VALIDATED ENVIRONMENTAL PRODUCT DECLARATION

TERBOND®

SPUNBOND REINFORCEMENTS FOR BITUMINOUS MEMBRANES MADE OF RECYCLED POLYESTER

EPD®

Revision 1.2 - August 2017
CPC 27922: Nonwovens for other purposes than clothing
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PCR 2012:01, vers. 2.2, 2017.05.30
Geographical Scope: Global

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1. DESCRIPTION OF THE COMPANY AND OF THE PRODUCT

1.1 The Global Division Building Materials

The Global Division Building Materials belongs to the Freudenberg Performance Materials Group, world leader in the nonwovens market for different applications. The Global Division's core business, with its headquarters in Italy in Novedrate (Como), is the production of polyester nonwovens, made using both staple and spunbonded technology.

The main market of the Group is the construction sector, where nonwovens of the "Roofing" division are sold as reinforcement for bituminous membranes for roofs waterproofing. The "Construction Materials" division includes a complete range of finished products for different applications: thermal insulation, acoustic insulation, underfloor soundproofing, waterproofing, reinforcement for walls and roads, underslating protection and geotextiles.

The majority products are manufactured using recycled raw materials, recovered and upgraded in-house, thanks to vertically integrated processes. The production of polyester starts with the recycling of post-consumer PET bottles, which are sorted, washed and ground to flakes. The flakes are then used in the production of fiber or directly in the spunbond process.

Freudenberg Performance Materials belongs to the Freudenberg Group, which comprises 12 Business Groups operating independently on various markets all over the world.

1.2 The production sites

The Global Division Building Materials, with an organizational structure capable of creating products to meet the needs of diverse markets around the world, operates out of six production sites: three in Italy, with two plants at Novedrate (Como) and one at Pisticci (Matera), one in France at Colmar, one in Russia in Nizhniy Novgorod and one in the United States at Macon (Georgia). Completing the organization of the Group are one trading companies in China at Shanghai and a comprehensive sales network.

1.3 Responsibility and the Environment

The Global Division Building Materials operations obtained the following certifications:

- ISO 9001 – Quality Management System
- ISO 14001 – Environmental Management System
- OHSAS 18001 – Health and Safety Management System

In Italy the Group joined Responsible Care, the voluntary programme of the global chemical industry, under which businesses commit themselves to the continuous improvement of products, processes and behaviour in the areas of Safety, Health and the Environment, in order to give a significant contribution to the sustainable development of industry, local communities and society.
All companies in the Global Division Building Materials adopt Corporate Governance rules and **Guiding Principles** (www.freudenberg-pm.com), highlighting responsibility with regard to People, the Environment and Safety in all fields of activity.

1.4 The product

Terbond® is a range of polyester fiber nonwovens manufactured with spunbond technology, available in numerous weights capable of meeting a wide range of technical requirements to satisfy the different needs of global markets. Nonwovens are used as reinforcement for waterproofing membranes.
The fiber used is mainly produced in-house through the recycling of post-consumer PET bottles.
The EPD is based on **Terbond®** family produced in Colmar (France) and Pisticci (Italy). In LCA study was taken into account a weighted average of the production information of two sites during the 2016.
The final application of **Terbond®** nonwovens is the bituminous membrane, obtained from the process of bitumen impregnation at the production sites of membrane manufacturers and then used for the waterproofing of roofs. For the LCA study of the finished product reference has to be made to any analysis carried out by bituminous membranes manufacturers.

Terbond®	Needlepunched and chemical bonded spunbond nonwovens Production: Pisticci (Italy) and Colmar (France)
Terbond® A	Needlepunched spunbond nonwovens Production: Colmar (France)
Terbond® TH	Needlepunched and thermal bonded spunbond nonwovens Production: Colmar (France)
Terbond® R	Needlepunched spunbond nonwovens reinforced with glass filaments Production: Pisticci (Italy)

Terbond® different types of weight and thickness:

	Terbond®	Terbond® A	Terbond® TH	Terbond® R	U.o.m.
Weight	from 100 to 300	from 50 to 275	from 100 to 250	from 110 to 270	g/m^2
Thickness	from 0,50 to 1,60	from 0,60 to 2,70	from 0,40 to 1,00	from 0,65 to 1,35	mm

