

ENVIRONMENTAL PRODUCT DECLARATION

CORAL WELCOME

FORBO FLOORING SYSTEMS
ENTRANCE FLOORING SYSTEM

Coral Welcome 3205 Blue Lagoon



FLOORING SYSTEMS

Forbo Coral entrance flooring delivers superior performance in even the toughest environments. Whether facing rain, snow, sand or soil, Coral keeps the outside from getting inside. Coral entrance floors are highly functional and through their design options always form an integral part of the buildings design scheme. Coral is the international market leader in textile entrance flooring for almost 50 years and now offers you more choice than ever before. Each individual range in the collection has been designed to interact with different soiling behavior as every entrance is a unique environment on its own. 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 to publish Environmental Product Declarations (EPD) for all products including full LCA reports. This EPD is using all recognized flooring Product Category Rules and is including 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 Coral Welcome into the true value and benefits to all our customers and stakeholders alike. For more information visit; www.forbo-flooring.com



ENVIRONMENTAL PRODUCT DECLARATION



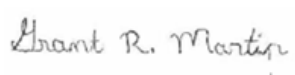
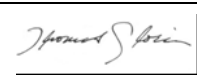
FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.



| | | |
|---|--|---|
| PROGRAM OPERATOR | UL Environment 333 Pfingsten Road Northbrook, IL 60611 | |
| DECLARATION HOLDER | Forbo Flooring B.V. Industrieweg 12 P.O. Box 13 NL-1560 AA Krommenie | |
| DECLARATION NUMBER | 4788294459.113.1 | |
| DECLARED PRODUCT | Coral Welcome Entrance Flooring System | |
| REFERENCE PCR | EN 16810: Resilient, Textile and Laminate floor coverings – Environmental product declarations – Product category rules | |
| DATE OF ISSUE | August 2, 2018 | |
| PERIOD OF VALIDITY | 5 Years | |
| CONTENTS OF THE DECLARATION | Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications | |
| The PCR review was conducted by: | | PCR Review Panel |
| This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL | |  Grant R. Martin, UL Environment |
| This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by: | |  Thomas P. Gloria, Industrial Ecology Consultants |

This EPD conforms with EN 15804

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Product Definition

Product Classification and description

This declaration covers Coral Welcome, a functional entrance flooring system. With its contemporary linear design and rich, deep pile, Coral Welcome packs the style and aesthetic appeal of a luxury carpet. It makes an unequivocal statement in any entrance area. But Coral Welcome is more than just a fabulous looking floor covering – it's an environmentally advanced one as well. The secret lies in its use of Econyl® 100% regenerated yarn, which is made from regenerated industrial and postconsumer waste. In the creation of Econyl® products our supplier is waste positive, which means the amount of waste removed from the earth is greater than the amount of waste resulting from production.

On top of that, the production has a low environmental impact because we limit the consumption of natural resources and energy to a minimum. Taking the environmental aspect even further, the primary backing of Coral Welcome is made from recycled PET bottles.

Coral Welcome is produced with green electricity and phthalate free technology. This declaration refers to Coral Welcome rolls and mats.

Coral Welcome is built up in 3 layers as illustrated in the following image :



Figure 1: Typical construction

1. **Yarn** : Econyl®, 100%-regenerated recycled yarns from industrial and postconsumer waste for maximum moisture absorption and effective dirt removal.
2. **Primary backing** : Made from a combination of regenerated polyamide and Recycled PET (from bottles).
3. **Backing** : Everfort vinyl

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

ENVIRONMENTAL PRODUCT DECLARATION




FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Range of application

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

| Area of application | Coral Welcome |
|---------------------|--|
| Commercial | <div>Class 33</div>  |

Product Standard

The product considered in this EPD has the following technical specifications:

- Meets or exceeds all requirements of EN1307: Textile Floor Coverings - Classification of Pile Carpets.



Coral Welcome meet the requirements of

| | |
|------------|---------------------------|
| EN 14041 | Essential characteristics |
| EN 13501-1 | Reaction to fire Bfl - s1 |
| EN 13893 | Slip resistance DS |
| ISO 6356 | Anti-static <2kV |

Accreditation

- ISO 9001 Quality Management System
- ISO 14001 Environmental Management System
- OHSAS 18001 Health & Safety Management System
- SA 8000 Social Accountability
- AgBB
- CHPS section 01350
- French act Grenelle: A+

Delivery Status

Table 1: Specification of delivered product

| Characteristics | | Nominal Value | Unit |
|-------------------|----------------|---------------|------------------|
| Product thickness | | 9 | mm |
| Product Weight | | 3950 | g/m ² |
| Rolls | Width x Length | 2.05 x 27.5 | m x m |
| Mats | Width x Length | 105 x 155 | cm x cm |

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Material Content

Material Content of the Product

Table 2: Composition of Coral Welcome

| Component | Material | Mass % | Availability | Origin of raw material |
|-----------------|-------------------|--------|------------------|------------------------|
| Yarn | Nylon 6 | 20 | Post industrial | Europe |
| Primary backing | Nylon 6 | 0.6 | Post industrial | Europe |
| | Polyester | 2.5 | Post industrial | Europe |
| Backing | PVC | 16.6 | Non-renewable | Europe |
| | DOTP | 16.2 | Non-renewable | Europe |
| | Calcium carbonate | 30 | Abundant mineral | Europe |
| | Recycled filler | 1.5 | Post industrial | Europe |
| | Various chemicals | 12.6 | Non-renewable | Europe/Asia |

Production of Main Materials

Nylon 6 : Made from Econyl, made with 100% Regenerated Nylon.

Primary backing : This is made from a combination of Recycled PET and Econyl, made with 100% Regenerated Nylon.

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

DOTP: A non-phthalate plasticiser, being the diester of terephthalic acid and the branched-chain 2-ethylhexanol. This colorless viscous liquid used for softening PVC plastics is known for chemical similarity to general purpose phthalates such as DEHP and DINP, but without any negative regulatory pressure.

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.

Various chemicals: Minor components including –pigments, fire retardant, heat stabiliser

Production of the Floor Covering

Coral Welcome is a cut pile entrance flooring system. Yarn is precisely inserted into the primary backing to create a mouline velour top-cloth. The residual yarn is subsequently rewound and recycled. The cloth is then backed with everfort Vinyl to anchor the bottom loop of the pile yarn in the backing.

Finally the tufted and backed entrance flooring system can be cut in any desired dimension, any cutting waste is subsequently recycled and all the waste yarn from Coral production is re-used by the yarn supplier.

Health, Safety and Environmental Aspects during Production

- ISO 14001 Environmental Management System
- SA 8000 Social Accountability standard
- OHSAS 18001 Health & Safety Management System



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Production Waste

Rejected material and the cuttings of the trimming stage are reused in the manufacturing process. Packaging materials are collected separately and externally recycled and all the waste yarn from Coral production is re-used by the yarn supplier.

Delivery and Installation of the Floor Covering

Delivery

A worldwide distribution by truck and container ship is considered. On average every square meter of Coral Welcome is transported as follows:

- | | |
|--|--------|
| ○ Transport distance 40 t truck | 326 km |
| ○ Transport distance 7.5t truck (Fine distribution) | 213 km |
| ○ Capacity utilization trucks (including empty runs) | 85 % |
| ○ Transport distance Ocean ship | 194 km |
| ○ Capacity utilization Ocean ship | 48% |

Installation

Because of the specific techniques used during the installation of Coral Welcome approximately 2% of the material is cut off as installation waste. For installation of Coral Tile on the floor a scenario has been modeled assuming an amount 0.25 kg/m² of flooring tackifier is applied to the sub-floor.

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 Coral Welcome is sold in 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 to use (low) zero emission adhesives for installing Coral Welcome floorcovering.

Waste

Waste during the installation process may be recycled as floor covering through the manufacturers' facilities or disposed of via land fill or thermally recycled in a waste incineration plant.

Packaging

Cardboard boxes and PE-foil can be collected separately and should be used in a local recycling process. The wooden pallets can be reused.



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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 occurs | Spotting agent |
| | Dry fusion clean Hot water extraction | Four times each year | Hot water Neutral detergent |

For the calculations the following cleaning regime is considered:

- Dry cleaning with a 1.5 kW vacuum cleaner for 0.21 min/m² every day. This equates to 1.92 kWh/m²*year.
- Four times a year wet cleaning with 0.062 l/m² water and 0.0008 kg/m² detergent. This result in the use of 0.248 l/m²*year water and 0.0032 kg/m²*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 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. Castor wheels should be suitable for Textilefloor coverings.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Health Aspects during Usage

Coral Welcome is in compliance with:

- AgBB/ABG requirements
- French act Grenelle: A+
- CHPS section 01350

Low emissions & phthalate free manufacturing ensures Coral Welcome can contribute to a healthy indoor environment

End of Life

The deconstruction of installed Coral tile from the floor is done manually, since the tiles are installed using a tackifier. For the End of Life stage 100% incineration is taken into account, the average distance to the incineration plant per lorry is set to 200 km.

