Secugrid®

Environmental Product Declaration

Declaration number:
EPD-NAUE-SG-001-ref1 2017

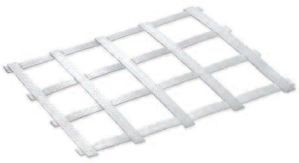
NAUE

Environmental Product Declaration (EPD)

Secugrid®

Secugrid® R6 uniaxial PET
Product family

Secugrid® Q1 biaxial PP
Product family



Secugrid® Q6 biaxial PET
Product family

Declaration holder

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Declared product:

NAUE Secugrid®, geosynthetic for slope retention

Data calculation by

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CEN standard EN 15804 serves as the core PCR	
Independent verification of the declaration and data, according to EN ISO 14025:2010 ☒ internal ☐ external	

1 General aspects

This Environmental Product Declaration (EPD) is commissioned by NAUE GmbH & Co. KG and accomplished by treeze Ltd. in 2016. The study has been conducted according to the requirements of IES product category rules (IES 2012) and the standard EN 15804+A1 (European Committee for Standardisation (CEN) 2013). The investigated products are the NAUE geosynthetics Secugrid® PET and Secugrid® PP intended for the use in many fields of civil engineering including landfill engineering and hydraulic engineering.

2 Product

2.1 Description and Application

The investigated products are the NAUE geogrids Secugrid® PET (Polyester) and Secugrid® PP (Polypropylene) intended for the use in many fields of civil engineering including road construction, landfill engineering and hydraulic engineering.

The classification number according to the UN CPC classification system is 36950.

The Secugrid® PET product line is mainly used for applications like reinforced slopes and retaining walls, load transfer platforms over piles, bridging of mining voids and sinkholes as well as veneer reinforcement in landfill engineering. The product line provides superior long-term design strength characteristics due to its high resistance against creep effects. Furthermore, high strength at low strain (high tensile modulus) is achieved as result of pre-stressed bars, which reduces deformation of the individual Secugrid® reinforced structures.

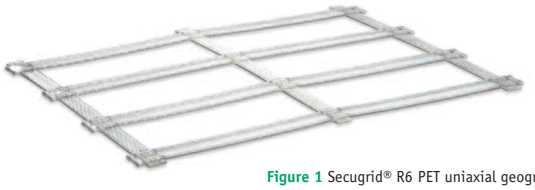

Figure 1 Secugrid® R6 PET uniaxial geogrid

The Secugrid® PP product line is mainly used for reinforcement and stabilisation of unbound aggregate layers in foundations, road pavements and trafficked areas. On top of weak subgrades the geogrid reinforcement increases the shear strength of the base aggregate and thus its load distribution capacity, which allows the reduction of fill material in comparison to unreinforced layers. Furthermore, the product can reduce potential differential settlements and provides lateral restraint for the base course material. Thus, the base course generates a higher stiffness, longer life times and higher serviceability compared to unreinforced constructions.

The main differences between the two product lines are the different raw materials. This EPD describes the weighted average Secugrid® products sold by NAUE. The results of this EPD are representative for all Secugrid® products of NAUE using the same raw material.