This EPD is based on the LCA study carried out on Terbond® products with average weight of 150 g/m^2:

			Terbond® 150	Terbond® A 150	Terbond® TH 150	Terbond® R 150	U.o.m.
Weight	ISO 9073-1		150	150	150	150	g/m^2
Thickness	ISO 9073-2		0,90	0,70	0,65	0,85	mm
Max. tensile strength	ISO 9073-3	MD	59	50	43	50	daN/5cm
		CD	36	47	43	36	
Elongation at break	ISO 9073-3	MD	29	52	30	25	%
		CD	32	58	30	30	

As example the above values refer to average values for the product from Pisticci (Terbond®) and for the product A2TC (Terbond® A).

1.5 Composition of the products

The products don’t contain substances that are listed in the “Candidate List of Substances of Very High Concern (SVHC) for authorisation”.

Product type	Terbond®		Terbond® A		Terbond® TH		Terbond® R	
	% weight	(thereof) % recycled	% weight	(thereof) % recycled	% weight	(thereof) % recycled	% weight	(thereof) % recycled
Polyester PET	81	100	100	37	100	17	77	100
Resin	15		0		0		12	
Bio Resin	4		0		0		6	
Glass fiber	0		0		0		5	
Total	**100**		**100**		**100**		**100**	

2. Environmental Performance Declaration

The results represented below are based on the Life Cycle Assessment (LCA) study carried out on the products **Terbond®, Terbond® A, Terbond® TH and Terbond® R** with the aim to inform the public and the interested parties about the environmental performance of its production process.
The methodology used follows the rules described in the standard ISO 14044:2006, in line with the International EPD System.

The reasons of the LCA study arose from the need to have a precise processes accounting and to highlight potential improvements that could be started in order to increase the processes and to reduce even more the environmental impacts. In addition the purpose was to quantify the environmental advantages deriving from the use of non virgin raw material.

2.1 The Evaluation Method

The environmental performance quantification has been carried out as provided by the PCR 2012:01 Construction Products and Construction services (version 2.2) according to the Life Cycle Assessment (LCA) methodology.

2.2 The Declared Unit

The declared unit of the study is represented by **1 m^2** of **Terbond®** family in 150 g/m^2 grammage. Carbon footprint information is represented for product surface of 1 kg.

2.3 The System Boundaries

The LCA developed is a “Cradle to Gate” type, measuring from A1 phase (production of raw materials) to A3 phase (production). The phases from A4 to C4 depend from the applications of the final product.
The Upstream Processes include the phase A1 (raw materials extraction and secondary raw materials treatment).
The Core Processes include the A2 (transportation to the factory) and A3 phase (production).

X= Included MND = Module Not Declared

Product stage			**Construction process stage**		**Use stage**							**End of life stage**				**Recovery stage**
Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction, demolition	Transport	Waste processing	Disposal	Reuse, recycling or energy recovery potentials
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Upstream Processes include:

- extraction and production of raw materials;
- manufacturing of semi-finished goods;
- manufacturing of additives (caustic soda, floating, surface-active, etc.);
- production processes for components and packaging (PE bags, labels, PE film);
- process of post-consumer PET bottles collection and selection (transports included);
- transport of post-consumer PET bottles from the selection plant to the factory;
- virgin and recycled PET from suppliers;
- generation of electricity.

Core Processes include:

- transports: from the supply of semi-finished goods and of consumables to the conveyance to landfill or waste recovery;
- internal transports;
- manufacturing processes for the production of **Terbond**® products (from bottles storage to different phases of nonwoven finishing, to end up with the sending to the warehouse of the **Terbond**® rolls);
- packaging of **Terbond**® product family;
- consumption of water.

Downstream Processes including distribution, use and end of life management, have been considered from a qualitative point of view because of the impossibility to outline a realistic reference scenario with appropriate data.

Terbond® nonwovens are distributed all over the world and the lifecycle of a bituminous membrane, installed on a roof, is estimated to be over 20 years, average period of guarantee provided by manufacturers of bituminous membranes.