Life Cycle Assessment

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

The following Life Cycle Stages are assessed :

- A1-3 : Product Stage (Raw material acquisition, transportation to Manufacturing and Manufacturing)
- A4-5 : Construction stage (Transport Gate to User, Installation flooring)
- B2 : Use Stage (Maintenance of the floor)
- C1-4 : End of Life Stage (Deconstruction, transport, waste processing, disposal)
- D : Benefits and loads beyond the system boundary (Reuse, recovery, recycling potential)

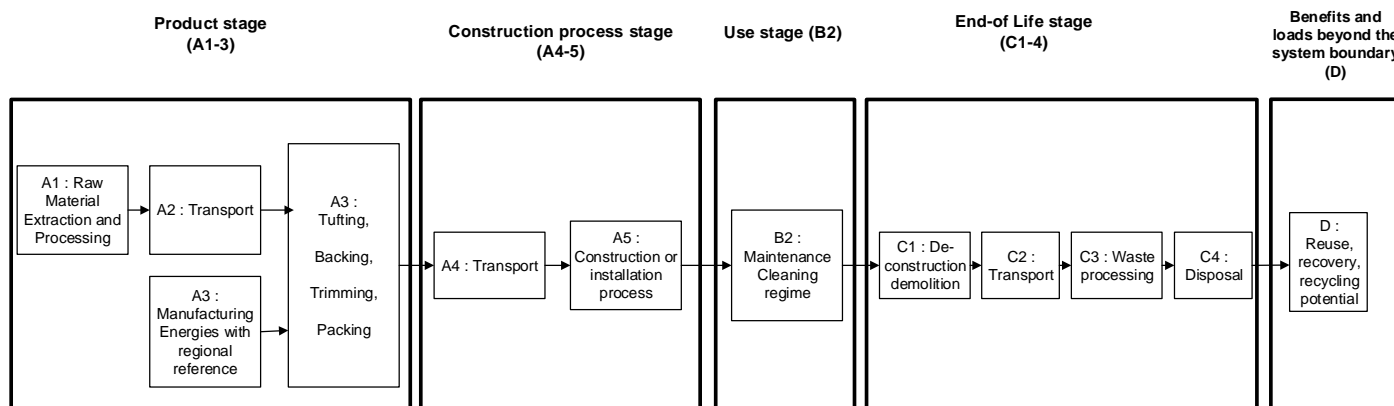


Figure 2: Flow chart of the Life Cycle Assessment

Comparisons of different floor coverings are only allowed, where EN 15804 consistent and/or preverified background data and EN 15804 consistent calculation methods and database versions are used and when the building context is taken into account, i.e. on the basis of the same use-classification (EN ISO 10874), same service life and comparable assumptions for the end of life.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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 Thinkstep 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 2017). 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 Thinkstep, 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.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Power mix

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

The products are manufactured in Krommenie, the Netherlands. The GaBi 6 Hydropower dataset has therefore been used (reference year 2017). The energy supplier is providing Forbo with a certificate every year.

CO₂-Certificates

No CO₂-certificates are considered in this study.

Life Cycle Inventory Analysis

In table 3 the environmental impacts for one lifecycle are presented for Coral Welcome. In table 4 the environmental impacts are presented for all the lifecycle stages.

Table 3: Results of the LCA – Environmental impacts one lifecycle (one year) – Coral Welcome

| Impact Category : CML 2001 – Jan. 2016 | Coral Welcome | Unit |
|---|---------------|----------------------------|
| Global Warming Potential (GWP 100 years) | 1,35E+01 | kg CO ₂ -Equiv. |
| Ozone Layer Depletion Potential (ODP. steady state) | 8,81E-08 | kg R11-Equiv. |
| Acidification Potential (AP) | 2,82E-02 | kg SO ₂ -Equiv. |
| Eutrophication Potential (EP) | 2,80E-03 | kg Phosphate-Equiv. |
| Photochem. Ozone Creation Potential (POCP) | 2,05E-03 | kg Ethene-Equiv. |
| Abiotic Depletion Potential Elements (ADPE) | 5,17E-02 | kg Sb-Equiv. |
| Abiotic Depletion Potential Fossil (ADPF) | 1,36E+02 | [MJ] |

Table 4: Results of the LCA – Environmental impact for Coral Welcome (one year)

| Impact Category : CML 2001 – Jan. 2016 | | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|---|---|---------------|--------------|----------|-----------|-------------|-----------|----------|-----------|
| Parameter | Unit | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| GWP | [kg CO ₂ -Eq.] | 7,10E+00 | 2,47E-01 | 7,63E-01 | 8,04E-01 | 0,00E+00 | 2,71E-02 | 6,78E+00 | -2,21E+00 |
| ODP | [kg CFC11-Eq.] | 8,73E-08 | 3,59E-15 | 5,91E-10 | 1,68E-10 | 0,00E+00 | 7,38E-16 | 1,56E-13 | -4,83E-12 |
| AP | [kg SO ₂ -Eq.] | 2,35E-02 | 7,83E-04 | 1,44E-03 | 2,27E-03 | 0,00E+00 | 6,58E-05 | 3,91E-03 | -3,73E-03 |
| EP | [kg PO ₄ ³⁻ -Eq.] | 1,71E-03 | 1,51E-04 | 2,16E-04 | 2,16E-04 | 0,00E+00 | 1,67E-05 | 8,90E-04 | -4,03E-04 |
| POCP | [kg Ethen Eq.] | 2,01E-03 | -1,62E-04 | 1,39E-04 | 1,43E-04 | 0,00E+00 | -2,27E-05 | 2,32E-04 | -2,92E-04 |
| ADPE | [kg Sb Eq.] | 5,17E-02 | 1,04E-08 | 1,56E-07 | 4,26E-07 | 0,00E+00 | 2,22E-09 | 1,06E-07 | -6,28E-07 |
| ADPF | [MJ] | 1,39E+02 | 1,80E+00 | 1,46E+01 | 8,57E+00 | 0,00E+00 | 3,68E-01 | 2,27E+00 | -3,04E+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

The relative contribution of each process stage to each impact category for Coral Welcome is shown in figure 3.

ENVIRONMENTAL PRODUCT DECLARATION

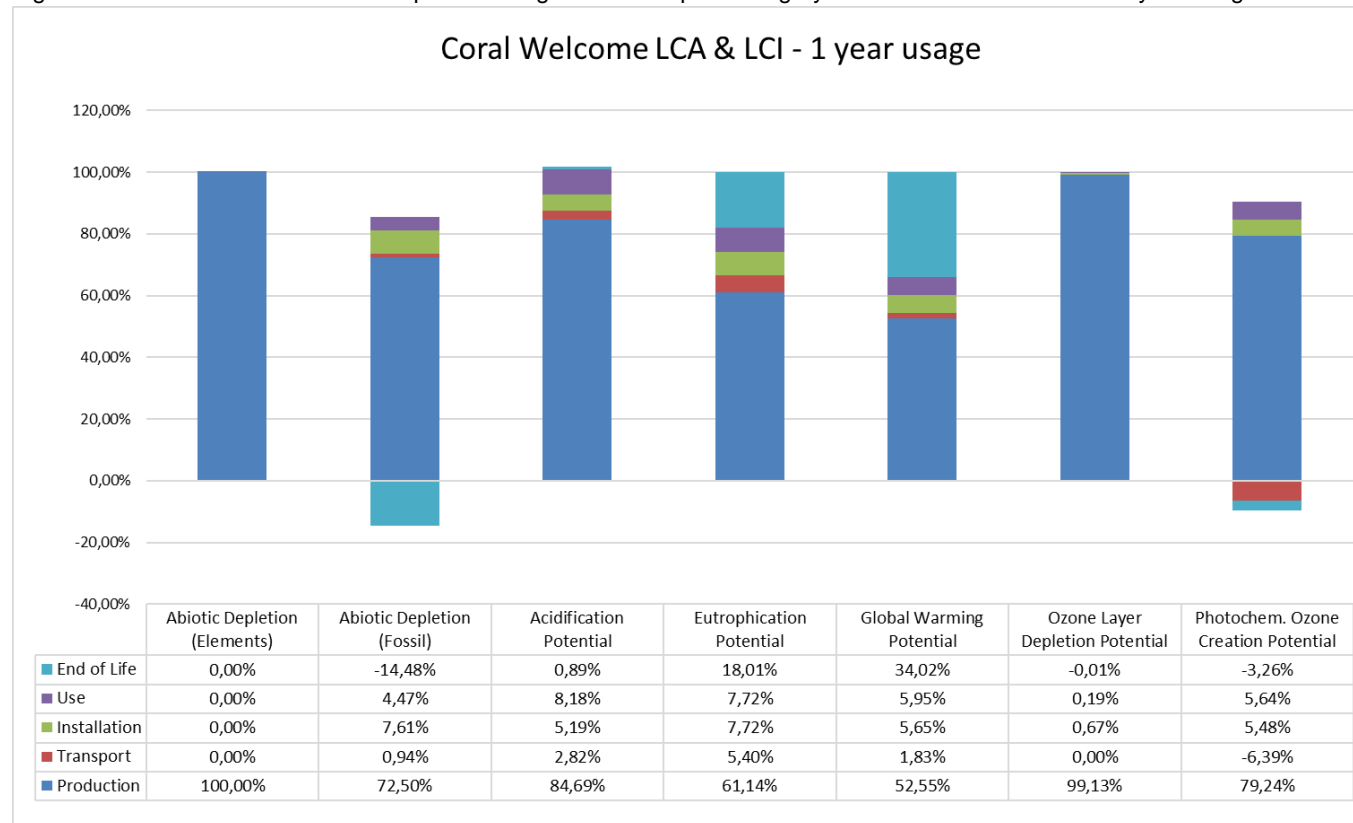


FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Figure 3: relative contribution of each process stage to each impact category for Coral Welcome for a one year usage.