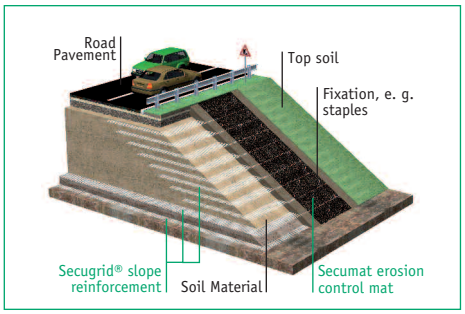

Figure 2 Secugrid® reinforced slope with 45° inclination

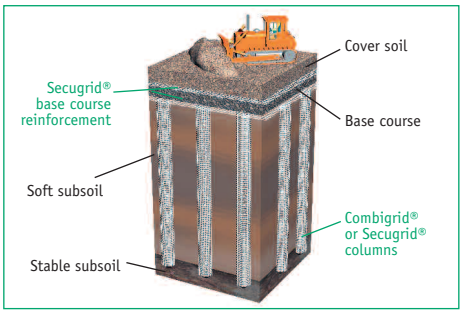

Figure 3 Base course reinforcement in areas with soft subsoils

Figure 4 Secugrid® reinforcement over areas prone to subsidence

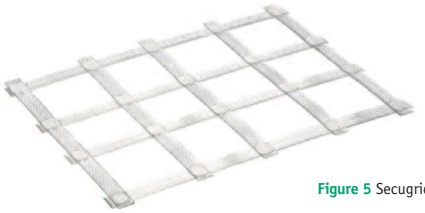

Figure 5 Secugrid® Q6 PET biaxial geogrid

Figure 6 Secugrid® Q1 PP biaxial geogrid

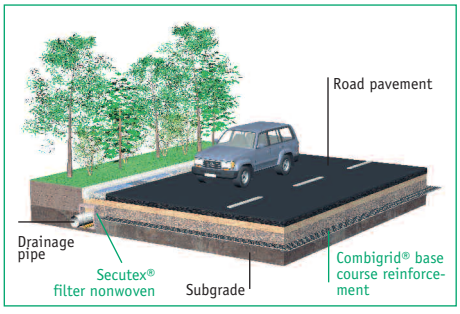

Figure 7 Base course improvement with the composite product Combigrid® for separation and reinforcement

Figure 8 Secugrid® soil reinforcement in railroad applications

Figure 9 Base course reinforcement for a windfarm access road over soft subsoils

Product			Construction		Use	End-of-life			
Raw material	Transport to manufacturer (inter-company logistics)	Manufacturing	Transport to the construction site	Construction and installation	Use	Deconstruction, demolition	Transport to the product's waste processing	Waste processing for reuse, recovery and/or recycling	Disposal
A1	A2	A3	A4	A5	B1-B5	C1	C2	C3	C4
x	x	x	x	x	n.a.	n.a.	n.a.	n.a.	n.a.

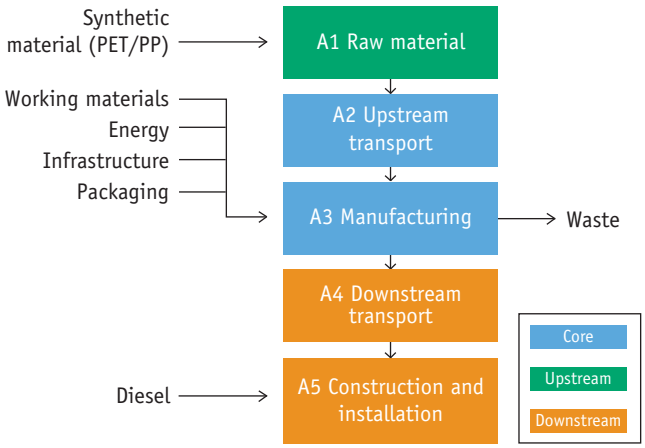

Figure 10
Graphical overview of the life cycle stages covered by the EPD of geosynthetics

[g/m²]	PET 120/40 R6, density 580 g/m²	PP 40/40 Q6, density 240 g/m²
PET	622	
PP		253
Additive 1		4.2
Talcum		7.6

Table 1
Raw material content of the different Secugrid® geogrids made of PET and PP

2.2 Raw material (A1)

The products are manufactured with the raw material as listed in table 1.

The additive input is modelled as Polypropylene, because reliable data inventory data on the additives is missing. Based on an expert judgment, this assumption overestimates the environmental impacts of the Secugrid® PP for most of the indicators analysed.

The product is delivered in linear low-density polyethylene packaging foils (1.4 g/m² Secugrid®).

2.3 Transport (A2)

The transport to manufacturer (A2) considers transports of raw materials to the NAUE manufacturing site. The raw materials are transported from the producer to the NAUE's production site by lorries only (figure 12). The average distance is 295km for PET and 444km for PP.

Table 2
Specific raw material, working material and energy consumption, wastes produced and infrastructure requirements per square meter of averaged geomembrane of the the different Secugrid® made of PET and PP

