high proportion of the yarn is in the wear surface providing a beautiful, rich, velour carpet tile which gives an excellent broadloom appearance.

All Westbond carpet tiles utilize a mixed vinyl waste backing which contains up to 74% pre-consumer recycled content, including PVC waste streams from our competitors, thereby decreasing the amount of waste going to landfill from the flooring industry as a whole. All Westbond N9000 is manufactured using renewable electricity.

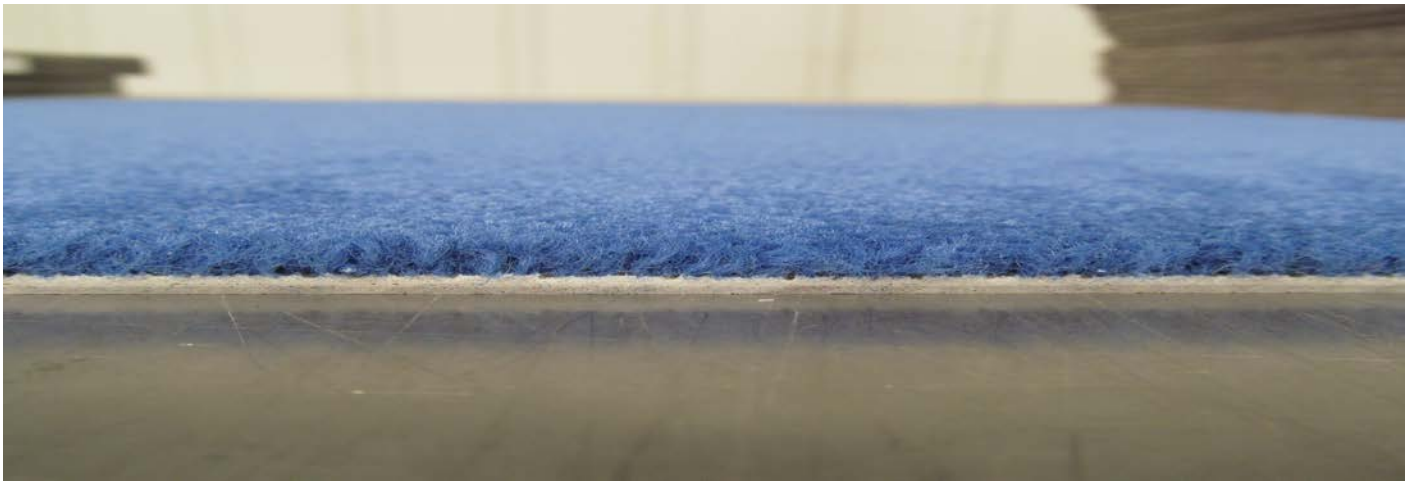


**Figure 1 : Illustration of Westbond N9000**

forbo FLOORING SYSTEMS

**Westbond N9000 Carpet Tile**
Textile Floor Covering

According to ISO 14025 & EN 15804

## Range of Applications

Westbond N9000 is classified in accordance with EN1307 to be installed in the following use areas defined in EN-ISO 10874:


## Product Standards

The products considered in this EPD have the following technical specifications:

- Meets or exceeds all technical requirements EN1307 Class 33

CE

Westbond N9000 meet the requirements of

| | | |
|---|---|---|
| EN 14041 | Essential characteristics | |
| EN 13501-1 | Reaction to fire | Bfl - s1 |
| EN 13893 | Slip resistance | DS: ≥ 0.30 |
| ISO 10965 | Static dissipative | $<1 \times 10^9\ \Omega$ |
| EN1815 | Body voltage | < 2 kV |
| EN 985 | Castor chair test | >2.4 |

## Accreditations

- ISO 9001 Quality Management System
- ISO 14001 Environmental Management System

## Delivery Status

| Characteristics | Nominal Value | Unit |
|---|---|---|
| Product thickness | 9mm | mm |
| Product Weight | 4000 | $g/m^2$ |
| Tile size | 50 x 50 | cm |

## Material Content

| Component | Material | Availability | Mass % | Origin of raw material |
|---|---|---|---|---|
| **Carpet Pile** | Nylon 6.6 | Non renewable | 23.75% | UK |
| **Substrate** | Glass Tissue | Non renewable | 1.50% | Finland |
| **Plasticizer** | DINP | Non renewable | 6.28% | Europe |
| **Backing** | Mixed vinyl waste | Recycled material | 42.50% | Europe |
| **Polymer** | PVC | Non renewable | 14.80% | Europe |
| **Fire retardant** | Aluminium hydroxide | Non renewable | 5.88% | Europe |
| **Filler** | Calcium carbonate | Abundant mineral | 3.72% | Europe |
| **Antistat** | Antistatic agent | Non renewable | 1.37% | Europe |
| **Additives** | Various chemicals | Non Renewable | 0.20% | Europe |

## Production of Main Materials

**Nylon 6.6 :** Synthethic yarn made from the condensation reaction of hexamethylene diamibe and adipic acid. Forms the pile surface of N9000 and gives excellent aestheics combined with durability

**Glass Tissue** : A non woven sheet material comprising chopped glass fiber filaments bound together with a binder imparts dimensional stability and lay flat properties.

**DINP**: Plasticiser manufactured by the reaction of phthalic anhydride and alcohol. Placticiser is added to increase flexibility, durability and longevity of the floor covering.

**Mixed vinyl waste:** Blend of waste carpet and vinyl floor coverings, which gives approximately 42.5% recycled content by weight in the finished tile product.

**PVC:** Polymer which is manuafctured by the polymerisation of vinyl chloride monomer.

**Aluminium hydroxide:** Fire retardent filler obtained by extracting alumina hydroxide from Bauxite which is naturally occuring in the Earth's surface. Imparts fire retardence of Westbond N9000

**Calcium carbonate:** An abundant mineral found in all parts of the world as the chief substance in rocks (i.e., marble and limestone). It can be ground to varying particle sizes and is widely used as filler.

**Antistatic agent:** A low volatility product combining antistatic performance with effective viscosity depressing action.

**Various chemicals:** Minor components including, viscosity depressents, antstatic agents, heat stabilisers

## Production of the Floor Covering

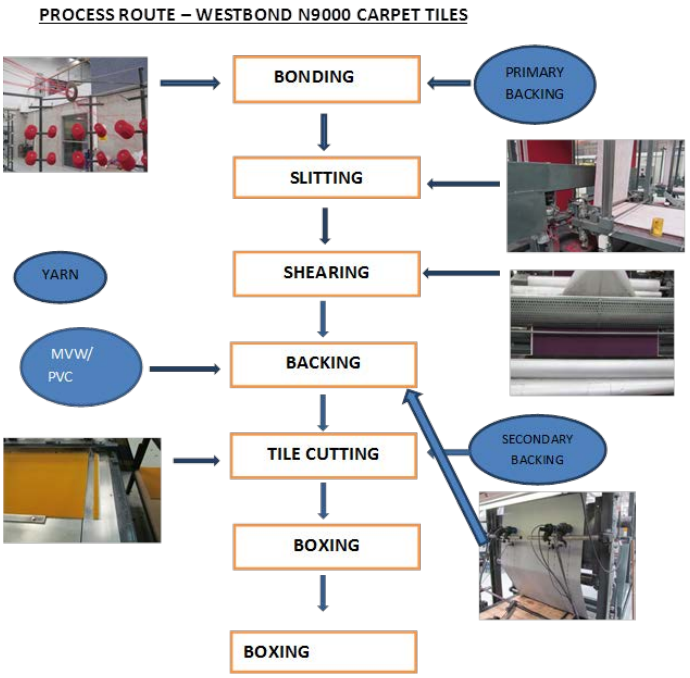



**Figure 2 : Production process of Westbond N9000**

Westbond N9000 is a cut pile product produced through our Fusion bonding process. The nylon yarn is cut into individual tufts, packed to stand vertically (this method ensures that a high proportion of the yarn is in the wear surface) before being joined with a primary backing and adhesive. This is then repeated prior to the roll being slit in the middle to form 2 rolls, tops and bottoms. The rolls are sheared to give a crisp surface appearance. Finally the recycled backing (mixed vinyl waste) is adhered on and the rolls are cut into tiles prior to boxing and dispatch.

### Health, Safety and Environmental Aspects during Production

- ISO 14001 Environmental Management System

### Production Waste

All product rejected at final inspection stage is either re-cycled through the manufacturing process or re-used externally. Incoming packaging materials are collected, separated and recycled.

## Delivery and Installation of the Floor Covering

### Delivery

A worldwide distribution by truck and container ship is utilized. On average every square meter of Westbond N9000 is transported as follows:

| | |
|---|---|
| Transport distance 40 t truck | 290 km |
| Transport distance 7.5 t truck | 84 km |
| Capacity utilization trucks (including empty runs) | 85 % |
| Transport distance Ocean ship | 0km |
| Capacity utilization Ocean ship | 48% |

Although a worldwide distribution is taken into account the average distance by Ocean ship is negligible.