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. The raw material supply is the key contributor for all of these impact categories with a share of 70 – 100% of the total impact of the production stage mainly coming from PVC, fire retardants and plasticizers used for the production of Coral Welcome. The main contributor to the manufacturing stage is the thermal energy used for producing Coral Welcome.

Although Forbo declares in the EPD a worldwide distribution by truck (539 km) and container ship (194 km) the transport stage has a limited effect on most of the impacts. Only AP and EP have a small contribution to the total impact category.

For AP, EP, GWP, POCP, and ADPF the adhesive as main contributor for the flooring installation has a minor share of 5 – 8% of the total environmental impact of Coral Welcome. In this life cycle stage very limited impact is coming from ADPE and ODP.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

In the Use stage ADPF, AP, EP, GWP and POCP have a share between 4.5 to 8% of the total impacts. This is mainly caused by the fact that an entrance flooring needs to be vacuumed daily for their best performance. In this way the cleaning of the floor coverings in the rest of the building can be reduced by 65%.

For ADPF and POCP the End of Life stage is showing a credit for the energy recovery due to the fact that the waste at the End of Life stage is considered as being incinerated. ADPE, AP and ODP show a very limited impact for this life cycle stage.

For GWP and EP the End of Life stage has got a significant influence of respectively 34 and 18% on the total impacts of these impact categories. Also for these two categories this is caused by the incineration of the waste at the End of Life stage.

Resource use

In table 5 the parameters describing resource use are presented for all the lifecycle stages for a one year usage.

Table 5: Results of the LCA – Resource use for Coral Welcome (one year)

| Parameter | Unit | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|-----------|-------------------|---------------|--------------|----------|-----------|-------------|----------|----------|-----------|
| | | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| PERE | [MJ] | 1,09E+01 | - | - | - | - | - | - | - |
| PERM | [MJ] | 0,00E+00 | - | - | - | - | - | - | - |
| PERT | [MJ] | 1,09E+01 | 9,27E-02 | 5,20E-01 | 5,47E+00 | 0,00E+00 | 2,04E-02 | 2,95E-01 | -7,49E+00 |
| PENRE | [MJ] | 1,11E+02 | - | - | - | - | - | - | - |
| PENRM | [MJ] | 3,52E+01 | - | - | - | - | - | - | - |
| PENRT | [MJ] | 1,46E+02 | 1,81E+00 | 1,49E+01 | 1,47E+01 | 0,00E+00 | 3,69E-01 | 2,55E+00 | -3,87E+01 |
| SM | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| RSF | [MJ] | 1,53E-07 | 9,04E-30 | 6,46E-21 | 2,68E-25 | 0,00E+00 | 1,99E-30 | 1,14E-22 | 0,00E+00 |
| NRSF | [MJ] | 1,95E-06 | 1,37E-28 | 7,59E-20 | 3,15E-24 | 0,00E+00 | 3,02E-29 | 1,34E-21 | -2,95E-29 |
| FW | [m ³] | 7,50E-02 | 1,71E-04 | 2,63E-03 | 7,47E-03 | 0,00E+00 | 3,75E-05 | 1,83E-02 | -1,02E-02 |

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



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Waste categories and output flows

In table 6 other environmental information describing different waste categories and output flows are presented for all the lifecycle stages.

Table 6: Results of the LCA – Output flows and Waste categories for Coral Welcome (one year)

| Parameter | Unit | Manufacturing | Transport | Installation | Use (1yr) | End of Life/credits | | | |
|-------------------|------|---------------|-----------|--------------|-----------|---------------------|----------|----------|-----------|
| | | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| HWD | [kg] | 4,31E-04 | 9,68E-08 | 4,51E-09 | 6,84E-09 | 0,00E+00 | 2,13E-08 | 2,08E-09 | -1,58E-08 |
| NHWD | [kg] | 2,29E-02 | 1,41E-04 | 5,19E-03 | 1,10E-02 | 0,00E+00 | 3,09E-05 | 5,35E-02 | -1,66E-02 |
| RWD | [kg] | 2,20E-03 | 2,45E-06 | 1,30E-04 | 2,41E-03 | 0,00E+00 | 5,05E-07 | 1,11E-04 | -3,29E-03 |
| CRU | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| MFR | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| MER | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| EE Power | [MJ] | 0,00E+00 | 0,00E+00 | 2,65E-01 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 1,21E+01 | 0,00E+00 |
| EE Thermal energy | [MJ] | 0,00E+00 | 0,00E+00 | 4,77E-01 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 2,18E+01 | 0,00E+00 |

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

Additional Environmental Information

To be fully transparent 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 USEtox™ 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. USEtox™ 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) – Coral Welcome

| Impact Category : USEtox | Coral Welcome | Unit |
|---------------------------|---------------|------------|
| Eco toxicity | 6,94E-03 | PAF m3.day |
| Human toxicity, cancer | 1,73E-09 | Cases |
| Human toxicity, non-canc. | 6,65E-10 | Cases |

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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

Table 8: Results of the LCA – Environmental impact for Coral Welcome (one year)

| Impact Category : USEtox | Unit | Production | Transport | Installation | Use (1yr) | End of Life |
|---------------------------|------------|------------|-----------|--------------|-----------|-------------|
| Eco toxicity | PAF m3.day | 5,29E-03 | 4,23E-04 | 1,50E-03 | 1,36E-03 | -1,63E-03 |
| Human toxicity, cancer | cases | 1,80E-09 | 4,20E-13 | 2,66E-11 | 3,61E-11 | -1,35E-10 |
| Human toxicity, non-canc. | cases | 5,69E-10 | 1,97E-13 | 9,67E-11 | 1,89E-12 | -3,40E-12 |

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 the Toxicity categories the production stage is the main contributor to the total overall impact. The raw material supply has a share of 75-99% of the production stage, mainly caused by the manufacturing of PVC.

The transport stage is negligible for Human toxicity (cancer) and Human toxicity (non-canc.). For Ecotoxicity it has a small impact of 4%, mainly caused by the use of diesel for the trucks.

The adhesive used for the installation of Coral Welcome is the dominant contributor for all toxicity categories, where Ecotoxicity and Human toxicity (non-canc.) have a share of approximately 14.5% over the total impacts of the life cycles. For Human toxicity (cancer) the impact is a little bit more than 1% of the total.

The Use stage has a very small impact for Human toxicity (cancer) and Human toxicity (non-canc.), only for Ecotoxicity the impact is significant with more than 13%. This is almost completely caused by the use of electricity for the cleaning of the floor. The cleaning regime used in the calculations is a worst-case scenario which will be in practice almost always be lower.

The scenario for the waste processing at the end of life is showing a significant credit for Ecotoxicity and Human toxicity (cancer) a very small impact is coming from Human toxicity (non-canc.).

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

References

| | |
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| PE 2012 ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance | Description of Selected Impact Categories, THINKSTEP AG, 2012 European Commission-Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook- Recommendations for Life Cycle Impact Assessment in the European context. First edition November 2011. EUR 24571 EN. Luxemburg. Publications Office of the European Union; 2011 |
| STANDARDS AND LAWS | |
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| 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 16810 | Resilient, Textile and laminate floor coverings - Environmental product declarations - Product category rules |
| EN 15804 | EN 15804: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products |
| 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 EN 1307 | Resilient, Textile and laminate floor coverings – Classification Textile floor coverings - Specification |



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Life Cycle Assessment

Coral Welcome



FLOORING SYSTEMS

LCA study conducted by:
Forbo Flooring
Industrieweg 12
1566 JP Assendelft
The Netherlands

July 2018

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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Nomenclature

| Abbreviation | Explanation |
|--------------|--|
| ADPF | Abiotic Depletion Potential Fossil |
| ADPE | Abiotic Depletion Potential Elements |
| 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 |
| FCSS | Floor Covering Standard Symbol |
| FW | Use of net fresh water |
| GWP | Global Warming Potential |
| HWD | Hazardous waste disposed |
| LCA | Life Cycle Assessment |
| LCI | Life Cycle Inventory analysis |
| LCIA | Life Cycle Impact 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 |



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

General

The present LCA study of the company Forbo Flooring, a manufacturer of resilient floor coverings, has been performed by Forbo Flooring and has been conducted according to the requirements of the European Standard EN15804 and EN16810 "Resilient, Textile and laminate floor coverings – Environmental product declarations – Product category rules. The LCA report was sent to verification on 27/07/18.

Scope

This document is the LCA report for the "Environmental Product Declaration" (EPD) of "Coral Welcome". 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 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, EN15804 and EN 16810.

Goal of the study

The reason for performing this LCA study is to publish an EPD based on EN 16810, EN 15804 and ISO 14025. This study contains the calculation and interpretation of the LCA results for Coral Welcome complying with EN 1307 Textile floor coverings – Specification.

Manufactured by
Forbo Flooring Coral N.V.
Vlietsend 20a
1561 AC Krommenie
The Netherlands

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

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and 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.

Coral Welcome is produced at the following manufacturing site:

Forbo Flooring Coral N.V.