In some cases the old damaged roofs are repaired with new additional layers, therefore the lifecycle of the membrane is prolonged and consequently also that of the nonwoven. In other cases the old roof is completely removed and the waste material is recovered mainly sending it to energy valorisation or with the reuse in road applications.
In the case of energy valorisation, each kilo of finished product has a calorific value (feedstock energy) of about 33 MJ which can be converted into useful energy. This feedstock energy is included in the energy from waste present in recycled PET bottles and represents the energy savings that is achieved by using recycled raw materials for the production of the nonwoven.

The use of recycled raw material for the production of nonwovens allows an upstream energy saving. **Terbond®** products fit in at the end of a virtuous cycle which increases the value and concretises the activities of the recycling chain and the efforts of citizens in sorting waste.

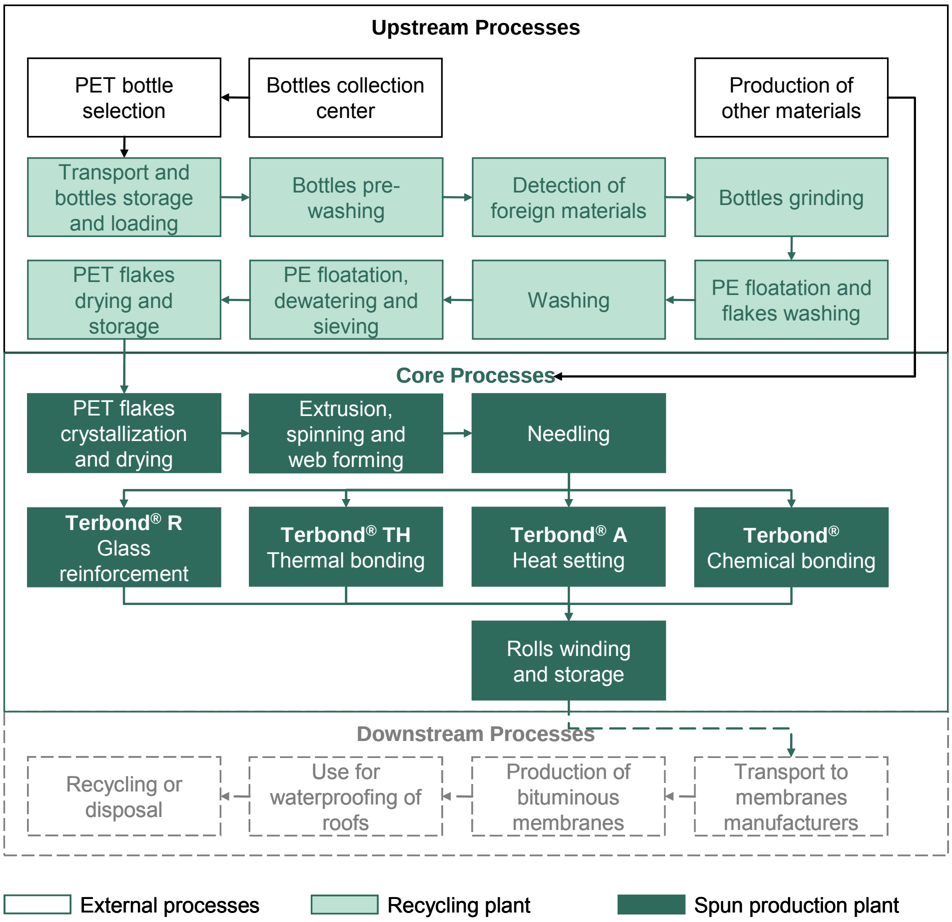

Figure 1. Scheme of the production process of Terbond® product family

2.4 Cut-off and allocation principles

The processes contributing for less than 1% of the total environmental impact for each impact category have been omitted from the inventory. In the study the allocation is used only for the part concerning utilities (electrical energy, thermal power, methane gas) on the basis of the consumption of the distinct departments (see Figure 1).