### Installation

During the installation of Westbond N9000 an average of 4% of the material becomes installation waste. For the installation of Westbond N9000 tiles 0.25 kg/m$^2$ of adhesive is required. Waste during the installation process may be recycled as floor covering through the manufacturers' facilities or thermally recycled in a waste incineration plant. The majority of Westbond N9000 tile is sold in UK / Europe the European electricity grid mix is used in the calculations for the energy recovery during incineration.

### Health, Safety and Environmental Aspects during Installation

Forbo flooring recommends the use of (low) zero emission adhesives for installing Westbond N9000.

### Waste

Waste during the installation process may be recycled as floor covering through the manufacturers' facilities or thermally recycled in a waste incineration plant. Since the major part of Westbond N9000 is sold in UK / Europe the European electricity grid mix is used in the calculations for the energy recovery during incineration.

### Packaging

Cardboard tile boxes, wooden pallets and PE-film can be collected separately and should be used in a local recycling process. In the calculation model 100% incineration is taken into account for which there is a credit received.

## Use stage

The service lifetime of a floor covering for a certain application on a floor is too widespread to give one common number. For this EPD model the reference service lifetime (RSL) is set to one year. This means that all impacts for the use phase are based on the cleaning and maintenance model for one year. Depending on the area of use, the technical lifetime advised by the manufacturer and the estimated time on the floor by the customer, the service lifetime can be determined. The use phase impacts should be calculated with the foreseen service life to arrive at the total environmental impact.

## Cleaning and Maintenance

| Level of use | Cleaning Process | Cleaning Frequency | Consumption of energy and resources |
|---|---|---|---|
| Commercial/Residential/Industrial | Vacuuming | Daily | Electricity |
| | Spot/spill clean | As spill occcurs | Spotting agent |
| | Dry fusion clean<br>Hot water extraction | Four times each year | Hot water<br>Neutral detergent |

For the calculations the following cleaning regime is considered:

- Dry cleaning with a 1.5 kW vacuum cleaner for 0.21 min/$m^2$ every day. This equates to 1.92 kWh/$m^2$*year.
- Four times a year wet cleaning with 0.062 l/$m^2$ water and 0.0008 kg/$m^2$ detergent. This result in the use of 0.248 l/$m^2$*year water and 0.0032 kg/$m^2$*year detergent. The wet cleaning takes place without power machine usage. The waste water treatment of the arising waste water from cleaning is considered (Data source from Forbo GaBi model).

The cleaning regime that is recommended in practice will be highly dependent on the use of the premises where the floor covering is installed. In high traffic areas more frequent cleaning will be needed compared to areas where there is low traffic. The use of an entrance mat of at least four steps will reduce the cleaning frequency.

The cleaning regime used in the calculations is suitable for high traffic areas.

## Prevention of Structural Damage

All newly laid floor covering should be covered and protected with a suitable non-staining protective covering if other building activities are still in progress.

## Health Aspects during Usage

Westbond N9000 complies with:

- AgBB requirements

# End of Life

The deconstruction of installed Westbond N9000 from the floor is a manual process. For the end of life stage, 100% incineration is taken into account, since the vast majority of the countries in which Westbond N9000 are sold have a non landfill policy. The average distance to an incineration facility in the calculations is 200 km by truck.

# Life Cycle Assessment

A full Life Cycle Assessment has bee carried out according to ISO 14040 and ISO 14044.

The following Life Cycle Stages are assessed :

- Production Stage (Raw material acquisition, transportation to Manufacturing and Manufacturing)
- Transport Gate to User
- Installation Stage
- Use Stage
- End of Life Stage

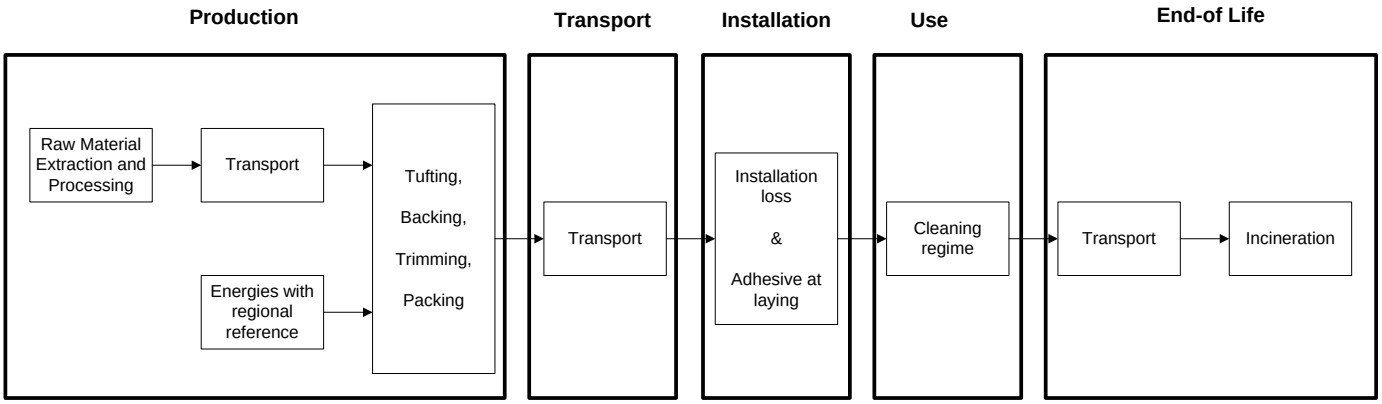



Figure 3 : Flow chart of the Life Cycle Assessment

## Description of the declared Functional Unit

The functional unit is one square meter of installed product and the use stage is considered for one year of service life.

## Cut off Criteria

The cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass of the unit process. The total neglected input flows per module shall be a maximum of 5% of energy usage and mass.

In practice, in this assessment, all data from the production data acquisition are considered, i.e. all raw materials used as per formulation, use of water, electricity and other fuels, the required packaging materials, and all direct production waste. Transport data on all considered inputs and output material are also considered.

## LCA Data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes have been used as the first choice as a basis for calculating an EPD.

For life cycle modeling of the considered products, the GaBi 6 Software System for Life Cycle Engineering, developed by PE INTERNATIONAL AG, has been used. All relevant LCA datasets are taken from the GaBi 6 software database. The datasets from the database GaBi are documented in the online documentation. To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

## Data Quality

The requirements for data quality and LCA data correspond to the specifications of the PCR.

Foreground data are based on 1 year averaged data (year 2012). The reference ages of LCA datasets vary but are given in the table in the Appendix. The time period over which inputs to and outputs from the system is accounted for is 100 years from the year for which the data set is deemed representative. The technological LCA of the collected data reflects the physical reality of the declared product. The datasets are complete, conform to the system boundaries and the criteria for the exclusion of inputs and outputs and are geographical representative for the supply chain of Forbo flooring.

For life cycle modeling of the considered products the GaBi 6 Software System for Life Cycle Engineering, developed by PE INTERNATIONAL AG, is used. All relevant LCA datasets are taken from the GaBi 6 software database. The last revision of the used data sets took place within the last 10 years.

**Table 1: LCA datasets used in the LCA model**

| Data set | Region | Reference year |
|---|---|---|
| Polyamide 6 Yarn | Germany | 2005 |
| PVC waste for recovery | Europe | 2006 |
| Calcium carbonate | Germany | 2011 |
| DINP | Germany | 2010 |
| PVC | Germany | 2012 |
| Alumina trihydrate | Global | 2011 |
| Additives | Germany | 2002 |
| Anti-Static Agent | Europe | 2007 |
| Glass tissue | Germany | 2010 |
| Water (desalinated; deionised) | Germany | 2010 |
| Detergent (ammonia based) | Germany | 2006 |
| Adhesive for resilient flooring | Germany | 2010 |
| Waste incineration of Westbond N9000 Carpet Tile | Europe | 2006 |
| Electricity from Hydro power | The United Kingdom | 2009 |
| Electricity from Wind power | The United Kingdom | 2009 |
| Electricity from Biomass | The United Kingdom | 2009 |
| Power grid mix | Europe | 2009 |
| Thermal energy from Natural gas | The United Kingdom | 2009 |
| Thermal energy from Natural gas | Europe | 2009 |
| Trucks | Global | 2010 |
| Municipal waste water treatment (Sludge incineration). | Europe | 2011 |
| Container ship | Global | 2010 |
| Diesel mix at refinery | Europe | 2009 |
| Heavy fuel oil at refinery (1.0wt.% S) | Europe | 2009 |
| Polyethylene film | Europe | 2005 |
| Corrugated board | Europe | 2002 |
| Wooden pallets | Europe | 1998 |

The documentation of the LCA data sets can be taken from the GaBi documentation.

## System Boundaries

Production Stage includes provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues during the product stage.

Transport and Installation Stage includes provision of all materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during the construction stage. These information modules also include all impacts and aspects related to any losses during this construction stage (i.e. production, transport, and waste processing and disposal of the lost products and materials). For the transportation a worldwide distribution is considered.