Vlietsend 20a

1561 AC Krommenie

The Netherlands



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Product Definition

Product Classification and description

This declaration covers Coral Welcome, a functional entrance flooring system. With its contemporary linear design and rich, deep pile, Coral Welcome packs the style and aesthetic appeal of a luxury carpet. It makes an unequivocal statement in any entrance area. But Coral Welcome is more than just a fabulous looking floor covering – it's an environmentally advanced one as well. The secret lies in its use of Econyl® 100% regenerated yarn, which is made from regenerated industrial and postconsumer waste. In the creation of Econyl® products our supplier is waste positive, which means the amount of waste removed from the earth is greater than the amount of waste resulting from production.

On top of that, the production has a low environmental impact because we limit the consumption of natural resources and energy to a minimum. Taking the environmental aspect even further, the primary backing of Coral Welcome is made from recycled PET bottles.

Coral Welcome is produced with green electricity and phthalate free technology. This declaration refers to Coral Welcome rolls and mats.

Coral Welcome is built up in 3 layers as illustrated in the following image :



Figure 1: Typical construction

1. **Yarn** : Econyl®, 100%-regenerated recycled yarns from industrial and postconsumer waste for maximum moisture absorption and effective dirt removal.
2. **Primary backing** : Made from a combination of regenerated polyamide and Recycled PET (from bottles).
3. **Backing** : Everfort vinyl

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

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Range of application

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

| Area of application | Coral Welcome |
|---------------------|---------------------|
| Commercial | <div>Class 33</div> |

Product Standard

The product considered in this EPD has the following technical specifications:

- Meets or exceeds all requirements of EN1307: Textile Floor Coverings - Classification of Pile Carpets.



Coral Welcome meet the requirements of

| | |
|------------|---------------------------|
| EN 14041 | Essential characteristics |
| EN 13501-1 | Reaction to fire Bfl - s1 |
| EN 13893 | Slip resistance DS |
| ISO 6356 | Anti-static <2kV |

Accreditation

- ISO 9001 Quality Management System
- ISO 14001 Environmental Management System
- OHSAS 18001 Health & Safety Management System
- SA 8000 Social Accountability
- AgBB
- CHPS section 01350
- French act Grenelle: A+

Delivery status

| Characteristics | | Nominal Value | Unit |
|-------------------|----------------|---------------|------------------|
| Product thickness | | 9 | mm |
| Product Weight | | 3950 | g/m ² |
| Rolls | Width x Length | 2.05 x 27.5 | m x m |
| Mats | Width x Length | 105 x 155 | cm x cm |

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Material Content

| Component | Material | Mass % | Availability | Origin of raw material |
|------------------------|-------------------|--------|------------------|------------------------|
| Yarn | Nylon 6 | 20 | Post industrial | Europe |
| Primary backing | Nylon 6 | 0.6 | Post industrial | Europe |
| | Polyester | 2.5 | Post industrial | Europe |
| Backing | PVC | 16.6 | Non-renewable | Europe |
| | DOTP | 16.2 | Non-renewable | Europe |
| | Calcium carbonate | 30 | Abundant mineral | Europe |
| | Recycled filler | 1.5 | Post industrial | Europe |
| | Various chemicals | 12.6 | Non-renewable | Europe/Asia |

Production of Main Materials

Nylon 6 : Made from Econyl, made with 100% Regenerated Nylon.

Primary backing : This is made from a combination of Recycled PET and Econyl, made with 100% Regenerated Nylon.

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

DOTP: A non-phthalate plasticiser, being the diester of terephthalic acid and the branched-chain 2-ethylhexanol. This colorless viscous liquid used for softening PVC plastics is known for chemical similarity to general purpose phthalates such as DEHP and DINP, but without any negative regulatory pressure.

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.

Various chemicals: Minor components including –pigments, fire retardant, heat stabiliser

Production of the Floor Covering

Coral Welcome is a cut pile entrance flooring system. Yarn is precisely inserted into the primary backing to create a mouline velour top-cloth. The residual yarn is subsequently rewound and recycled. The cloth is then backed with everfort Vinyl to anchor the bottom loop of the pile yarn in the backing.

Finally the tufted and backed entrance flooring system can be cut in any desired dimension, any cutting waste is subsequently recycled and all the waste yarn from Coral production is re-used by the yarn supplier.

Health, Safety and Environmental Aspects during Production

- ISO 14001 Environmental Management System
- SA 8000 Social Accountability standard
- OHSAS 18001 Health & Safety Management System

Production Waste

Rejected material and the cuttings of the trimming stage are reused in the manufacturing process. Packaging materials are collected separately and externally recycled and all the waste yarn from Coral production is re-used by the yarn supplier.

Environment





Delivery and Installation of the Floor Covering

Delivery

A worldwide distribution by truck and container ship is considered. On average every square meter of Coral Welcome is transported as follows:

- | | |
|--|--------|
| • Transport distance 40 t truck | 326 km |
| • Transport distance 7.5t truck (Fine distribution) | 213 km |
| • Capacity utilization trucks (including empty runs) | 85 % |
| • Transport distance Ocean ship | 194 km |
| • Capacity utilization Ocean ship | 48% |

Installation

Because of the specific techniques used during the installation of Coral Welcome approximately 2% of the material is cut off as installation waste. For installation of Coral Tile on the floor a scenario has been modeled assuming an amount 0.25 kg/m² of flooring tackifier is applied to the sub-floor.

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 Coral Welcome is sold in 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 to use (low) zero emission adhesives for installing Coral Welcome floorcovering.

Waste

Waste during the installation process may be recycled as floor covering through the manufacturers' facilities or disposed of via land fill or thermally recycled in a waste incineration plant.

Packaging

Cardboard boxes and PE-foil can be collected separately and should be used in a local recycling process. The wooden pallets can be reused.

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.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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 occurs | Spotting agent |
| | Dry fusion clean Hot water extraction | Four times each year | Hot water Neutral detergent |

For the calculations the following cleaning regime is considered:

- Dry cleaning with a 1.5 kW vacuum cleaner for 0.21 min/m² every day. This equates to 1.92 kWh/m²*year.
- Four times a year wet cleaning with 0.062 l/m² water and 0.0008 kg/m² detergent. This result in the use of 0.248 l/m²*year water and 0.0032 kg/m²*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 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. Use protective feet on chairs and tables to reduce scratching. Castor wheels should be suitable for resilient floor coverings

Health Aspects during Usage

Coral Welcome is complying with:

- AgBB requirements
- CHPS section 01350
- French act Grenelle: A+

Low emissions & phthalate free manufacturing ensures Coral Welcome can contribute to a healthy indoor environment

End of Life

The deconstruction of installed Coral tile from the floor is done manually, since the tiles are installed using a tackifier. For the End of Life stage 100% incineration is taken into account, the average distance to the incineration plant per lorry is set to 200 km.



Life Cycle Assessment

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

The following Life Cycle Stages are assessed :

- A1-3 : Product Stage (Raw material acquisition, transportation to Manufacturing and Manufacturing)
- A4-5 : Construction stage (Transport Gate to User, Installation flooring)
- B2 : Use Stage (Maintenance of the floor)
- C1-4 : End of Life Stage (Deconstruction, transport, waste processing, disposal)
- D : Benefits and loads beyond the system boundary (Reuse, recovery, recycling potential)

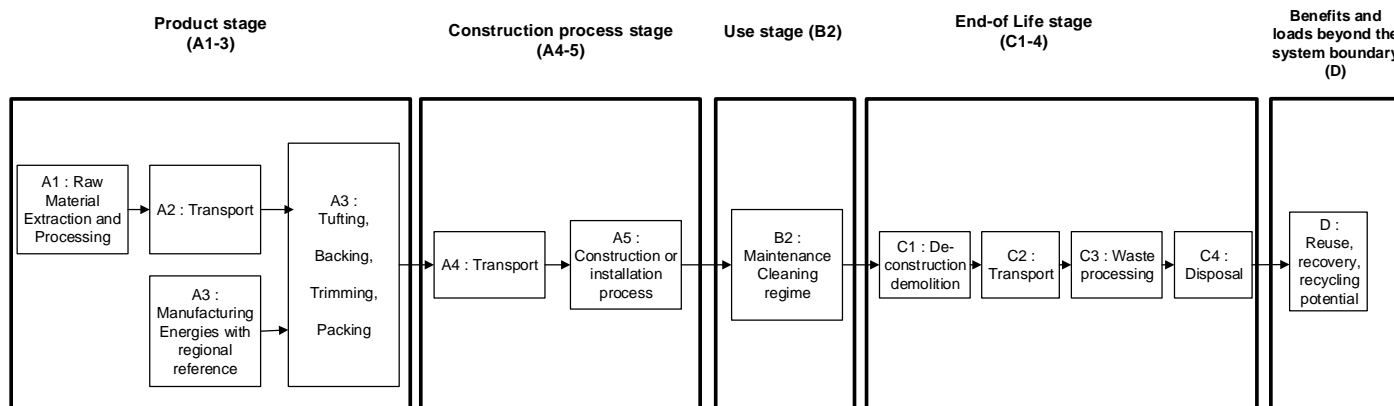


Figure 2 : Flow chart of the Life Cycle Assessment

Comparisons of different floor coverings are only allowed, where EN 15804 consistent and/or preverified background data and EN 15804 consistent calculation methods and database versions are used and when the building context is taken into account, i.e. on the basis of the same use-classification (EN ISO 10874), same service life and comparable assumptions for the end of life.