DE: Germany
OCE: Oceanic
RER: Europe
GLO: Global

tkm/m² - ton-kilometer per m²
* filed confidentially

Specific material consumption	Specific material and energy use per m²	Country Code	Unit	Secugrid® PET	Secugrid® PP
Production volume and reference year	Annual production volume		tons	*	*
	Annual production volume		m²	*	*
	Reference year			2015	2015
	Mass per unit area		kg/m²	0.580	0.240
A1 Raw material	PET	RER	kg/m²	0.622	0.000
	PP	RER	kg/m²	0.000	0.237
A2 Transports to production site	Lorry, 25 tons	RER	tkm/m²	1.84E-01	1.09E-01
A3 Working material and energy consumption	**Working material**				
	Tap water	RER	kg/m²	3.82E-02	4.03E-02
	Lubricating oil	RER	kg/m²	3.19E-05	2.21E-05
	Packaging				
	LLDPE (Packaging)	RER	kg/m²	2.79E-03	1.61E-03
	Paper case / cardboard	RER	kg/m²	4.56E-03	7.13E-03
	Energy				
	Electricity	DE	kWh/m²	2.97E-01	2.97E-01
	Diesel	GLO	MJ/m²	1.29E-02	1.36E-02
	Light fuel oil	DE	MJ/m²	1.46E-02	1.54E-02
	Waste				
	Municipal waste	DE	kg/m²	2.41E-02	2.00E-02
	Hazardous waste (machine oil)	DE	kg/m²	5.31E-05	1.05E-05
	PET to recycling		kg/m²	2.41E-02	0.00E+00
	Land use				
	Total area		m²/m²	1.37E-03	8.78E-04
	Factory halls	DE	m²/m²	3.87E-04	2.48E-04
	Office buildings	DE	m²/m²	1.87E-05	1.20E-05
	Other sealed area	-	m²/m²	6.22E-04	3.99E-04
A4 Transports to construction site	Ship	OCE	tkm/m²	3.25E+00	1.12E+00
	Lorry, 25 tons	RER	tkm/m²	9.32E-01	3.25E-01
A5 Installation	Diesel consumption	GLO	MJ/m²	1.04	1.04
Other parameters	Life time buildings/structures		years	80	80
	NCV diesel		MJ/liter	35.95	35.95
	NCV light fuel oil		MJ/liter	36.64	36.64
	NCV natural gas		MJ/m³	36.32	36.32

2.4 Manufacturing (A3)

Secugrid® is made of stretched, monolithic plastics flat or profile bars with welded junctions. The geogrids Secugrid® PET and Secugrid® PP consist of 100% PET and PP, respectively. No secondary plastic is used. The PET production waste amounts to 4.3% relative to the product output of Secugrid® PET. No PP production waste occurs during the production of Secugrid® PP. Manufacturing includes energy and working materials consumption, a share of the infrastructure (factory halls and office buildings) as well as disposal of production wastes (scrap, lubricating oil and municipal waste).

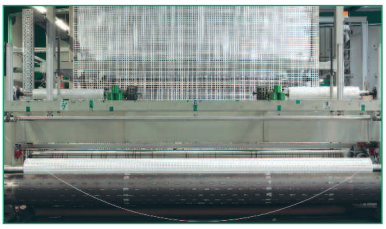

Figure 11
Secugrid® production

2.5 Distribution transport (A4)

Transports from the manufacturer to the customer, merchant or distribution platform are taken into account based on the current sales of NAUE. Shipping within Europe is realized by truck and to the rest of the world mainly by means of freight ships. Shipped geosynthetics are transported to port by lorries.

Figure 12
Secugrid® loading

2.6 Installation (A5)

The construction and installation (figure 13) considers the application of Secugrid®. Other processes such as excavation of foundation or ground compaction are outside the system boundary. The diesel consumption of mounting the geosynthetics amounts to 1.0MJ/m².

Figure 13
Secugrid® installation

3 Life Cycle Assessement (LCA) – Calculation rules

3.1 Declared Unit

The declared unit is 1m² of Secugrid® PET and Secugrid® PP with densities of 580 and 240g/m², respectively.

3.2 System boundaries

This EPD is a cradle-to-gate declaration excluding usage and end-of-life stages. The product system of geosynthetics comprises the product stage (manufacture and supply of raw materials including purchase and intercompany logistics, manufacture of the components and of the product) and the construction stage (mounting of the product).

The comparison of products on the basis of their EPD is defined by the contribution they make to the environmental performance of the structure. Consequently, the comparison of the environmental performance of construction products using the EPD information shall be based on the product's use in and its impacts on the structure, and shall consider the complete life cycle (all information modules).