Use Stage includes provision and transport of all materials, products and related energy and water use, as well as waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage. These information modules also include all impacts and aspects related to the losses during this part of the use stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

End of Life Stage includes provision and all transports, provision of all materials, products and related energy and water use. It also includes any declared benefits and loads from net flows leaving the product system that have not been allocated as co-products and that have passed the end-of-waste state in the form of reuse, recovery and/or recycling potentials.

## Power mix

The selection of LCA data for the electricity generation is in line with the PCR.

The products are manufactured in Bamber Bridge, the United Kingdom. The GaBi 6 Hydropower, Wind power and Biomass datasets have therefore been used (reference year 2009). The energy supplier is providing Forbo with a certificate every year.

## $CO_2$-Certificates

No $CO_2$-certificates are considered in this study.

## Allocations

In the present study some allocations have been made. Detailed explanations can be found in the chapters below.

### Co-product allocation

No co-product allocation occurs in the product system.

### Allocation of multi-Input processes

The Production and End of Life stage include incineration plants. In these processes different products are treated together within a process. The allocation procedures followed in these cases are based on a physical classification of the mass flows or calorific values.

Credits from energy substitution are allocated to the production stage, because the gained energy from energy substitution is lower than the energy input in this stage. The same quality of energy is considered.

### Allocation procedure of reuse, recycling and recovery

The installation waste and end of life waste can be fed into incineration processes. Incineration processes include cogeneration processes which give thermal and power energy as outputs. It is assumed that this recovered energy offsets that produced by the European average grid mix and thermal energy generation from natural gas.

### Description of the allocation processes in the LCA report

The description of allocation rules in of this LCA report meets the requirements of the PCR.

## Description of the unit processes in the LCA report

The modeling of the unit processes reported for the LCA are documented in a transparent way, respecting the confidentiality of the data present in the LCA report.

In the following tables the type and amount of the different input and output flows are listed for 1m² produced flooring; installed flooring includes the material loss during installation (4%):

**Table 2: Composition of Westbond N9000 Carpet Tile**

| Process data | Unit | Westbond N9000 Carpet Tile |
|---|---|---|
| Nylon 6.6 | kg/m2 | 0.95 |
| Glass Tissue | kg/m2 | 0.06 |
| DINP | kg/m2 | 0.25 |
| Mixed vinyl waste | kg/m2 | 1.70 |
| PVC | kg/m2 | 0.59 |
| Aluminium hydroxide | kg/m2 | 0.24 |
| Calcium carbonate | kg/m2 | 0.15 |
| Antistatic agent | kg/m2 | 0.05 |
| Various chemicals | kg/m2 | 0.008 |

**Table 3: Production related inputs/outputs**

| Process data | Unit | Westbond N9000 Carpet Tile |
|---|---|---|
| **INPUTS** | | |
| Westbond N9000 Carpet Tile | kg | 4.68 |
| Electricity | MJ | 9.04 |
| Thermal energy from N9000 gas | MJ | 9.91 |
| **OUTPUTS** | | |
| Westbond N9000 Carpet Tile | kg | 4.00 |
| Waste | kg | 0.68 |

**Table 4: Packaging requirements (per $m^2$ manufactured product)**

| Process data | Unit | Westbond N9000 Carpet Tile |
|---|---|---|
| Polyethylene film | kg | 0.0023 |
| Corrugated board | kg | 0.142 |
| Wooden pallets | kg | 0.111 |

**Table 5: Transport distances (same for both products)**

| Process data | Unit | Road | Truck size | Ship |
|---|---|---|---|---|
| Polyamide 6 Yarn | km | 30 | 14 - 20t gross weight / 11,4t payload capacity | - |
| PVC waste for recovery | km | 90 | | - |
| Calcium carbonate | km | 75 | | - |
| DINP | km | 70 | | - |
| PVC | km | 15 | | 170 |
| Alumina trihydrate | km | 100 | | - |
| Additives | km | 15 | | - |
| Glass tissue | km | 650 | | 1360 |
| Corrugated board | km | 250 | | - |
| Wooden pallets | km | 180 | | - |
| Polyethylene film | km | 75 | | - |
| Transport to construction site :<br>-Transport distance 40 t truck<br>-Transport distance 7.5 t truck | <br>km<br>km | <br>290<br>84 | 34 - 40 t gross weight / 27t payload capacity | - |
| Waste transport to incineration | km | 200 | 7,5 t - 12t gross weight / 5t payload capacity | - |

**Table 6: Inputs/outputs from Installation**

| Process data | Unit | Westbond N9000 Carpet Tile |
|---|---|---|
| **INPUTS** | | |
| Westbond N9000 Carpet Tile | kg | 4.00 |
| Adhesive (30% water content)<br>o Water<br>o Acrylate co-polymer<br>o Styrene Butadiene co-polymer<br>o Limestone flour<br>o Sand | kg | 0.25 |
| **OUTPUTS** | | |
| Installed Westbond N9000 Carpet Tile | kg | 3.84 |
| Installation Waste | kg | 0.16 |

**Table 7: Inputs from use stage (per $m^2$.year of installed product)**

| Process data | Unit | Westbond N9000 Carpet Tile |
|---|---|---|
| Detergent | kg/year | 0.003 |
| Electricity | kWh/year | 1.920 |
| Water | kg/year | 0.248 |

**Table 8: Disposal**

| Process data | Unit | Westbond N9000 Carpet Tile |
|---|---|---|
| Post-consumer Westbond N9000 Carpet Tile to incineration | % | 100 |

## Life Cycle Inventory Analysis

In table 9 the environmental impacts for one lifecycle are presented for Westbond N9000 Carpet Tile . In table 10 the environmental impacts are presented for all the lifecycle stages.

**Table 9: Results of the LCA – Environmental impacts one lifecycle (one year) – Westbond N9000 Carpet Tile**

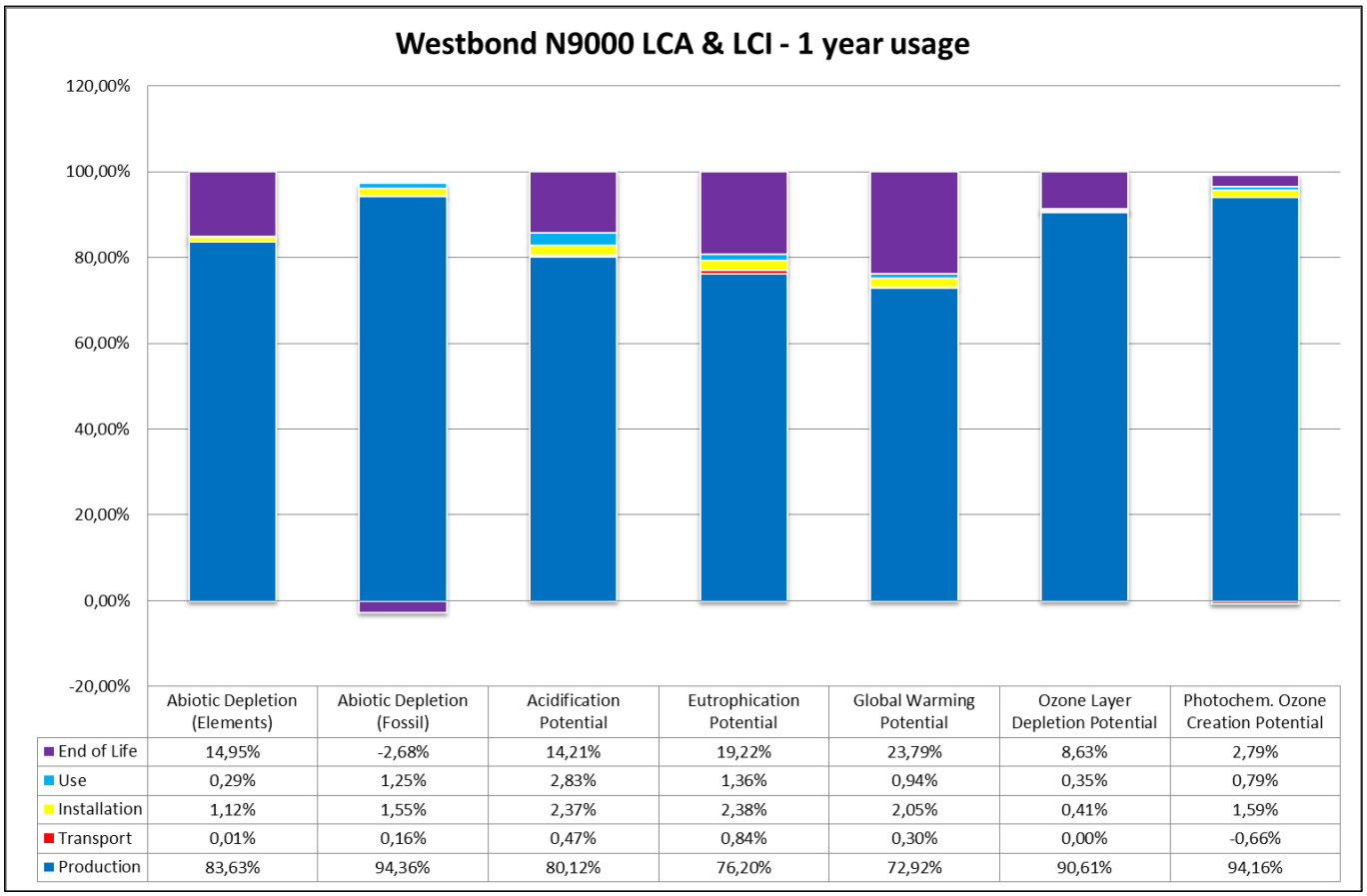
| Impact Category : CML 2001 – Nov. 2010 | Westbond N9000 Carpet Tile | Unit |
|---|---|---|
| Global Warming Potential (GWP 100 years) | 3.43E+01 | kg CO2-Equiv. |
| Ozone Layer Depletion Potential (ODP. steady state) | 6.55E-07 | kg R11-Equiv. |
| Acidification Potential (AP) | 4.76E-02 | kg SO2-Equiv. |
| Eutrophication Potential (EP) | 6.07E-03 | kg Phosphate-Equiv. |
| Photochem. Ozone Creation Potential (POCP) | 1.14E-02 | kg Ethene-Equiv. |
| Abiotic Depletion Potential Elements (ADPE) | 2.16E-05 | kg Sb-Equiv. |
| Abiotic Depletion Potential Fossil (ADPF) | 4.37E+02 | [MJ] |