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 THINKSTEP, has been used. All relevant LCA datasets are taken from the GaBi 6 software database. The datasets

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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 2017). 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 THINKSTEP, 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 |
|--|-----------------|----------------|
| Polyvinyl chloride | Germany | 2017 |
| Di-Isononyl Phthalate (DOTP) | Germany | 2012 |
| Recycled polyamide 6 yarn | Europe | 2013 |
| Recycled material | Europe | 2018 |
| Pigment | Germany | 2018 |
| Calcium-Zinc Stabilizer | Europe | 2012 |
| Calcium carbonate | Germany | 2017 |
| Fire retardant | Global | 2010 |
| Recycled PET fibers | Europe | 2013 |
| Various chemicals | Global | 2012 |
| Water (desalinated; deionized) | Germany | 2017 |
| Detergent (ammonia based) | Germany | 2007 |
| Tap water | Germany | 2017 |
| Adhesive for resilient flooring | Germany | 2012 |
| Waste incineration of Textiles | Europe | 2017 |
| Electricity from Hydro power | The Netherlands | 2018 |
| Power grid mix | Europe | 2018 |
| Thermal energy from natural gas | The Netherlands | 2018 |
| Thermal energy from natural gas | Europe | 2018 |
| Trucks | Global | 2018 |
| Municipal waste water treatment (Sludge incineration). | Europe | 2018 |
| Container ship | Global | 2018 |
| Diesel mix at refinery | Europe | 2018 |
| Heavy fuel oil at refinery (1.0wt.% S) | Europe | 2018 |
| Polyethylene film | Germany | 2018 |
| Corrugated boxes | Europe | 2018 |

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 Krommenie, the Netherlands. The GaBi 6 Hydro power datasets has therefore been used (reference year 2017). The energy supplier is providing Forbo with a certificate every year.

CO₂-Certificates

No CO₂-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.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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 (2%):

Table 2: Composition of Coral Welcome

| Process data | Unit | Coral Welcome |
|----------------------|-------------------|---------------|
| PVC | kg/m ² | 0.65 |
| DOTP | kg/m ² | 0.63 |
| Calcium carbonate | kg/m ² | 1.17 |
| Recycled filler | kg/m ² | 0.05 |
| Recycled Polyamide 6 | kg/m ² | 0.80 |
| Various chemicals | kg/m ² | 0.50 |
| Recycled Polyester | kg/m ² | 0.10 |

Table 3: Production related inputs/outputs

| Process data | Unit | Coral Welcome |
|---------------------------------|------|---------------|
| INPUTS | | |
| Coral Welcome | kg | 3.92 |
| Electricity | MJ | 4.05 |
| Thermal energy from natural gas | MJ | 23.9 |
| OUTPUTS | | |
| Coral Welcome | kg | 3.90 |
| Waste | kg | 0.02 |

Table 4: Packaging requirements (per m² manufactured product)

| Process data | Unit | Coral Welcome |
|------------------|------|---------------|
| Polyethylene | kg | 0.013 |
| Corrugated boxes | kg | 0.035 |

Table 5: Transport distances

| Process data | Unit | Road | Truck size | Ship |
|--|------|------------|--|------|
| Calcium carbonate | km | 230 | 14 - 20t gross weight / 11,4t payload capacity | - |
| Recycled filler | km | 704 | | - |
| Recycled Polyamide 6 | km | 1208 | | - |
| PVC | km | 313 | | - |
| DOTP | km | 523 | | - |
| CaZn-stabilizer | km | 481 | | - |
| Various chemicals | km | 538 | | 8000 |
| Recycled Polyester | km | 116 | | - |
| Fire retardant | km | 333 | | - |
| Polyethylene film | km | 178 | | - |
| Corrugated boxes | km | 225 | | - |
| Transport to construction site : -Transport distance 40 t truck | km | 539 326 | 34 - 40 t gross weight / 27t payload capacity | 194 |

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

| Process data | Unit | Road | Truck size | Ship |
|--|------|------|--|------|
| -Transport distance 7.5t truck (Fine distribution) | | 213 | 7,5 t - 12t gross weight / 5t 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 | Coral Welcome |
|--------------------------------|------|---------------|
| INPUTS | | |
| Coral Welcome | kg | 3.98 |
| Adhesive (30% water content) | kg | 0.25 |
| - Water | | |
| - Acrylate co-polymer | | |
| - Styrene Butadiene co-polymer | | |
| - Limestone flour | | |
| - Sand | | |
| OUTPUTS | | |
| Installed Coral Welcome | kg | 3.9 |
| Installation Waste | kg | 0.08 |

Table 7: Inputs from use stage (per m².year of installed product)

| Process data | Unit | Coral Welcome |
|--------------|----------|---------------|
| Detergent | kg/year | 0.003 |
| Electricity | kWh/year | 1.92 |
| Water | kg/year | 0.248 |

Table 8: Disposal

| Process data | Unit | Coral Welcome |
|---|------|---------------|
| Post-consumer Coral Welcome to incineration | % | 100 |

Life Cycle Inventory Analysis

In table 9 the environmental impacts for one lifecycle are presented for Coral Welcome. In the table 10 the environmental impacts are presented for all the lifecycle stages.

Table 9: Results of the LCA – Environmental impacts one lifecycle (one year) – Coral Welcome

| Impact Category : CML 2001 – Jan 2016 | Coral Welcome | Unit |
|---|---------------|----------------------------|
| Global Warming Potential (GWP 100 years) | 1,35E+01 | kg CO ₂ -Equiv. |
| Ozone Layer Depletion Potential (ODP. steady state) | 8,81E-08 | kg R11-Equiv. |
| Acidification Potential (AP) | 2,82E-02 | kg SO ₂ -Equiv. |
| Eutrophication Potential (EP) | 2,80E-03 | kg Phosphate-Equiv. |
| Photochem. Ozone Creation Potential (POCP) | 2,05E-03 | kg Ethene-Equiv. |
| Abiotic Depletion Potential Elements (ADPE) | 5,17E-02 | kg Sb-Equiv. |
| Abiotic Depletion Potential Fossil (ADPF) | 1,36E+02 | [MJ] |

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

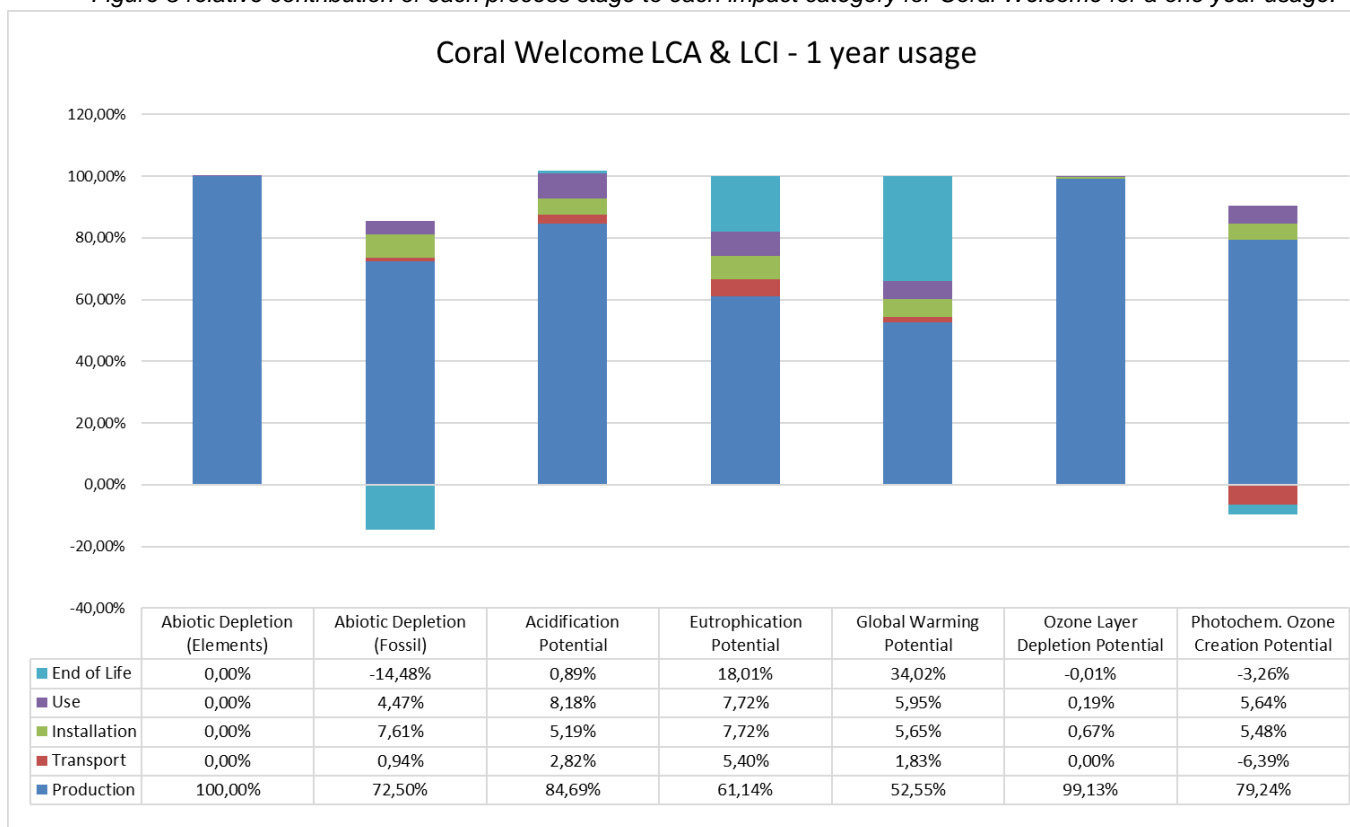
Table 10: Results of the LCA – Environmental impact for Coral Welcome (one year)