2.5 Data Quality

Data refer to the year 2016 and were collected in Global Division Building Materials plant located in Colmar (France) and Pisticci (Italy). The calculation model adopted is SimaPro and the database Ecoinvent. The contribution of the other generic data to each impact category is below:

- 6 % for Terbond®
- 1 % for Terbond® A
- 1 % for Terbond® TH
- 1 % for Terbond® R

Data concerning energy aspects refers to the energy mix of the French site in Colmar and the production process for the electrical energy from palm oil in Pisticci. The data collection was conducted in compliance with the modalities contained in the ISO 14044:2006 and the EN 15804:2012+A1:2013.

2.6 Environmental profile of the product

To have univocal environmental information the impact categories have been analyzed in line with what requested by the indications of the Environmental Product Declaration (EPD) and referred to the production process illustrated in Figure 1. For the production of 1 m^2 **Terbond®** the inflow material (post-consumer PET bottles) passes through the stages described in the figure. The table below provides information on the resources consumed to the production of 1 m^2 of **Terbond®**.

Use of resources Terbond			Renewable primary energy (excl. raw materials)	Renewable primary energy (raw materials)	Total use of renewable primary energy	Non-renewable primary energy (excl. raw materials)	Non-renewable primary energy (raw materials)	Total use of non-renewable primary energy	Use of secondary material	Use of renewable secondary fuels	Use of non-renewable secondary fuels	Use of net fresh water
Unit of measure			MJ	MJ	**MJ**	MJ	MJ	**MJ**	kg	MJ	MJ	m^3
Results per R=1 m^2	A1) Raw material supply	Ter	0,000	0,340	**0,340**	5,791	0,950	**6,741**	0,121	0,000	0,000	0,000
		Ter A	0,000	0,756	**0,756**	8,179	4,476	**12,655**	0,056	0,000	0,000	0,000
		Ter TH	0,000	0,553	**0,553**	9,939	5,534	**15,473**	0,026	0,000	0,000	0,000
		Ter R	0,000	4,717	**4,717**	3,478	0,090	**3,568**	0,115	0,000	0,000	0,000
	A2) Transport	Ter	0,000	0,002	**0,002**	0,380	0,000	**0,380**	0,000	0,000	0,000	0,000
		Ter A	0,000	0,001	**0,001**	0,008	0,000	**0,008**	0,000	0,000	0,000	0,000
		Ter TH	0,000	0,211	**0,211**	0,055	0,000	**0,055**	0,000	0,000	0,000	0,000
		Ter R	0,000	0,003	**0,003**	0,065	0,000	**0,065**	0,000	0,000	0,000	0,000
	A3) Manufacturing	Ter	0,000	1,196	**1,196**	0,466	0,000	**0,466**	0,000	0,000	0,000	0,000
		Ter A	0,000	0,000	**0,000**	0,002	0,000	**0,002**	0,000	0,000	0,000	0,000
		Ter TH	0,000	0,001	**0,001**	0,018	0,000	**0,018**	0,000	0,000	0,000	0,000
		Ter R	0,000	2,900	**2,900**	1,388	0,000	**1,388**	0,000	0,000	0,000	0,000
	TOTAL	Ter	0,000	1,538	**1,538**	6,637	0,950	**7,587**	0,121	0,000	0,000	0,001
		Ter A	0,000	0,757	**0,757**	8,189	4,476	**12,665**	0,056	0,000	0,000	0,000
		Ter TH	0,000	0,764	**0,764**	10,012	5,534	**15,546**	0,026	0,000	0,000	0,000
		Ter R	0,000	7,620	**7,620**	4,931	0,090	**5,021**	0,115	0,000	0,000	0,001
Results per 1 kg	TOTAL	Ter	0,000	10,254	**10,254**	44,244	6,337	**50,581**	0,808	0,000	0,000	0,004
		Ter A	0,000	5,047	**5,047**	54,605	29,840	**84,445**	0,370	0,000	0,000	0,001
		Ter TH	0,000	5,093	**5,093**	66,748	36,893	**103,641**	0,170	0,000	0,000	0,001
		Ter R	0,000	50,799	**50,799**	32,875	0,598	**33,473**	0,766	0,000	0,000	0,004

Table 1. Total consumption of resources associated to the production of Terbond® products

The results of the characterization of the impacts are shown in the following Table 2.