**Table 10: Results of the LCA – Environmental impact for Westbond N9000 Carpet Tile (one year)**

| Impact Category : CML 2001 – Nov. 2010 | Unit | Production | Transport | Installation | Use (1yr) | End of Life |
|---|---|---|---|---|---|---|
| Global Warming Potential | kg CO2-Equiv. | 2.50E+01 | 1.02E-01 | 7.03E-01 | 3.22E-01 | 8.15E+00 |
| Ozone Layer Depletion Potential | kg R11-Equiv. | 5.94E-07 | 9.31E-13 | 2.67E-09 | 2.30E-09 | 5.66E-08 |
| Acidification Potential | kg SO2-Equiv. | 3.81E-02 | 2.22E-04 | 1.13E-03 | 1.35E-03 | 6.76E-03 |
| Eutrophication Potential | kg PSO4-Equiv. | 4.63E-03 | 5.07E-05 | 1.44E-04 | 8.29E-05 | 1.17E-03 |
| Photochem. Ozone Creation Potential | kg Ethene-Equiv. | 1.09E-02 | -7.67E-05 | 1.84E-04 | 9.17E-05 | 3.24E-04 |
| Abiotic Depletion Elements | kg Sb-Equiv. | 1.81E-05 | 1.99E-09 | 2.42E-07 | 6.36E-08 | 3.23E-06 |
| Abiotic Depletion Fossil | MJ | 4.35E+02 | 7.38E-01 | 7.16E+00 | 5.78E+00 | -1.23E+01 |

The relative contribution of each process stage to each impact category for Westbond N9000 Carpet Tile is shown in figures 4.

**Figure 4: Relative contribution of each process stage to each impact category for Westbond N9000 Carpet Tile for a one year usage.**




| | Abiotic Depletion (Elements) | Abiotic Depletion (Fossil) | Acidification Potential | Eutrophication Potential | Global Warming Potential | Ozone Layer Depletion Potential | Photochem. Ozone Creation Potential |
|---|---|---|---|---|---|---|---|
| End of Life | 14,95% | -2,68% | 14,21% | 19,22% | 23,79% | 8,63% | 2,79% |
| Use | 0,29% | 1,25% | 2,83% | 1,36% | 0,94% | 0,35% | 0,79% |
| Installation | 1,12% | 1,55% | 2,37% | 2,38% | 2,05% | 0,41% | 1,59% |
| Transport | 0,01% | 0,16% | 0,47% | 0,84% | 0,30% | 0,00% | -0,66% |
| Production | 83,63% | 94,36% | 80,12% | 76,20% | 72,92% | 90,61% | 94,16% |

## Interpretation

The interpretation of the results has been carried out considering the assumptions and limitations declared in the EPD, both methodology- and data-related for a one year usage.

In all of the impact categories the production stage has the main contribution to the overall impact with the raw material supply as the key contributor with a share of 95 – 99%, except for POCP where the raw materials account for 57% of the total. In all cases this contribution is caused by the manufacturing of Polyamide 6, PVC and to a lesser extent DINP. For POCP the share of the Forbo manufacturing stage is 43%, caused by the use of energy during the manufacturing of Westbond N9000.

The transport, installation and use phase are contribute little to the overall impact, for all categories every single measurement is to a greater or lesser extent below 3%.

Except for ADPF every category has got a significant share in the impacts at the End of Life stage. This is caused by the incineration of 100% of the deconstructed floor that is considered in the calculations. For ADPF there is a credit for the waste to energy conversion.

## Additional Environmental Information

To be fully transparant Forbo Flooring does not only want to declare the environmental impacts required in the PCR, but also the impacts on human health and eco-toxicity. Furthermore the outcome of the calculations according to the european Standard EN15804 are published in this section.

### Toxicity

For this calculations the USEtoxTM model is used as being the globally recommended preferred model for characterization modeling of human and eco-toxic impacts in LCIA by the United Nations Environment Programme SETAC Life Cycle Initiative.

According to the "ILCD Handbook: Recommendations for Life Cycle Impact Assessment in the European context" the recommended characterization models and associated characterization factors are classified according to their quality into three levels:

- Level I (recommended and satisfactory),
- Level II (recommended but in need of some improvements)
- Level III (recommended, but to be applied with caution).

A mixed classification sometimes is related to the application of the classified method to different types of substances. USEtoxTM is classified as Level II / III, unlike for example the CML impact categories which are classified as Level I.

**Table 11: Results of the LCA – Environmental impacts one lifecycle (one year) – Westbond N9000 Carpet Tile**

| Impact Category : USEtox | Westbond N9000 Carpet Tile | Unit |
|---|---|---|
| Eco toxicity | 6.01E-01 | PAF m3.day |
| Human toxicity, cancer | 9.01E-09 | Cases |
| Human toxicity, non-canc. | 4.92E-07 | Cases |

In the following table the impacts are subdivided into the lifecycle stages.

**Table 12: Results of the LCA – Environmental impact for Westbond N9000 Carpet Tile (one year)**

| Impact Category : USEtox | Unit | Production | Transport | Installation | Use (1yr) | End of Life |
|---|---|---|---|---|---|---|
| Eco toxicity | PAF m3.day | 5.18E-01 | 6.66E-03 | 1.09E-02 | 2.78E-02 | 3.76E-02 |
| Human toxicity, cancer | cases | 7.97E-09 | 2.78E-11 | 1.75E-10 | 2.66E-10 | 5.72E-10 |
| Human toxicity, non-canc. | cases | 3.24E-07 | 1.30E-08 | 1.75E-08 | 5.50E-08 | 8.22E-08 |

### Interpretation

The interpretation of the results has been carried out considering the assumptions and limitations declared in the EPD, both methodology- and data-related for a one year usage.

All the Toxicity categories are dominated by the production stage in which the raw materials are having a big impact with a share of around 93-99%. The raw materials with the highest impact are Polyamide 6 and PVC.

The transport and installation stage are both having a minor impact on the total impact compared to the other life cycle stages. For the transport life cycle the contribution comes completely from the Diesel that is used for the trucks. In the installation stage the adhesive is the main contributor.

The use stage is contributing 3 – 11% of the total, mainly caused by the use of electricity needed for vacuuming the floor. The cleaning regime considered in the calculation is an assumption, in practice this will be dependent on the use of the premises where the floor covering is installed.

At the End of Life stage the main contributor is the 100% of the floor that is incinerated after it is deconstructed. The possibility to recycle the post-consumer waste is not taken into account for these calculations, because this is not yet widely practiced.

## EN15804 results

In this section the calculations have been conducted according to the requirements of the European Standard EN 158024 following the document “Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report”.