| Impact Category : CML 2001 – Jan 2016 | | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|--|--|---------------|--------------|----------|-----------|-------------|-----------|----------|-----------|
| Parameter | Unit | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| GWP | [kg CO ₂ -Eq.] | 7,10E+00 | 2,47E-01 | 7,63E-01 | 8,04E-01 | 0,00E+00 | 2,71E-02 | 6,78E+00 | -2,21E+00 |
| ODP | [kg CFC11-Eq.] | 8,73E-08 | 3,59E-15 | 5,91E-10 | 1,68E-10 | 0,00E+00 | 7,38E-16 | 1,56E-13 | -4,83E-12 |
| AP | [kg SO ₂ -Eq.] | 2,35E-02 | 7,83E-04 | 1,44E-03 | 2,27E-03 | 0,00E+00 | 6,58E-05 | 3,91E-03 | -3,73E-03 |
| EP | [kg PO ₄ ³⁻ - Eq.] | 1,71E-03 | 1,51E-04 | 2,16E-04 | 2,16E-04 | 0,00E+00 | 1,67E-05 | 8,90E-04 | -4,03E-04 |
| POCP | [kg Ethen Eq.] | 2,01E-03 | -1,62E-04 | 1,39E-04 | 1,43E-04 | 0,00E+00 | -2,27E-05 | 2,32E-04 | -2,92E-04 |
| ADPE | [kg Sb Eq.] | 5,17E-02 | 1,04E-08 | 1,56E-07 | 4,26E-07 | 0,00E+00 | 2,22E-09 | 1,06E-07 | -6,28E-07 |
| ADPF | [MJ] | 1,39E+02 | 1,80E+00 | 1,46E+01 | 8,57E+00 | 0,00E+00 | 3,68E-01 | 2,27E+00 | -3,04E+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

The relative contribution of each process stage to each impact category for Coral Welcome is shown in figure 3.

Figure 3 relative contribution of each process stage to each impact category for Coral Welcome for a one year usage.



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.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

In all of the impact categories the production stage has the main contribution to the overall impact. The raw material supply is the key contributor for all of these impact categories with a share of 70 – 100% of the total impact of the production stage mainly coming from PVC, fire retardants and plasticizers used for the production of Coral Welcome. The main contributor to the manufacturing stage is the thermal energy used for producing Coral Welcome.

Although Forbo declares in the EPD a worldwide distribution by truck (539 km) and container ship (194 km) the transport stage has a limited effect on most of the impacts. Only AP and EP have a small contribution to the total impact category.

For AP, EP, GWP, POCP, and ADPF the adhesive as main contributor for the flooring installation has a minor share of 5 – 8% of the total environmental impact of Coral Welcome. In this life cycle stage very limited impact is coming from ADPE and ODP.

In the Use stage ADPF, AP, EP, GWP and POCP have a share between 4.5 to 8% of the total impacts. This is mainly caused by the fact that an entrance flooring needs to be vacuumed daily for their best performance. In this way the cleaning of the floor coverings in the rest of the building can be reduced by 65%.

For ADPF and POCP the End of Life stage is showing a credit for the energy recovery due to the fact that the waste at the End of Life stage is considered as being incinerated. ADPE, AP and ODP show a very limited impact for this life cycle stage.

For GWP and EP the End of Life stage has got a significant influence of respectively 34 and 18% on the total impacts of these impact categories. Also for these two categories this is caused by the incineration of the waste at the End of Life stage.

Resource use

In table 11 the parameters describing resource use are presented for all the life cycle stages for a one year usage.

Table 11 : Results of the LCA – Resource use for Coral Welcome (one year)

| | | Manufacturing | Installation | | Use (1yr) | End of Life | | | Credits |
|-----------|-------------------|---------------|--------------|----------|-----------|-------------|----------|----------|-----------|
| Parameter | Unit | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| PERE | [MJ] | 1,09E+01 | - | - | - | - | - | - | - |
| PERM | [MJ] | 0,00E+00 | - | - | - | - | - | - | - |
| PERT | [MJ] | 1,09E+01 | 9,27E-02 | 5,20E-01 | 5,47E+00 | 0,00E+00 | 2,04E-02 | 2,95E-01 | -7,49E+00 |
| PENRE | [MJ] | 1,11E+02 | - | - | - | - | - | - | - |
| PENRM | [MJ] | 3,52E+01 | - | - | - | - | - | - | - |
| PENRT | [MJ] | 1,46E+02 | 1,81E+00 | 1,49E+01 | 1,47E+01 | 0,00E+00 | 3,69E-01 | 2,55E+00 | -3,87E+01 |
| SM | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| RSF | [MJ] | 1,53E-07 | 9,04E-30 | 6,46E-21 | 2,68E-25 | 0,00E+00 | 1,99E-30 | 1,14E-22 | 0,00E+00 |
| NRSF | [MJ] | 1,95E-06 | 1,37E-28 | 7,59E-20 | 3,15E-24 | 0,00E+00 | 3,02E-29 | 1,34E-21 | -2,95E-29 |
| FW | [m ³] | 7,50E-02 | 1,71E-04 | 2,63E-03 | 7,47E-03 | 0,00E+00 | 3,75E-05 | 1,83E-02 | -1,02E-02 |

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



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Waste categories and output flows

In table 12 other environmental information describing different waste categories and output flows are presented for all the life cycle stages.

Table 12: Results of the LCA – Output flows and Waste categories for Coral Welcome (one year)

| Parameter | Unit | Manufacturing | Transport | Installation | Use (1yr) | End of Life/credits | | | |
|-------------------|------|---------------|-----------|--------------|-----------|---------------------|----------|----------|-----------|
| | | A1-3 | A4 | A5 | B2 | C1 | C2 | C3 | D |
| HWD | [kg] | 4,31E-04 | 9,68E-08 | 4,51E-09 | 6,84E-09 | 0,00E+00 | 2,13E-08 | 2,08E-09 | -1,58E-08 |
| NHWD | [kg] | 2,29E-02 | 1,41E-04 | 5,19E-03 | 1,10E-02 | 0,00E+00 | 3,09E-05 | 5,35E-02 | -1,66E-02 |
| RWD | [kg] | 2,20E-03 | 2,45E-06 | 1,30E-04 | 2,41E-03 | 0,00E+00 | 5,05E-07 | 1,11E-04 | -3,29E-03 |
| CRU | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| MFR | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| MER | [kg] | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| EE Power | [MJ] | 0,00E+00 | 0,00E+00 | 2,65E-01 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 1,21E+01 | 0,00E+00 |
| EE Thermal energy | [MJ] | 0,00E+00 | 0,00E+00 | 4,77E-01 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 2,18E+01 | 0,00E+00 |

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

Additional Environmental Information

To be fully transparent 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 USEtox™ 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. USEtox™ is classified as Level II / III, unlike for example the CML impact categories which are classified as Level I.

Table 13: Results of the LCA – Environmental impacts one lifecycle (one year) – Coral Welcome

| Impact Category : USEtox | Coral Welcome | Unit |
|---------------------------|---------------|------------|
| Eco toxicity | 6,94E-03 | PAF m3.day |
| Human toxicity, cancer | 1,73E-09 | Cases |
| Human toxicity, non-canc. | 6,65E-10 | Cases |

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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

Table 14: Results of the LCA – Environmental impact for Coral Welcome (one year)

| Impact Category : USEtox | Unit | Production | Transport | Installation | Use (1yr) | End of Life |
|---------------------------|------------|------------|-----------|--------------|-----------|-------------|
| Eco toxicity | PAF m3.day | 5,29E-03 | 4,23E-04 | 1,50E-03 | 1,36E-03 | -1,63E-03 |
| Human toxicity, cancer | cases | 1,80E-09 | 4,20E-13 | 2,66E-11 | 3,61E-11 | -1,35E-10 |
| Human toxicity, non-canc. | cases | 5,69E-10 | 1,97E-13 | 9,67E-11 | 1,89E-12 | -3,40E-12 |

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 the Toxicity categories the production stage is the main contributor to the total overall impact. The raw material supply has a share of 75-99% of the production stage, mainly caused by the manufacturing of PVC.

The transport stage is negligible for Human toxicity (cancer) and Human toxicity (non-canc.). For Ecotoxicity it has a small impact of 4%, mainly caused by the use of diesel for the trucks.

The adhesive used for the installation of Coral Welcome is the dominant contributor for all toxicity categories, where Ecotoxicity and Human toxicity (non-canc.) have a share of approximately 14.5% over the total impacts of the life cycles. For Human toxicity (cancer) the impact is a little bit more than 1% of the total.