Potential Enviromental Impact Terbond			Global Warming Potential (GWP100)	Ozone depletion potential	Photochemical oxidation potential	Acidification potential	Eutrophication Potential	Depletion of abiotic resources (elements)	Depletion of abiotic resources (fossil)
Unit of measure			kg CO_2eq	kg CFC_{11}eq	g C_2H_4 eq	g SO2 eq	g PO_4^{---}eq	kg Sb-eq	MJ
Results per R=1 m^2	A1) Raw material supply	Ter	0,188	0,000	0,000	0,653	0,271	0,000	5,866
		Ter A	0,339	0,000	0,083	1,238	0,484	0,000	8,583
		Ter TH	0,429	0,000	0,095	1,504	0,551	0,000	0,187
		Ter R	0,272	0,000	0,338	1,201	0,474	0,000	5,375
	A2) Transport	Ter	0,001	0,000	0,000	0,004	0,000	0,000	0,011
		Ter A	0,001	0,000	0,000	0,008	0,001	0,000	0,000
		Ter TH	0,004	0,000	0,003	0,084	0,010	0,000	0,000
		Ter R	0,005	0,000	0,001	0,023	0,003	0,000	0,027
	A3) Manufacturing	Ter	0,033	0,000	0,002	0,027	0,041	0,000	0,001
		Ter A	0,000	0,000	0,000	0,000	0,000	0,000	0,005
		Ter TH	0,001	0,000	0,000	0,002	0,045	0,000	9,661
		Ter R	0,065	0,000	0,004	0,050	0,015	0,000	0,000
	TOTAL	Ter	0,222	0,000	0,002	0,684	0,312	0,000	5,878
		Ter A	0,340	0,000	0,083	1,246	0,485	0,000	8,588
		Ter TH	0,434	0,000	0,098	1,590	0,606	0,000	9,848
		Ter R	0,342	0,000	0,343	1,274	0,492	0,000	5,402
Results per 1 kg	TOTAL	Ter	1,479	0,000	0,718	4,575	2,084	0,000	39,187
		Ter A	2,265	0,000	0,552	8,310	3,241	0,000	57,296
		Ter TH	2,896	0,000	0,653	10,614	4,055	0,000	65,657
		Ter R	2,279	0,000	2,284	8,496	3,277	0,000	36,011

Table 2. Potential contribution to the main environmental effects for the production of Terbond® products

3. OTHER ENVIRONMENTAL INFORMATION

In the description of the environmental impacts of a product it is important to take into consideration the waste generation. For what concerns **Terbond®** products, Table 3 shows the total waste generated in the different processes.

Waste Terbond			Hazardous waste disposed	Non-hazardous waste disposed	Radioactive waste disposed	Total waste
Unit of measure			kg	kg	kg	kg
Results per R=1 m^2	A1) Raw material supply	Ter	0,001	0,016	0,000	**0,017**
		Ter A	0,000	0,002	0,000	**0,002**
		Ter TH	0,000	0,003	0,000	**0,003**
		Ter R	0,004	0,057	0,000	**0,061**
	A2) Transport	Ter	0,000	0,000	0,000	**0,000**
		Ter A	0,000	0,000	0,000	**0,000**
		Ter TH	0,000	0,000	0,000	**0,000**
		Ter R	0,000	0,000	0,000	**0,000**
	A3) Manufacturing	Ter	0,000	0,004	0,000	**0,004**
		Ter A	0,000	0,013	0,000	**0,013**
		Ter TH	0,000	0,013	0,000	**0,013**
		Ter R	0,000	0,016	0,000	**0,016**
	TOTAL	Ter	0,001	0,020	0,000	**0,021**
		Ter A	0,000	0,015	0,000	**0,015**
		Ter TH	0,000	0,016	0,000	**0,016**
		Ter R	0,004	0,073	0,000	**0,077**
Results per 1 kg	TOTAL	Ter	5,193	134,217	0,000	**139,410**
		Ter A	0,042	103,059	0,000	**103,101**
		Ter TH	0,068	106,460	0,000	**106,528**
		Ter R	23,690	488,953	0,000	**512,643**

Table 3. Total production of hazardous and non hazardous waste generated for the production of Terbond® products

From the results of the assessment of the life cycle of the product is possible to measure the carbon footprint that is the total amount of CO_2 and to measure also other greenhouse gasses during the entire life cycle.
As an indication, the table 4 here below represents the **Carbon Footprint** of different weights of Terbond® products per surface unit (**1 m^2**).