3.3 Allocation and recycling

Wastes that reach the end of waste state and that are recycled leave the product system without bearing a share of the environmental impacts of the first life cycle. No credits are given for potentially avoided production. Secondary raw materials bear environmental impacts caused by waste collection and recycling activities. This is in line with the "polluter pays" principle (EN 15804, IES 2012). Energy and working materials consumption as well as infrastructure requirements of Secugrid® manufacture are allocated according to the m² of the geosynthetics outputs.

3.4 Temporal and geographic validity

The life cycle assessment of Secugrid® PET and Secugrid® PP describes the geosynthetics used worldwide. It is valid for the purchase, production and distribution situation in the recent past (last two years). All product alternatives described in this report are currently available on the market.

3.5 Background data

Foreground inventory data are mainly based on averaged annual production data provided by NAUE GmbH & Co. KG for the year 2015. The primary sources of background inventory data are the KBOB LCI data v2.2:2016 (KBOB et al. 2016). These data are based on the eocinvent data v2.2 (ecoinvent Centre 2010) and include updates of some background inventory data: electricity supply (Itten et al. 2014), natural gas supply (Schori et al. 2012), photovoltaics (Jungbluth et al. 2012), hydroelectric power generation (Flury & Frischknecht 2012), oil supply chain (Stolz & Frischknecht 2016) and lorry transport (Stolz et al. 2016). The plastics inventory data of PET and PP refer to the years 1999/2000 and 1999, respectively, and are based on data provided by PlasticsEurope (Boustead 2005-07).

The modelling and all calculations are performed with the LCA software SimaPro (PRé Consultants 2015).

4 LCA – Results

LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. Indicators required by the environmental product declaration standard were modelled as follows:

- Global Warming Potential (GWP): assessed with the characterization factors by the IPCC (2007) with a time horizon of 100 years.
- Ozone Depletion (ODP), steady state: assessed with CML 2012-IA v4.2 (base on Guinée et al. 2001).
- Acidification (AP), assessed with CML 2012 v4.2 (based on Guinée et al. 2001).
- Eutrophication (EP), assessed with CML 2012 v4.2 (based on Guinée et al. 2001).
- Photochemical oxidation (POCP), High-NO_X, assessed with CML 2012 v4.2 (based on Guinée et al. 2001).
- Abiotic Depletion, reported in the sub-categories "elements", which excludes fossil fuels, and "fossil fuels" which is to be reported in MJ net calorific value as required by the EN 15804 (2013).
- Use of renewable and non-renewable energy (cumulative energy demand, CED): reported in net calorific value, as demanded in the product declaration guidelines. For each the total and the two subcategories "primary energy resources used as raw material" (feedstock) and "primary energy resources excluding use as raw material" are reported.
- The "CED, raw materials used" was assessed on product basis, i.e. the net calorific value of the materials contained in the geosynthetics.
- The "CED total, renewable" and "CED total, non-renewable" are calculated with the method published in ecoinvent version 2.0 and expanded by PRé Consultants for resources available in SimaPro 8 database (Frischknecht et al. 2007, PRé Consultants 2015).
- Use of secondary materials: based on the feedstock used in the production of the geosynthetics.
- Use of renewable secondary fuels and use of non-renewable secondary fuels. Electricity is assumed to contain no secondary fuels.
- Use of net fresh water: Evaporated water is considered with 100%; elementary flows in the background system are accounted for as follows: 10% of water extracted from water bodies and 10% of process water used (e.g. water, lake; water, process, drinking) and 5% of cooling water used (e.g. water, cooling, surface).
- Waste, life cycle based: "Hazardous waste" covers hazardous waste deposited in underground storage facilities and is accounted for via the elementary flow of volume occupied in an underground deposit. The density of hazardous waste for the conversion to kg is taken from the ecoinvent report 13-III (Doka 2009). "Radioactive waste" covers low radioactive waste and high and medium radioactive waste. It is assessed likewise via the elementary flows "volume occupied, final repository for radioactive waste" and "volume occupied, final repository, low-active waste", respectively. The density of radioactive waste is taken from Dones (Dones 2007). Non-hazardous waste covers all waste going to landfills. The conversion of the land transformation elementary flows "transformation, to dumpsite" for slag compartment (22,500 kg/m^2), inert material landfill (22,500 kg/m^2), sanitary landfill (20,000 kg/m^2) and residual material landfill (16,000 kg/m^2) is conducted according to the average depth of the landfill sites and average waste densities given in Doka (2007).
- Materials for recycling: based on the materials wasted in production, i.e. HDPE sold to the recycling company. The share of the waste for HDPE is 2.3%.
- Materials for energy recovery: weight of materials sent to municipal waste incineration plant, i.e. municipal waste.
- Long-term emissions are not included in the assessment because of implausible results of the indicator eutrophication.