The Use stage has a very small impact for Human toxicity (cancer) and Human toxicity (non-canc.), only for Ecotoxicity the impact is significant with more than 13%. This is almost completely caused by the use of electricity for the cleaning of the floor. The cleaning regime used in the calculations is a worst-case scenario which will be in practice almost always be lower.

The scenario for the waste processing at the end of life is showing a significant credit for Ecotoxicity and Human toxicity (cancer) a very small impact is coming from Human toxicity (non-canc.).

Interpretation main modules and flows

The interpretation of the main modules and flows contributing to the total impact in each category is presented in following figure and table.

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

Figure 4: relative contribution of each process stage to each impact category for Coral Welcome for a one year usage.

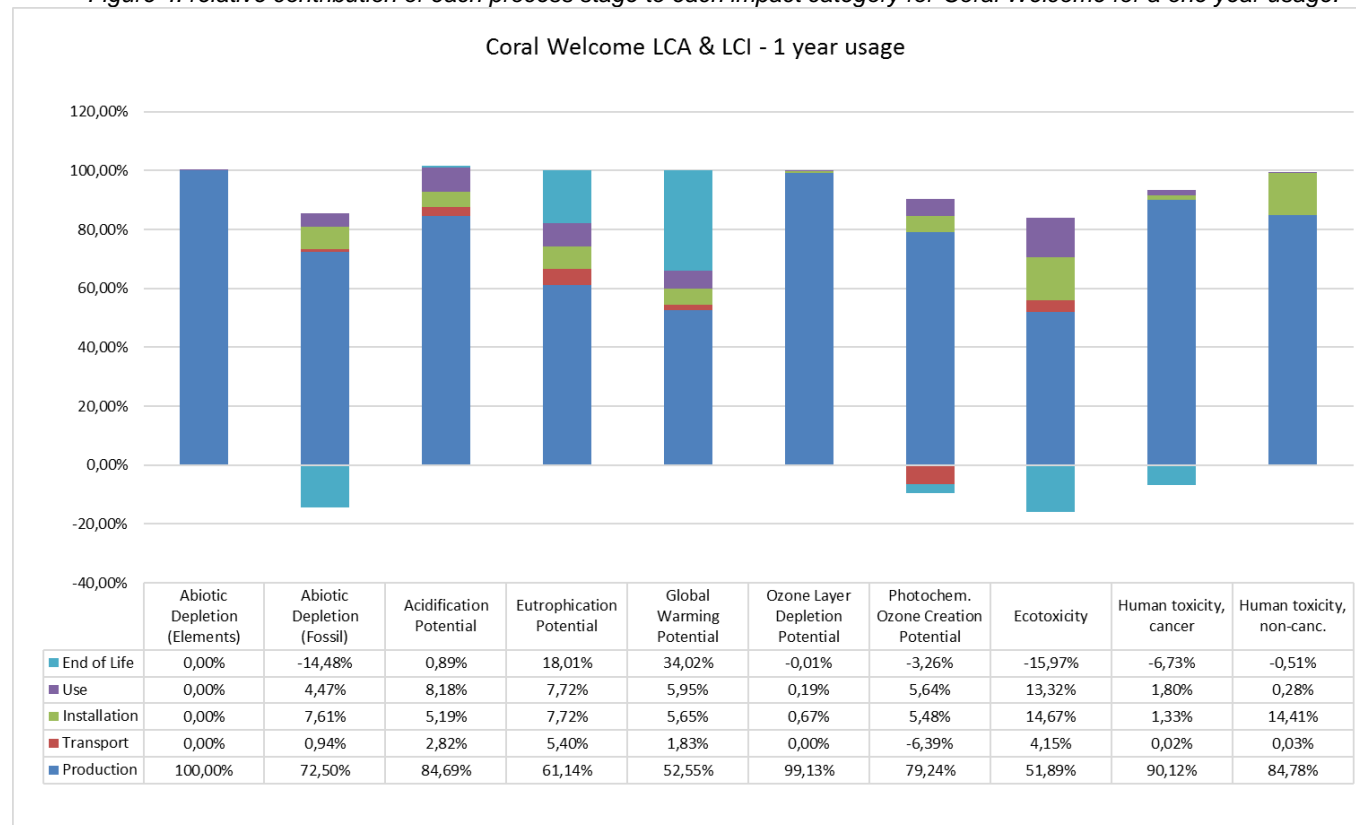


Table 15: Main modules and flows contributing to the total impact in each impact category for Coral Welcome for a one year usage

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|-----------------|--------------|----------------------------|---------------------------------|---|--|
| GWP | Production | Raw Material Extraction | 5.0 kg CO ₂ -equiv. | DOTP (2.1 kg CO ₂ -eq.) PVC (1.6 kg CO ₂ -eq.) Antimony oxide (1.3 kg CO ₂ -eq.) | Production : Inorganic emissions to air, Carbon dioxide |
| | | Transport of Raw materials | 0.02 kg CO ₂ -equiv. | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 2.1 kg CO ₂ -equiv. | 97% Thermal energy | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Inorganic emissions to air, Carbon dioxide |
| | Installation | Installation | | 81% Adhesive 19% Disposal of Coral installation waste | |
| | Use | Use | | 99% Electricity | Use : Inorganic emissions to air, Carbon dioxide |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL : Inorganic emissions to air, Carbon dioxide, Carbon dioxide (Biotic) |
| ODP | Production | Raw Material Extraction | 100% | 36% Antimony dioxide 63% DOTP | Production : Halogenated organic emissions to air, R11 (trichlorofluoromethane), |

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|-----------------|--------------|----------------------------|---------|--|--|
| | | Transport of Raw materials | < 0.05% | Means of transport (truck, container ship) and their fuels | R114 (Dichlorotetrafluorethane), R12 (Dichlorodifluoromethane) |
| | | Manufacturing | < 0.05% | 97% Electricity | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Halogenated organic emissions to air, R114 (Dichlorotetrafluorethane) |
| | Installation | Installation | | 100% Adhesive | |
| | Use | Use | | 98% Detergent | Use : Halogenated organic emissions to air, R11 (trichlorofluoromethane), R114 (Dichlorotetrafluorethane), R12 (Dichlorodifluoromethane) |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL: Halogenated organic emissions to air, R22 (chlorodifluoromethane) |
| AP | Production | Raw Material Extraction | 97% | 17% DOTP 11% PVC 68% Antimony oxide | Production : Inorganic emissions to air, NO _x and Sulphur dioxide |
| | | Transport of Raw materials | < 0.3% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 3% | 90% Thermal energy | |
| | 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 | | 94% Adhesive | |
| | Use | Use | | 99% Electricity | Use : Inorganic emissions to air, NO _x and Sulphur dioxide |
| EP | Production | Raw Material Extraction | 90% | 44% Antimony oxide 24% PVC 24% DOTP | Production : Inorganic emissions to air, Ammonia, NO _x Production : Inorganic emissions to fresh water, Nitrate, Nitrogen, Ammonium/Ammonia |
| | | Transport of Raw materials | 1% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 9% | 90% Thermal energy | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Inorganic emissions to air, NO _x Transport & Installation : Inorganic emissions to fresh water, Ammonium / ammonia |
| | Installation | Installation | | 91% Adhesive | |
| | Use | Use | | 98% Electricity | Use : Inorganic emissions to air, NO _x Use : Inorganic emissions to fresh water, Ammonium / ammonia, Nitrate, Phosphorus |
| POCP | Production | Raw Material Extraction | 91% | 28% PVC 28% DOTP 42% Antimony oxide | Production : Inorganic emissions to air, Carbon monoxide, NO _x , Sulphur dioxide Production : Halogenated organic emissions to air, NMVOC (Unspecified), Propane, Methane, Ethane |
| | | Transport of Raw materials | 1% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 8% | 96% Thermal energy | |
| | 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 Transport & Installation : Halogenated organic emissions to air, NMVOC (Unspecified), |
| | Installation | Installation | | 97% Adhesive | |
| | Use | Use | | 99% electricity | Use : Inorganic emissions to air, Sulphur dioxide, Nitrogen dioxide |
| | EOL | EOL | | Incineration of post-consumer | EOL : Inorganic emissions to air, Carbon |