**Table 13: Results of the LCA – Environmental impact for Westbond N9000 Carpet Tile (one year)**

| | | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | Unit | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| GWP | [kg $CO_2$-Equiv.] | 2.50E+01 | 1.02E-01 | 8.07E-01 | 3.22E-01 | 0.00E+00 | 1.09E-01 | 9.77E+00 | -1.83E+00 |
| ODP | [kg CFC11-Equiv.] | 5.94E-07 | 9.31E-13 | 2.69E-09 | 2.30E-09 | 0.00E+00 | 1.90E-12 | 5.68E-08 | -2.78E-10 |
| AP | [kg $SO_2$-Equiv.] | 3.81E-02 | 2.22E-04 | 1.31E-03 | 1.35E-03 | 0.00E+00 | 5.46E-04 | 8.58E-03 | -2.54E-03 |
| EP | [kg $PO_4^{3-}$- Equiv.] | 4.63E-03 | 5.07E-05 | 1.59E-04 | 8.29E-05 | 0.00E+00 | 1.26E-04 | 1.26E-03 | -2.30E-04 |
| POCP | [kg Ethen Equiv.] | 1.09E-02 | -7.67E-05 | 2.02E-04 | 9.17E-05 | 0.00E+00 | 6.08E-05 | 5.45E-04 | -3.00E-04 |
| ADPE | [kg Sb Equiv.] | 1.81E-05 | 1.99E-09 | 2.48E-07 | 6.36E-08 | 0.00E+00 | 4.05E-09 | 3.32E-06 | -9.70E-08 |
| ADPF | [MJ] | 4.35E+02 | 7.38E-01 | 8.89E+00 | 5.78E+00 | 0.00E+00 | 1.51E+00 | 1.47E+01 | -3.03E+01 |

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources

**Table 14: Results of the LCA – Resource use for Westbond N9000 Carpet Tile (one year)**

| | | Manufacturing | Installation | | Use (1yr) | End of Life | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Unit | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | C4 | D |
| PERE | [MJ] | - | - | - | - | - | - | - | - | - |
| PERM | [MJ] | - | - | - | - | - | - | - | - | - |
| PERT | [MJ] | 8.46E+00 | 6.88E-02 | 1.67E-01 | 7.88E-01 | 4.24E-02 | 6.87E-02 | 2.44E-01 | -8.31E-01 | -8.31E-01 |
| PENRE | [MJ] | - | - | - | - | - | - | - | - | - |
| PENRM | [MJ] | - | - | - | - | - | - | - | - | - |
| PENRT | [MJ] | 4.71E+02 | 1.75E+00 | 8.42E+00 | 5.84E+00 | 2.55E-01 | 1.75E+00 | 1.40E+01 | -2.73E+01 | -2.73E+01 |
| SM | [kg] | 0.00E+00 | - | - | - | - | - | - | - | - |
| RSF | [MJ] | 1.61E-03 | 1.11E-05 | 2.22E-04 | 9.54E-05 | 5.20E-06 | 1.11E-05 | 0.00E+00 | -3.04E-04 | -3.04E-04 |
| NRSF | [MJ] | 1.68E-02 | 1.16E-04 | 1.48E-03 | 9.99E-04 | 5.45E-05 | 1.16E-04 | 0.00E+00 | -3.19E-03 | -3.19E-03 |
| FW | [kg] | 6.98E+01 | 7.63E-02 | 1.47E+00 | 5.28E+00 | 1.14E-01 | 7.62E-02 | -1.64E+00 | -2.58E+00 | -2.58E+00 |

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

**Table 15: Results of the LCA – Output flows and Waste categories for Westbond N9000 Carpet Tile (one year)**

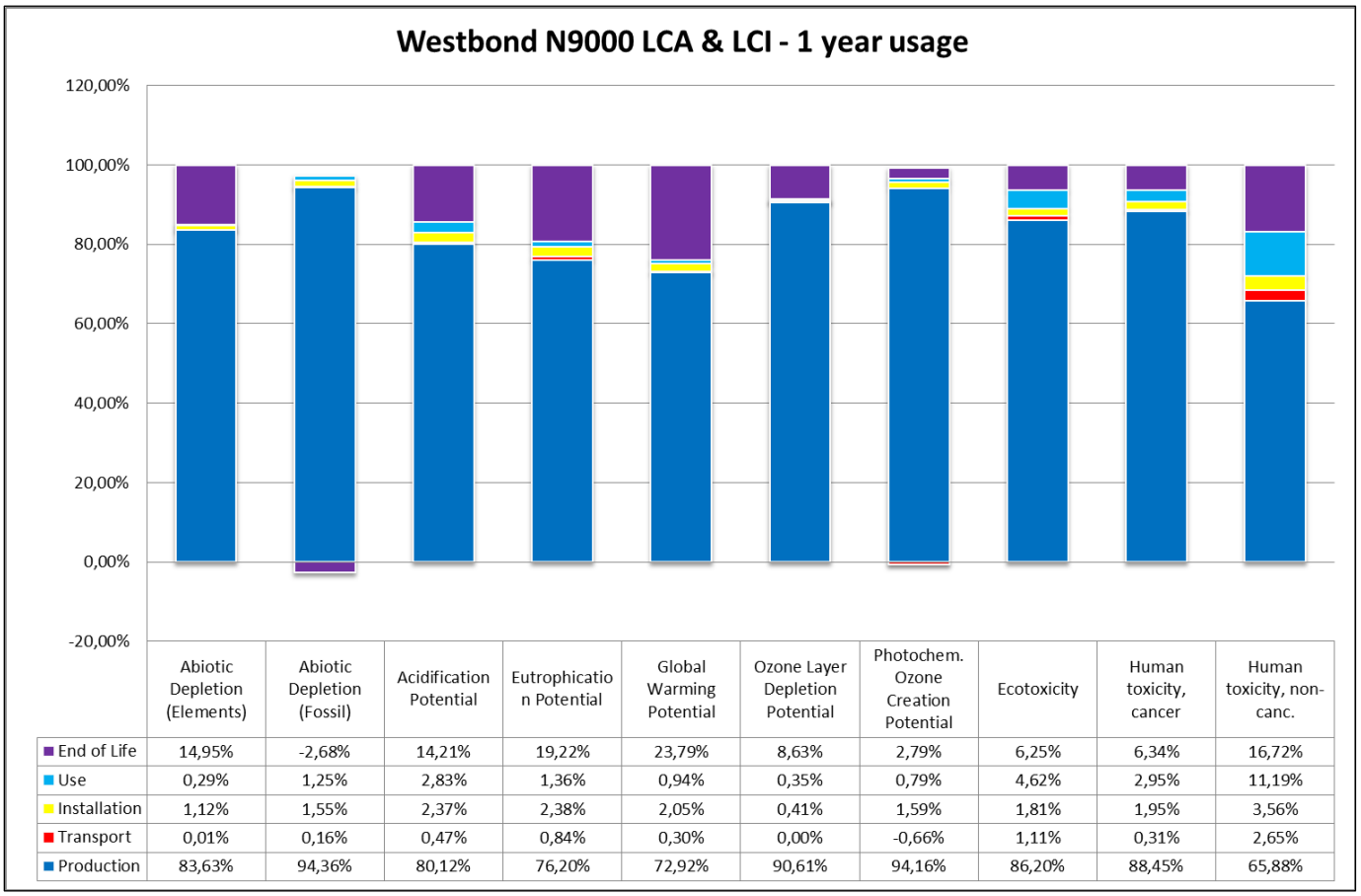
| | | Manufacturing | Transport | Installation | Use (1yr) | End of Life/credits | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Unit | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | C4 | D |
| HWD | [kg] | 1.29E-03 | 0.00E+00 | 1.01E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NHWD | [kg] | 2.55E+01 | 2.63E-03 | 4.57E-01 | 1.12E+00 | 0.00E+00 | 5.36E-03 | 3.18E+00 | -1.22E+00 | -1.14E+00 |
| RWD | [kg] | 9.40E-03 | 1.03E-06 | 1.29E-04 | 7.12E-04 | 0.00E+00 | 2.09E-06 | 7.12E-04 | -7.85E-04 | 7.31E-04 |
| CRU | [kg] | - | - | - | - | - | - | - | - | - |
| MFR | [kg] | - | - | - | - | - | - | - | - | - |
| MER | [kg] | - | - | - | - | - | - | 4.09E+00 | - | - |
| EE Power | [MJ] | - | - | 1.16E-01 | - | - | - | 2.78E+00 | - | - |
| EE Thermal energy | [MJ] | - | - | 1.43E+00 | - | - | - | 3.42E+01 | - | - |

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Exported energy per energy carrier

## Interpretation

The interpretation of the environmental impacts calculated according to EN 15804 are similar to the interpretation according to ISO 14025. A more detailed interpretation for a one year useage is presented in following figures and tables.