4.1 Life cycle impact assessment results

4.1.1 Secugrid® PET

Environmental Impact 1m² Secugrid® PET 580g/m²	Unit	A1 Raw material	A2 Upstream transport	A3 Manufacturing	A4 Downstream transport	A5 Construction and installation
Global Warming (GWP)	kg CO_2-eq.	1.65E+00	2.44E-02	2.27E-01	1.59E-01	9.77E-02
Ozone layer depletion (ODP)	kg CFC-11-eq	5.49E-08	9.52E-10	8.49E-09	6.02E-09	3.23E-09
Acidification (AP)	kg SO_2-eq	5.57E-03	1.54E-04	3.73E-04	1.56E-03	7.88E-04
Eutrophication (EP)	kg PO_4^{3-}-eq	6.25E-04	3.08E-05	1.29E-04	2.24E-04	1.63E-04
Photochemical oxidation (POCP)	kg C_2H_4	3.58E-04	4.79E-06	1.79E-05	4.92E-05	2.12E-05
Abiotic Depletion, elements (ADPE)	kg Sb-eq	8.19E-06	9.66E-08	4.90E-07	4.96E-07	2.76E-08
Abiotic Depletion, fossil (ADPF)	MJ oil-eq	4.09E+01	3.65E-01	2.31E+00	2.32E+00	1.34E+00

Table 3 Environmental impact caused by the production of 1 square meter of Secugrid® PET

Energy Demand 1m² Secugrid® PET 580g/m²	Unit	A1 Raw material	A2 Upstream transport	A3 Manufacturing	A4 Downstream transport	A5 Construction and installation
CED, non-renewable, total	MJ oil-eq	4.44E+01	3.86E-01	3.25E+00	2.46E+00	1.36E+00
CED, non-ren., w/o raw mat. use	MJ oil-eq	3.01E+01	3.86E-01	3.16E+00	2.46E+00	1.36E+00
CED, non-ren., raw mat. use	MJ oil-eq	1.43E+01	0.00E+00	8.59E-02	0.00E+00	0.00E+00
CED, renewable, total	MJ oil-eq	9.95E-01	6.02E-03	4.55E-01	4.14E-02	6.73E-03
CED, renew., w/o raw material use	MJ oil-eq	9.95E-01	6.02E-03	4.55E-01	4.14E-02	6.73E-03
CED, renew., raw material use	MJ oil-eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels	MJ oil-eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ oil-eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of electricity	MJ	0.00E+00	0.00E+00	1.07E+00	0.00E+00	0.00E+00

Table 4 Cumulative energy demand caused by the production of 1 square meter of Secugrid® PET

Material Use 1m² Secugrid® PET 580g/m²	Unit	A1 Raw material	A2 Upstream transport	A3 Manufacturing	A4 Downstream transport	A5 Construction and installation
Use of net fresh water	m^3	3.58E-03	1.67E-05	6.44E-04	1.07E-04	2.62E-05
Hazardous waste	kg	1.87E-04	4.60E-07	9.28E-06	2.54E-06	3.69E-07
Non-hazardous waste	kg	1.19E-01	2.84E-03	1.65E-02	1.47E-02	8.79E-04
Radioactive waste	kg	7.10E-05	4.98E-07	2.25E-05	3.51E-06	5.30E-07
Use of material	kg	6.22E-01	0.00E+00	7.38E-03	0.00E+00	0.00E+00
Use of renewable material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of secondary material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	2.41E-02	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	2.41E-02	0.00E+00	0.00E+00

Table 5 Material use and waste flows caused by the production of 1 square meter of Secugrid® PET