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|------------------------|--------------|----------------------------|---------|--|---|
| | | | | Coral Welcome. Energy substitution from incineration | monoxide, NO _x , Sulphur dioxide EOL : Organic emissions to air (Group VOC), NMVOC (Unspecified) |
| ADPe | Production | Raw Material Extraction | 100% | 100% Antimony oxide | Production : Nonrenewable resources, Antimony – Gold – ore (0.09%) |
| | | Transport of Raw materials | < 0,01% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | < 0.01% | 15% Thermal energy 80% Electricity | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Nonrenewable resources, Sodium chloride (rock salt) |
| | Installation | Installation | | 99% Adhesive | Transport & Installation : Nonrenewable elements, Lead, Silver, Copper |
| | Use | Use | | 99% Electricity | Use : Nonrenewable resources, Sodium chloride (Rock salt) Use : Nonrenewable elements, Copper |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL : Nonrenewable resources, Magnesium chloride leach (40%) |
| ADPf | Production | Raw Material Extraction | 75% | 35% PVC 52% DOTP 12% Antimony oxide | Production : Crude oil resource, Crude oil (in MJ) Production : Natural gas (resource), Natural gas (in MJ) |
| | | Transport of Raw materials | <0.3% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 25% | 98% Thermal energy | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Crude oil (resource) |
| | Installation | Installation | | 99% Adhesive | Transport & Installation : Natural gas (resource), |
| | Use | Use | | 99% electricity | Use : Hard coal (resource), Natural gas (resource), Hard coal (resource) |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL : Hard coal (resource), Natural gas (resource), Lignite (resource), Crude oil (resource) |
| Eco toxicity | Production | Raw Material Extraction | 83% | 60% PVC 30% DOTP | Production : Halogenated emissions to air, Formaldehyde (Methanal) Production : Hydrocarbons to fresh water, Phenol (hydroxy benzene), Anthracene, Benzene, Toluene (Methyl benzene) Production : Pesticides to fresh water, Alachlor |
| | | Transport of Raw materials | 1% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 16% | 64% Thermal energy 37% Packaging | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & installation : Hydrocarbons to fresh water, Phenol (hydroxy benzene), Anthracene, Benzene, Toluene (Methyl benzene), Methanol |
| | Installation | Installation | | 99% Adhesive | Transport & installation : Pesticides to fresh water, Alachlor |
| | Use | Use | | 100% Electricity | Use : Hydrocarbons to fresh water, Phenol (hydroxy benzene), Anthracene, Benzene, Toluene (Methyl benzene) Use : Pesticides to fresh water, Alachlor |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL : Hydrocarbons to fresh water, Phenol (hydroxy benzene), Anthracene, Benzene, Toluene (Methyl benzene) EOL : Pesticides to fresh water, Alachlor |
| Human toxicity, cancer | Production | Raw Material Extraction | 75% | 89% PVC | Production : Organic emissions to air (Group VOC), Vinyl chloride (VCM; chloroethene), Formaldehyde (Methanal) |
| | | Transport of | < 0.1% | Means of transport (truck, | |

Environment



ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

| Impact Category | Stage | Module | | Main contributor | Main contributing flows |
|---------------------------|--------------|----------------------------|---------|--|---|
| | | Raw materials | | container ship) and their fuels | |
| | | Manufacturing | 25% | 100% Thermal energy | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Organic emissions to air (Group VOC), Formaldehyde (Methanal) |
| | Installation | Installation | | 99% adhesive | |
| | Use | Use | | 99% Electricity | Use : Organic emissions to air (Group VOC), Formaldehyde (Methanal) |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL : Organic emissions to air (Group VOC), Formaldehyde (Methanal) |
| Human toxicity, non canc. | Production | Raw Material Extraction | 99% | 98% PVC | Production : Organic emissions to air (Group VOC), Vinyl chloride (VCM; chloroethene), Formaldehyde (Methanal) Production : Halogenated organic emissions to fresh water, Vinyl chloride (VCM; chloroethene) |
| | | Transport of Raw materials | < 0.01% | Means of transport (truck, container ship) and their fuels | |
| | | Manufacturing | 1% | 99% Thermal energy | |
| | Transport | Transport Gate to User | | Means of transport (truck, container ship) and their fuels | Transport & Installation : Organic emissions to air (Group VOC), Formaldehyde (Methanal), Methyl Methacrylate (MMA) |
| | Installation | Installation | | 100% adhesive | |
| | Use | Use | | 99% electricity | Use : Organic emissions to air (Group VOC), Formaldehyde (Methanal), Xylene (dimethyl benzene) |
| | EOL | EOL | | Incineration of post-consumer Coral Welcome. Energy substitution from incineration | EOL : Organic emissions to air (Group VOC), Formaldehyde (Methanal) |



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 SiedIABf.

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 ($\text{CO}_2\text{-Eq.}$). 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.

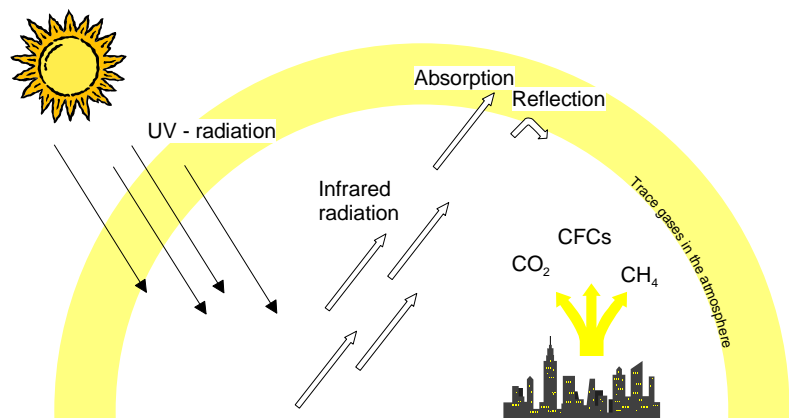


Figure A1: Greenhouse effect (KREISSIG 1999)

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 natural 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 ($\text{SO}_2\text{-Eq.}$). 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.

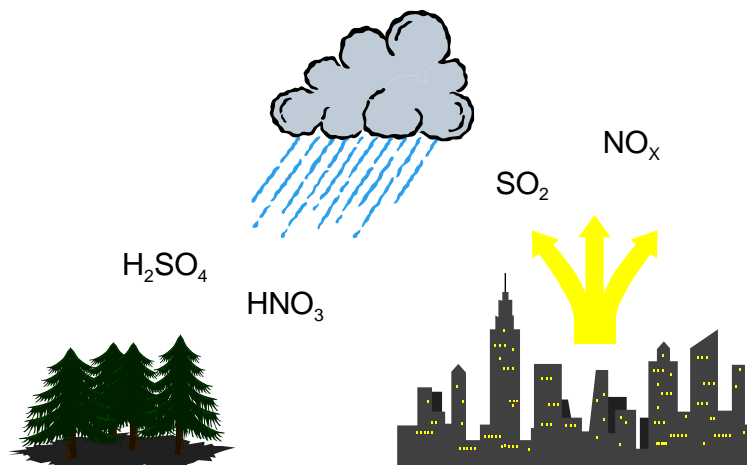


Figure A2: Acidification Potential (KREISSIG 1999)

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 nitrification 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.

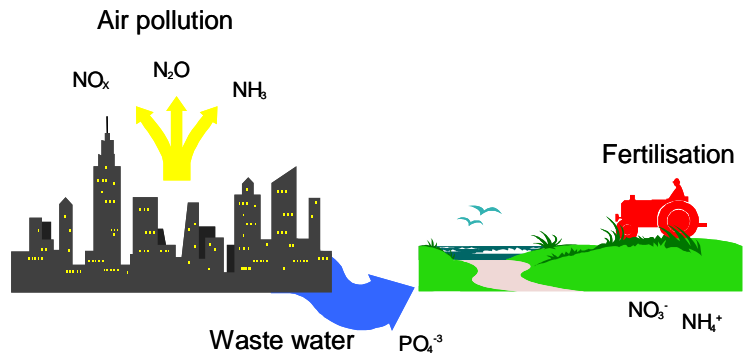


Figure A3: Eutrophication Potential (KREISSIG 1999)

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 NO₂, CO₂ and O₂. 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 (C₂H₄-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.

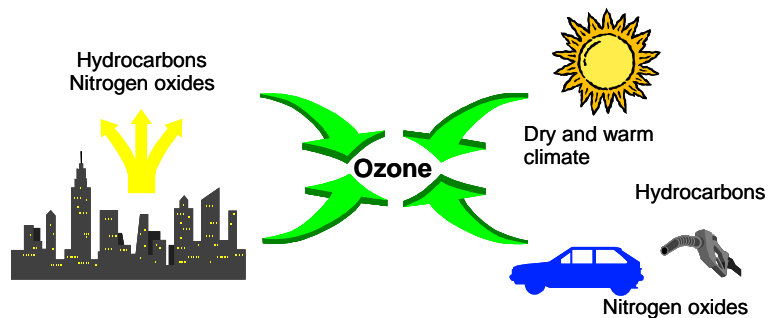


Figure A4: Photochemical Ozone Creation Potential

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.

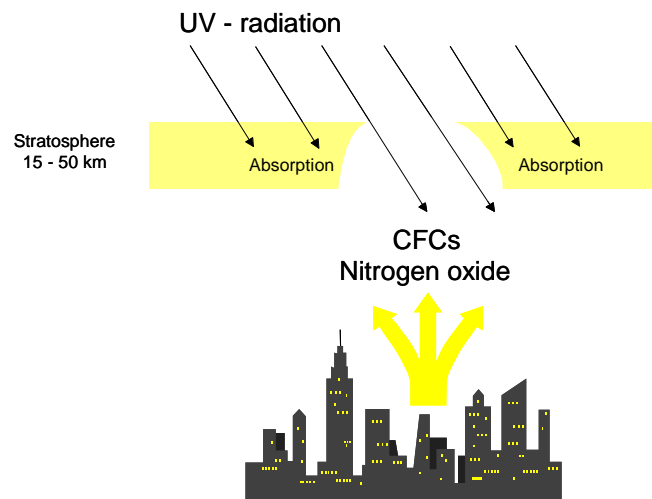


Figure A5:

Ozone Depletion Potential (KREISSIG 1999)

ENVIRONMENTAL PRODUCT DECLARATION



FLOORING SYSTEMS

Coral Welcome
Entrance Flooring System

According to ISO 14025 and EN 15804

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