**Figure 5: Relative contribution of each process stage to each impact category for Westbond N9000 Carpet Tile for a one year usage.**




| | Abiotic Depletion (Elements) | Abiotic Depletion (Fossil) | Acidification Potential | Eutrophication Potential | Global Warming Potential | Ozone Layer Depletion Potential | Photochem. Ozone Creation Potential | Ecotoxicity | Human toxicity, cancer | Human toxicity, non-canc. |
|---|---|---|---|---|---|---|---|---|---|---|
| End of Life | 14,95% | -2,68% | 14,21% | 19,22% | 23,79% | 8,63% | 2,79% | 6,25% | 6,34% | 16,72% |
| Use | 0,29% | 1,25% | 2,83% | 1,36% | 0,94% | 0,35% | 0,79% | 4,62% | 2,95% | 11,19% |
| Installation | 1,12% | 1,55% | 2,37% | 2,38% | 2,05% | 0,41% | 1,59% | 1,81% | 1,95% | 3,56% |
| Transport | 0,01% | 0,16% | 0,47% | 0,84% | 0,30% | 0,00% | -0,66% | 1,11% | 0,31% | 2,65% |
| Production | 83,63% | 94,36% | 80,12% | 76,20% | 72,92% | 90,61% | 94,16% | 86,20% | 88,45% | 65,88% |

**Table 16: Main modules and flows contributing to the total impact in each impact category for Westbond N9000 Carpet Tile for a one year usage**

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|---|---|---|---|---|---|
| GWP | Production | Raw Material Extraction | 23.7 kg $CO_2$-equiv. | Polyamide (19.7 kg $CO_2$-eq.) PVC (2.7 kg $Co_2$-eg.) | Production : Inorganic emissions to air, Carbon dioxide |
| | | Transport of Raw materials | 0.028 kg $CO_2$-equiv. | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 1.24 kg $CO_2$-equiv. | 39% Thermal energy<br>58% Non-hazardous waste | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Inorganic emissions to air, Carbon dioxide |
| | Installation | Installation | | 74% Adhesive | |
| | Use | Use | | 82% Electricity | Use : Inorganic emissions to air, Carbon dioxide |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile<br>Energy substitution from incineration | EOL : Inorganic emissions to air, Carbon dioxide |
| ODP | Production | Raw Material Extraction | 99% | 99% Polyamide | Production : Halogenated organic emissions to air, R11 (trichlorofluoromethane), R114 (Dichlorotetrafluorethane), R12 (Dichlorodifluoromethane) |
| | | Transport of Raw materials | < 0.01% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 1% | 33% Cardboard packaging<br>67% Non-hazardous waste | |
| | Transport | Transport Gate | | Means of transport (truck, | Transport & Installation : Halogenated |

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|---|---|---|---|---|---|
| | | to User | | container ship) and their fuels | organic emissions to air, R11 (trichlorofluoromethane), R114 (Dichlorotetrafluorethane) |
| | Installation | Installation | | 58% Disposal of Carpet installation waste<br>41% Adhesive | |
| | Use | Use | | 90% Detergent | Use : Halogenated organic emissions to air, R11 (trichlorofluoromethane), R114 (Dichlorotetrafluorethane) |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL: Halogenated organic emissions to air, R11 (trichlorofluoromethane), R114 (Dichlorotetrafluorethane), R12 (Dichlorodifluoromethane) |
| AP | Production | Raw Material Extraction | 98% | 80% Polyamide<br>13% PVC | Production : Inorganic emissions to air, $NO_x$ and Sulphur dioxide |
| | | Transport of Raw materials | <0.5% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 2% | 12% Cardboard packaging<br>85% Non-hazardous waste | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Inorganic emissions to air, $NO_x$ and Sulphur dioxide |
| | Installation | Installation | | 93% Adhesive | |
| | Use | Use | | 93% Electricity | Use : Inorganic emissions to air, $NO_x$ and Sulphur dioxide |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Inorganic emissions to air, Hydrogen chloride, $NO_x$ and Sulphur dioxide |
| EP | Production | Raw Material Extraction | 97% | 81% Polyamide<br>13% PVC | Production : Inorganic emissions to air, Ammonia, $NO_x$<br>Production : Inorganic emissions to fresh water, Ammonium/Ammonia, Nitrate |
| | | Transport of Raw materials | 0.5% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 2.5% | 85% Non-hazardous waste | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Inorganic emissions to air, $NO_x$ |
| | Installation | Installation | | 90% Adhesive | |
| | Use | Use | | 80% Electricity | Use : Inorganic emissions to air, $NO_x$ |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Inorganic emissions to air, $NO_x$ and Ammonia |
| POCP | Production | Raw Material Extraction | 57% | 58% Polyamide<br>23% PVC<br>18% DINP | Production : Inorganic emissions to air, Carbon monoxide, $NO_x$ , Sulphur dioxide<br>Production : Halogenated organic emissions to air, Butane (n-butane), NMVOC (Unspecified), VOC (Unspecified) |
| | | Transport of Raw materials | < 0.2% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 43% | 52% Thermal energy<br>47% Electricity | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Inorganic emissions to air, Carbon monoxide, $NO_x$, Sulphur dioxide<br>Transport & Installation : Halogenated organic emissions to air, NMVOC (Unspecified) |
| | Installation | Installation | | 94% Adhesive | |
| | Use | Use | | 81% electricity | Use : Inorganic emissions to air, Sulphur dioxide, $NO_x$<br>Use : Halogenated organic emissions to air, NMVOC (Unspecified) |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Inorganic emissions to air, Carbon monoxide , $NO_x$, Sulphur dioxide<br>EOL : Organic emissions to air (Group VOC), NMVOC (Unspecified) |
| ADPe | Production | Raw Material Extraction | 98% | 48% Polyamide<br>50% PVC | Production : Nonrenewable resources, Sodium chloride (Rock salt), Lead-Zinc ore (4.6%-0.6%) |
| | | Transport of Raw materials | <0,1% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 2% | 94% Non-hazardous waste | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Nonrenewable resources, Sodium chloride (rock salt) |
| | Installation | Installation | | 97% Adhesive | |

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|---|---|---|---|---|---|
| | Use | Use | | 57% Electricity<br>43% Detergent | Use : Nonrenewable elements, Chromium, Copper, Gold, Lead, Molybdenum<br>Use : Nonrenewable resources, Sodium chloride (rock salt) |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Nonrenewable resources, Magnesium chloride leach (40%) |
| ADPf | Production | Raw Material Extraction | 98% | 77% Polyamide<br>14% PVC<br>9% DINP | Production : Crude oil resource, Crude oil (in MJ)<br>Production : Natural gas (resource), Natural gas (in MJ) |
| | | Transport of Raw materials | <0.2% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 2% | 84% Thermal energy | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Crude oil (resource)<br>Transport & Installation : Natural gas (resource), |
| | Installation | Installation | | 97% Adhesive | |
| | Use | Use | | 81% electricity | Use : Hard coal (resource), Natural gas (resource), Uranium (resource) |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Natural gas (resource) |
| Eco toxicity | Production | Raw Material Extraction | 97% | 70% Polyamide<br>23% PVC | Production : Heavy metals to air, Copper (+II), Zinc (+II), Nickel (+II), Arsenic (+V)<br>Production : Heavy metals to agricultural soil, Copper (+II), Zinc (+II)<br>Production : Heavy metals to fresh water, Copper (+II), Zinc (+II), Nickel (+II), Arsenic (+V) |
| | | Transport of Raw materials | 1% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 2% | 42% Cardboard packaging<br>49% Non-hazardous waste | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & installation : Heavy metals to fresh water, Copper (+II), Nickel (+II), Zinc (+II)<br>Transport & installation : Heavy metals to agricultural soil, Zinc (+II), Copper (+II) |
| | Installation | Installation | | 88% Adhesive | |
| | Use | Use | | 93% Electricity | Use : Heavy metals to agricultural soil, Copper (+II), Zinc (+II) |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Heavy metals to air, Copper (+II), Zinc (+II)<br>EOL : Heavy metals to agricultural soil, Mercury (+II), Zinc (+II)<br>EOL : Heavy metals to fresh water, Copper (+II), Zinc (+II), Arsenic (+V) |
| Human toxicity, cancer | Production | Raw Material Extraction | 99% | 43% Polyamide<br>54% PVC | Production : Heavy metals to air, Mercury (+II)<br>Production : Organic emissions to air, Formaldehyde (methanol), Vinyl chloride (VCM, chloroethene)<br>Production : Heavy metals to fresh water, Chromium (+VI), Arsenic (+V), Nickel (+II) |
| | | Transport of Raw materials | < 0.3% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 1% | 27% Thermal energy<br>66% Non-hazardous waste | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Heavy metals to air, Mercury (+II)<br>Transport & Installation : Heavy metals to fresh water, Chromium (+IV) |
| | Installation | Installation | | 97% adhesive | |
| | Use | Use | | 85% Electricity | Use : Heavy metals to air, Mercury (+II)<br>Use : Heavy metals to agricultural soil, Mercury (+II) |
| | EOL | EOL | | Incineration of post-consumer Westbond N9000 Carpet Tile Energy substitution from incineration | EOL : Heavy metals to air, Mercury (+II)<br>EOL : Heavy metals to agricultural soil, Mercury (+II), Lead (+II) |
| Human toxicity, non canc. | Production | Raw Material Extraction | 93% | 46% Polyamide<br>48% PVC | Production : Heavy metals to air, Zinc (+II), Mercury (+II)<br>Production : Heavy metals to agricultural soil, Zinc (+II), Lead (+II), Mercury (+II) |
| | | Transport of Raw materials | 3% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 4% | 22% Cardboard packaging<br>61% Non-hazardous waste | |
| | Transport | Transport Gate | | Means of transport (truck, | Transport & Installation : Heavy metals to air, |

| Impact Category | Stage | Module | Main contributor | Main contributing flows |
|---|---|---|---|---|
| | | to User | container ship) and their fuels | Mercury (+II) |
| | Installation | Installation | 88% adhesive | Transport & Installation : Heavy metals to agricultural soil, Lead (+II), Mercury (+II), Zinc (+II) |
| | Use | Use | 99% electricity | Use : Heavy metals to air, Mercury (+II), Zinc (+II)<br>Use : Heavy metals to agricultural soil, Mercury (+II), Zinc (+II) |
| | EOL | EOL | Incineration of post-consumer Westbond N9000 Carpet Tile<br>Energy substitution from incineration | EOL : Heavy metals to agricultural soil, Lead (+II), Mercury (+II), Zinc (+II)<br>EOL : Heavy metals to air, Mercury (+II) |

## Description of Selected Impact Categories

### Abiotic Depletion Potential

The abiotic depletion potential covers all natural resources such as metal containing ores, crude oil and mineral raw materials. Abiotic resources include all raw materials from non-living resources that are non-renewable. This impact category describes the reduction of the global amount of non-renewable raw materials. Non-renewable means a time frame of at least 500 years. This impact category covers an evaluation of the availability of natural elements in general, as well as the availability of fossil energy carriers.