4.1.2 Secugrid® PP

Environmental Impact 1m² Secugrid® PP 240g/m²	Unit	A1 Raw material	A2 Upstream transport	A3 Manufacturing	A4 Downstream transport	A5 Construction and installation
Global Warming (GWP)	kg CO_2-eq.	4.68E-01	1.44E-02	2.24E-01	5.52E-02	9.77E-02
Ozone layer depletion (ODP)	kg CFC-11-eq	5.72E-11	5.64E-10	8.55E-09	2.09E-09	3.23E-09
Acidification (AP)	kg SO_2-eq	1.47E-03	9.12E-05	3.73E-04	5.40E-04	7.88E-04
Eutrophication (EP)	kg PO_4^{3-}-eq	1.38E-04	1.83E-05	1.31E-04	7.80E-05	1.63E-04
Photochemical oxidation (POCP)	kg C_2H_4	9.99E-05	2.84E-06	1.81E-05	1.71E-05	2.12E-05
Abiotic Depletion, elements (ADPE)	kg Sb-eq	3.49E-09	5.72E-08	4.95E-07	1.73E-07	2.76E-08
Abiotic Depletion, fossil (ADPF)	MJ oil-eq	1.57E+01	2.16E-01	2.25E+00	8.07E-01	1.34E+00

Table 6 Environmental impact caused by the production of 1 square meter of Secugrid® PP

Energy Demand 1m² Secugrid® PP 240g/m²	Unit	A1 Raw material	A2 Upstream transport	A3 Manufacturing	A4 Downstream transport	A5 Construction and installation
CED, non-renewable, total	MJ oil-eq	1.67E+01	2.29E-01	3.18E+00	8.56E-01	1.36E+00
CED, non-ren., w/o raw mat. use	MJ oil-eq	8.93E+00	2.29E-01	3.13E+00	8.56E-01	1.36E+00
CED, non-ren., raw mat. use	MJ oil-eq	7.77E+00	0.00E+00	4.95E-02	0.00E+00	0.00E+00
CED, renewable, total	MJ oil-eq	1.17E-01	3.56E-03	5.77E-01	1.44E-02	6.73E-03
CED, renew., w/o raw material use	MJ oil-eq	1.17E-01	3.56E-03	5.77E-01	1.44E-02	6.73E-03
CED, renew., raw material use	MJ oil-eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels	MJ oil-eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ oil-eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of electricity	MJ	0.00E+00	0.00E+00	1.07E+00	0.00E+00	0.00E+00

Table 7 Cumulative energy demand caused by the production of 1 square meter of Secugrid® PP

Material Use 1m² Secugrid® PP 240g/m²	Unit	A1 Raw material	A2 Upstream transport	A3 Manufacturing	A4 Downstream transport	A5 Construction and installation
Use of net fresh water	m^3	5.62E-04	9.87E-06	6.66E-04	3.72E-05	2.62E-05
Hazardous waste	kg	4.11E-08	2.73E-07	9.44E-06	8.84E-07	3.69E-07
Non-hazardous waste	kg	4.59E-03	1.68E-03	1.38E-02	5.14E-03	8.79E-04
Radioactive waste	kg	8.02E-08	2.95E-07	2.27E-05	1.22E-06	5.30E-07
Use of material	kg	2.45E-01	0.00E+00	8.76E-03	0.00E+00	0.00E+00
Use of renewable material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of secondary material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary material	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00

Table 8 Material use and waste flows caused by the production of 1 square meter of the Secugrid® PP

4.2 Relative contribution of life cycle stages

The contribution is shown for seven different indicators: global warming (GWP), ozone depletion (ODP), acidifi-cation (AP), eutrophication (EP), photochemical oxidation (POCP), abiotic depletion of elements (ADPE), and abiotic depletion of fossil fuels (ADPF).

4.2.1 Secugrid® PET

Figure 14 and 15 show the relative contribution of the different life cycle stages to the total impact of the Secugrid® geogrids.