ADP (elements) describes the quantity of non-energetic resources directly withdrawn from the geosphere. It reflects the scarcity of the materials in the geosphere and is expressed in Antimony equivalents. The characterization factors are published by the CML, Oers 2010.

Are fossil energy carriers included in the impact category, it is ADP (fossil). Fossil fuels are used similarly to the primary energy consumption; the unit is therefore also MJ. In contrast to the primary fossil energy ADP fossil does not contain uranium, because this does not count as a fossil fuel.

### Primary energy consumption

Primary energy demand is often difficult to determine due to the various types of energy source. Primary energy demand is the quantity of energy directly withdrawn from the hydrosphere, atmosphere or geosphere or energy source without any anthropogenic change. For fossil fuels and uranium, this would be the amount of resource withdrawn expressed in its energy equivalent (i.e. the energy content of the raw material). For renewable resources, the energy-characterized amount of biomass consumed would be described. For hydropower, it would be based on the amount of energy that is gained from the change in the potential energy of water (i.e. from the height difference). As aggregated values, the following primary energies are designated:

The total **“Primary energy consumption non-renewable”**, given in MJ, essentially characterizes the gain from the energy sources natural gas, crude oil, lignite, coal and uranium. natural gas and crude oil will both be used for energy production and as material constituents e.g. in plastics. Coal will primarily be used for energy production. Uranium will only be used for electricity production in nuclear power stations.

The total **“Primary energy consumption renewable”**, given in MJ, is generally accounted separately and comprises hydropower, wind power, solar energy and biomass. It is important that the end energy (e.g. 1 kWh of electricity) and the primary energy used are not miscalculated with each other; otherwise the efficiency for production or supply of the end energy will not be accounted for. The energy content of the manufactured products will be considered as feedstock energy content. It will be characterized by the net calorific value of the product. It represents the still usable energy content.

### Waste categories

There are various different qualities of waste. For example, waste can be classed according to German and European waste directives. The modeling principles have changed with the last GaBi4 database update in October 2006. Now all LCA data sets (electricity generation, raw material etc.) already contain the treatment of the waste with very low

waste output at the end of the stage. So the amount of waste is predominantly caused by foreground processes during the production phase. This is important for the interpretation of waste amounts.

From a balancing point of view, it makes sense to divide waste into three categories. The categories overburden/tailings, industrial waste for municipal disposal and hazardous waste will be used.

**Overburden / tailings** in kg: This category consists of the layer which must be removed in order to access raw material extraction, ash and other raw material extraction conditional materials for disposal. Also included in this category are tailings such as inert rock, slag, red mud etc.

**Industrial waste for municipal disposal** in kg: This term contains the aggregated values of industrial waste for municipal waste according to 3. AbfVwV TA SiedlABf.

**Hazardous waste** in kg: This category includes materials that will be treated in a hazardous waste incinerator or hazardous waste landfill, such as painting sludge's, galvanic sludge's, filter dusts or other solid or liquid hazardous waste and radioactive waste from the operation of nuclear power plants and fuel rod production.

## Global Warming Potential (GWP)

The mechanism of the greenhouse effect can be observed on a small scale, as the name suggests, in a greenhouse. These effects are also occurring on a global scale. The occurring short-wave radiation from the sun comes into contact with the earth's surface and is partly absorbed (leading to direct warming) and partly reflected as infrared radiation. The reflected part is absorbed by so-called greenhouse gases in the troposphere and is re-radiated in all directions, including back to earth. This results in a warming effect on the earth's surface.

In addition to the natural mechanism, the greenhouse effect is enhanced by human activities. Greenhouse gases that are considered to be caused, or increased, anthropogenically are, for example, carbon dioxide, methane and CFCs. *Figure A1* shows the main processes of the anthropogenic greenhouse effect. An analysis of the greenhouse effect should consider the possible long term global effects.

The global warming potential is calculated in carbon dioxide equivalents ($CO_2$-Eq.). This means that the greenhouse potential of an emission is given in relation to $CO_2$. Since the residence time of the gases in the atmosphere is incorporated into the calculation, a time range for the assessment must also be specified. A period of 100 years is customary.

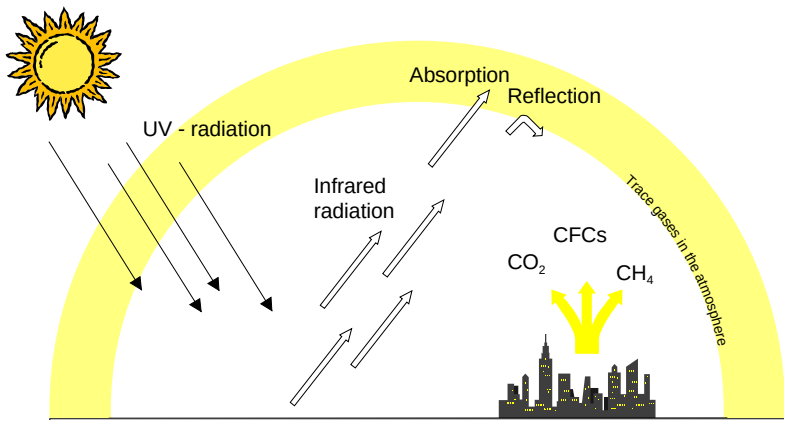



*Figure A1: Greenhouse effect (KREISSIG 1999)*

## Acidification Potential (AP)

The acidification of soils and waters predominantly occurs through the transformation of air pollutants into acids. This leads to a decrease in the pH-value of rainwater and fog from 5.6 to 4 and below. Sulphur dioxide and nitrogen oxide and their respective acids ($H_2SO_4$ and $HNO_3$) produce relevant contributions. This damages ecosystems, whereby forest dieback is the most well-known impact.

Acidification has direct and indirect damaging effects (such as nutrients being elutriated from soils or an increased solubility of metals into soils). But even buildings and building materials can be damaged. Examples include metals and N9000 stones which are corroded or disintegrated at an increased rate.

When analyzing acidification, it should be considered that although it is a global problem, the regional effects of acidification can vary. *Figure A2* displays the primary impact pathways of acidification.

The acidification potential is given in sulphur dioxide equivalents (SO2-Eq.). The acidification potential is described as the ability of certain substances to build and release H+ - ions. Certain emissions can also be considered to have an acidification potential, if the given S-, N- and halogen atoms are set in proportion to the molecular mass of the emission. The reference substance is sulphur dioxide.

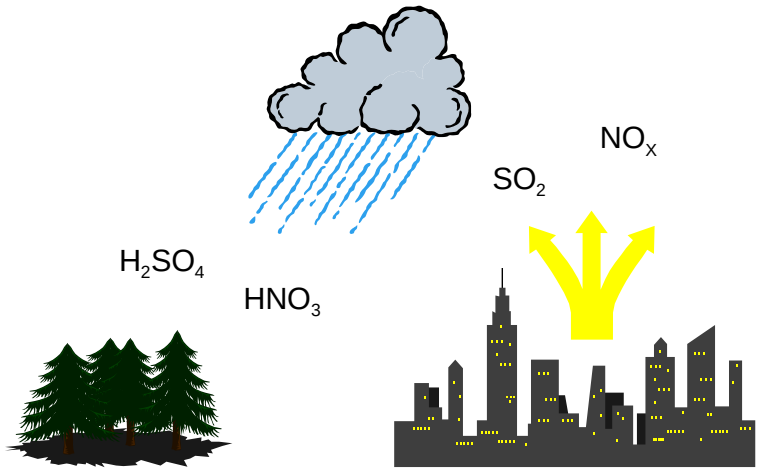



*Figure A2: Acidification Potential (KREISSIG 1999)*

## Eutrophication Potential (EP)

Eutrophication is the enrichment of nutrients in a certain place. Eutrophication can be aquatic or terrestrial. Air pollutants, waste water and fertilization in agriculture all contribute to eutrophication.

The result in water is an accelerated algae growth, which in turn, prevents sunlight from reaching the lower depths. This leads to a decrease in photosynthesis and less oxygen production. In addition, oxygen is needed for the decomposition of dead algae. Both effects cause a decreased oxygen concentration in the water, which can eventually lead to fish dying and to anaerobic decomposition (decomposition without the presence of oxygen). Hydrogen sulphide and methane are thereby produced. This can lead, among others, to the destruction of the eco-system.

On eutrophicated soils, an increased susceptibility of plants to diseases and pests is often observed, as is a degradation of plant stability. If the nutrification level exceeds the amounts of nitrogen necessary for a maximum harvest, it can lead to an enrichment of nitrate. This can cause, by means of leaching, increased nitrate content in groundwater. Nitrate also ends up in drinking water.

Nitrate at low levels is harmless from a toxicological point of view. However, nitrite, a reaction product of nitrate, is toxic to humans. The causes of eutrophication are displayed in Figure A3. The eutrophication potential is calculated in phosphate equivalents (PO4-Eq). As with acidification potential, it's important to remember that the effects of eutrophication potential differ regionally.

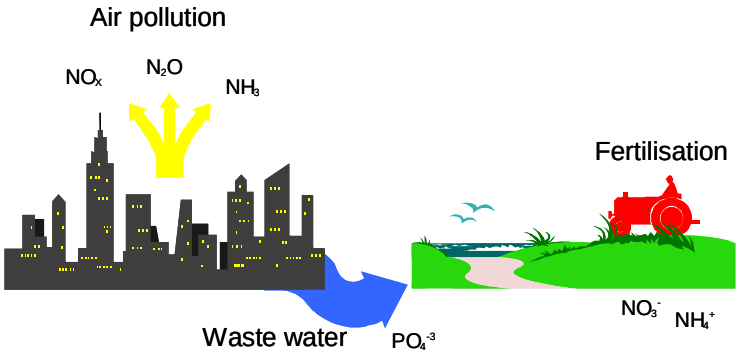



*Figure A3: Eutrophication Potential (KREISSIG 1999)*

## Photochemical Ozone Creation Potential (POCP)

Despite playing a protective role in the stratosphere, at ground-level ozone is classified as a damaging trace gas. Photochemical ozone production in the troposphere, also known as summer smog, is suspected to damage vegetation and material. High concentrations of ozone are toxic to humans.

Radiation from the sun and the presence of nitrogen oxides and hydrocarbons incur complex chemical reactions, producing aggressive reaction products, one of which is ozone. Nitrogen oxides alone do not cause high ozone concentration levels. Hydrocarbon emissions occur from incomplete combustion, in conjunction with petrol (storage, turnover, refueling etc.) or from solvents. High concentrations of ozone arise when the temperature is high, humidity is

low, when air is relatively static and when there are high concentrations of hydrocarbons. Today it is assumed that the existence of NO and CO reduces the accumulated ozone to $NO_2$, $CO_2$ and $O_2$. This means, that high concentrations of ozone do not often occur near hydrocarbon emission sources. Higher ozone concentrations more commonly arise in areas of clean air, such as forests, where there is less NO and CO (*Figure A4*).

In Life Cycle Assessments, photochemical ozone creation potential (POCP) is referred to in ethylene-equivalents ($C_2H_4$-Äq.). When analyzing, it's important to remember that the actual ozone concentration is strongly influenced by the weather and by the characteristics of the local conditions.

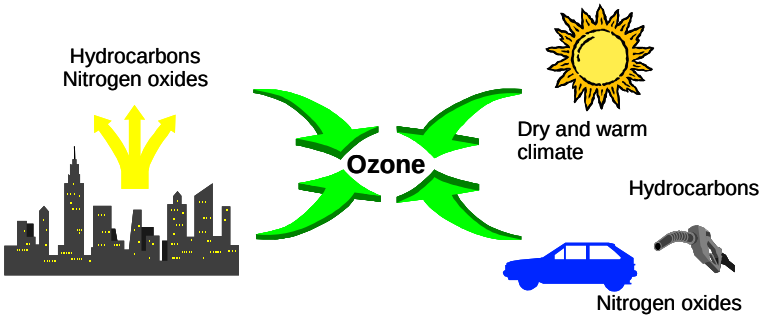



***Figure A4:*** ***Photochemical Ozone Creation Potential***

## Ozone Depletion Potential (ODP)

Ozone is created in the stratosphere by the disassociation of oxygen atoms that are exposed to short-wave UV-light. This leads to the formation of the so-called ozone layer in the stratosphere (15 - 50 km high). About 10 % of this ozone reaches the troposphere through mixing processes. In spite of its minimal concentration, the ozone layer is essential for life on earth. Ozone absorbs the short-wave UV-radiation and releases it in longer wavelengths. As a result, only a small part of the UV-radiation reaches the earth.

Anthropogenic emissions deplete ozone. This is well-known from reports on the hole in the ozone layer. The hole is currently confined to the region above Antarctica, however another ozone depletion can be identified, albeit not to the same extent, over the mid-latitudes (e.g. Europe). The substances which have a depleting effect on the ozone can essentially be divided into two groups; the fluorine-chlorine-hydrocarbons (CFCs) and the nitrogen oxides (NOX). *Figure A5* depicts the procedure of ozone depletion.

One effect of ozone depletion is the warming of the earth's surface. The sensitivity of humans, animals and plants to UV-B and UV-A radiation is of particular importance. Possible effects are changes in growth or a decrease in harvest crops (disruption of photosynthesis), indications of tumors (skin cancer and eye diseases) and decrease of sea plankton, which would strongly affect the food chain. In calculating the ozone depletion potential, the anthropogenically released halogenated hydrocarbons, which can destroy many ozone molecules, are recorded first. The so-called Ozone Depletion Potential (ODP) results from the calculation of the potential of different ozone relevant substances.

This is done by calculating, first of all, a scenario for a fixed quantity of emissions of a CFC reference (CFC 11). This results in an equilibrium state of total ozone reduction. The same scenario is considered for each substance under study whereby CFC 11 is replaced by the quantity of the substance. This leads to the ozone depletion potential for each respective substance, which is given in CFC 11 equivalents. An evaluation of the ozone depletion potential should take the long term, global and partly irreversible effects into consideration.

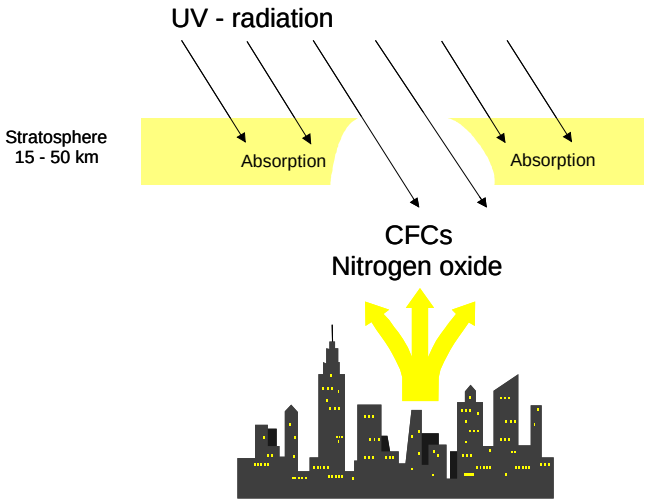



*Figure A5: Ozone Depletion Potential (KREISSIG 1999)*

## References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|---|---|
| GABI 5 2012 | PE INTERNATIONAL AG; GaBi 5: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2012. |
| GABI 5 2012D | GaBi 5: Documentation of GaBi 5: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2012. http://documentation.gabi-software.com/ |
| NSF International May 22, 2012 | Product Category Rule for Environmental Product Declarations *Flooring: Carpet, Resilient, Laminate, Ceramic, Wood* |
| UL ENVIRONMENT | UL Environment's Program Operator Rules |
| ERFMI 2008 | Final report: LCA, Environmental Information Sheet and Eco design Model of Resilient Flooring by order of ERFMI, PE International, 2008 |
| IBU 2011 | PCR - Part A: Calculation rules for the Life Cycle Assessment and Requirements on the Background Report, Institut Bauen und Umwelt e.V. |
| PE 2012 | Description of Selected Impact Categories, PE International AG, 2012 |
| ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance | European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010 |
| **STANDARDS AND LAWS** | |
| DIN EN ISO 14044 | Environmental management - Life cycle assessment - Requirements and guidelines (ISO 14044:2006); German and English version EN ISO 14044 |
| ISO 14025 2006 | DIN EN ISO 14025: Environmental labels and declarations — Type III environmental declarations — Principles and procedures |
| ISO 14040 2006 | Environmental management - Life cycle assessment - Principles and framework (ISO 14040); German and English version EN ISO 14040 |
| CEN/TR 15941 | Sustainability of construction works - Environmental product declarations - Methodology for selection and use of generic data; German version CEN/TR 15941 |
| EN 15804 | EN 15804: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products |
| ISO 24011 | Resilient floor coverings - Specification for plain and decorative Westbond N9000 Carpet Tile |
| CPR | REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2011 laying down harmonized conditions for the marketing of construction products and repealing Council Directive 89/106/EEC |
| EN-ISO 10874 | Resilient, textile and laminate floor coverings - Classification |