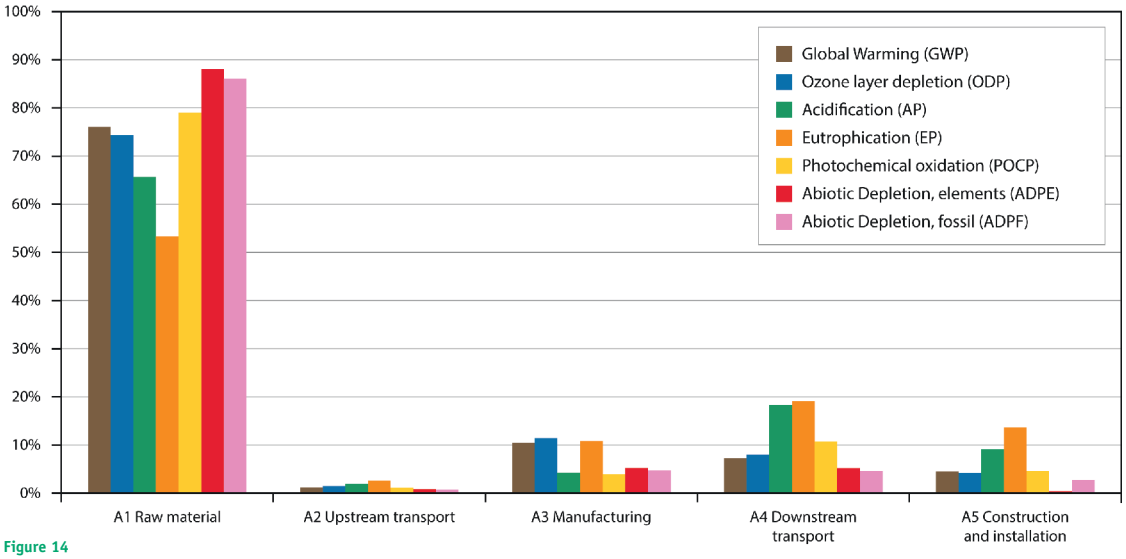

Figure 14
Relative contribution of the different life cycle stages to the total impact of the Secugrid® made of PET

4.2.2 Secugrid® PP

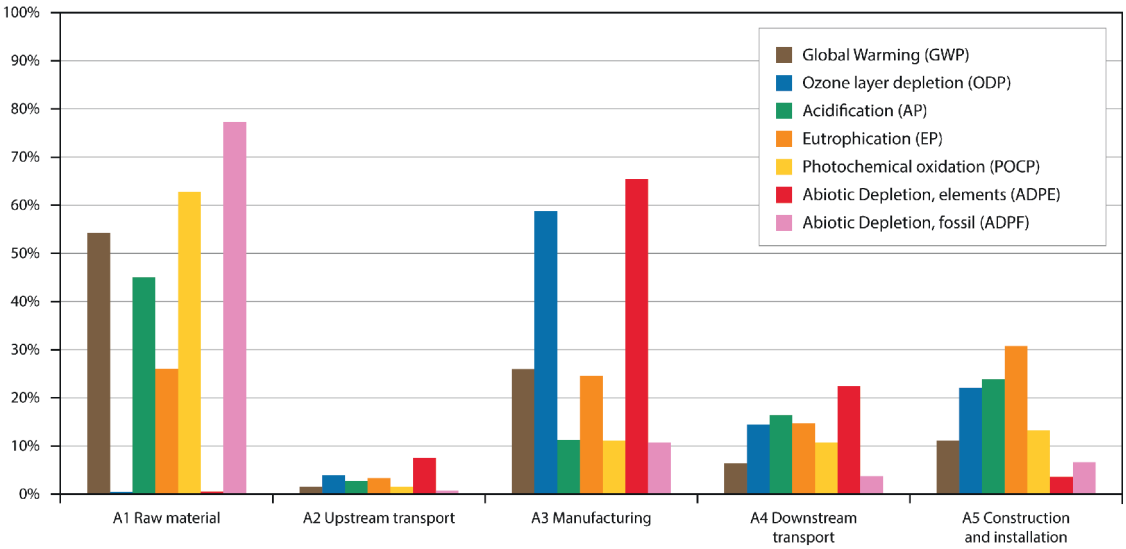

Figure 15
Relative contribution of the different life cycle stages to the total impact of the Secugrid® made of PP

4.3 Data quality

The quality of the data used to model geosynthetics produced by NAUE GmbH & Co. KG is high regarding the material composition, the transport logistics and the manufacture of components. Data provided by NAUE GmbH & Co. KG and are reliable and detailed. The material supply of plastics is represented by best available data provided by the European Plastics association PlasticsEurope.

The KBOB LCI data v2.2:2016 are used as background inventory data to complement the product system of geosynthetics. The KBOB LCI data v2.2:2016 are based on the ecoinvent data v2.2 and contain inventory data of many basic materials and services. The database includes the most recent datasets of plastic feedstock. Most of the important background data are less than 10 years old.

The manufacturer's data are less than three years old and based on annual averages.

Additional data quality considerations are documented within the KBOB LCI and ecoinvent database. A Monte Carlo analysis to assess uncertainties was not conducted. The overall background data quality is appropriate for the use in this LCA.

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