Terbond®	**150**	170	180	230	250	300	g/m^2
Global warming potential (GWP_{100})	**0,22**	0,25	0,27	0,34	0,37	0,44	$kgCO_2eq/m^2$

Terbond® A	50	110	130	**150**	160	230	g/m^2
Global warming potential (GWP_{100})	0,11	0,25	0,29	**0,34**	0,36	0,52	$kgCO_2eq/m^2$

Terbond® TH	110	**150**	160	180	200	230	g/m^2
Global warming potential (GWP_{100})	0,32	**0,43**	0,46	0,52	0,58	0,67	$kgCO_2eq/m^2$

Terbond® R	**150**	170	180	230	250	300	g/m^2
Global warming potential (GWP_{100})	**0,34**	0,39	0,41	0,52	0,57	0,68	$kgCO_2eq/m^2$

Table 4. Global warming potential for different weights for m^2 of Terbond® products

4. Significant changes from the previous version

Comparing to past EPD version, production mix of Terbond TH e Terbond A has changed and the new PCR was adopted.

5. Information about the Organization and the Verifier

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For further information
Further information about The Global Division Building Materials and the product **Terbond®** are available on the web www.freudenberg-pm.com.
Further information about International EPD® system is available on the web www.environdec.com.

Present EPD and the PCR riferimento (PCR 2012:01 Construction products and Construction services version 2.2) are available on the internet site www.environdec.com.

EPD of construction products may not be comparable if they do not comply with EN 15804. Environmental product declarations within the same product category from different programs may not be comparable.

The LCA study and the present EPD have been issued by GIFIN srl with the technical scientific support of the University of Basilicata Matera (Italy) and of the Eng. Francesca Intini.

CEN standard EN 15804 served as the core PCR	
PCR:	PCR 2012:01 Construction products and construction services, Version 2.2
PCR review was conducted by:	The Technical Committee of the International EPD® System. Chair: Massimo Marino. Contact info@environdec.com
Independent verification of the declaration and data, according to ISO 14025:	☐ EPD process certification ☒ EPD verification
Third party verifier:	Adriana Del Borghi adry@unige.it
Accredited or approved by:	“The International EPD® System”

6. References

1. Life Cycle Assessment (LCA) applied for the **Terbond**® product family, rev. 1.2, August 2017.
2. IEC (2015), General Programme Instructions for Environmental Product Declarations, EPD. The International EPD Corporation. Document version 2.5. Available at www.environdec.com.
3. PCR 2012:01 Construction products and construction services, ver. 2.2, 2017-05-30. www.environdec.com
4. ISO 14040:2006, Environmental management - Life cycle assessment - Principles and framework.
5. ISO 14025:2006 Type III – Environmental labels and declarations – Type III environmental declaration – Principles and procedures.
6. ISO 21930, Environmental declaration of building products.
7. EN 15804:2012+A1:2013, Sustainability of construction works — Environmental product declarations
8. Publications on International Journal of Life Cycle Assessment.

7. Glossary

The Global Warming Potential (GWP100) is a measure of the greenhouse effect and it indicates the ratio between the warming caused by a certain type of greenhouse gas in a period of 100 years and the warming caused by the same mass of carbon dioxide (whose GWP is by definition 1) in the same period. The GWP is measured in $kgCO_2eq$.

The stratospheric **Ozone Depletion Potential** is the indicator of the gradual degradation of the stratosphere ozone layer, referring to the presence in the atmosphere of a number of chemical compounds attacking ozone. The substance used as comparison to evaluate the effect of the other substances is CFC-11 (chlorofluorocarbons), therefore CFC-11 eq.

Acidification is a phenomenon in which atmospheric precipitations have a lower pH (measuring the acidity of water) than normal, causing damages to forests and cultivated crops, as well as to aquatic ecosystems and objects. It is measured with the factor of Acidification Potential (AP) estimated for each substance in terms of SO_2 eq.

Photochemical ozone formation is the production of compounds which as a result of the effects of light may encourage an oxidisation reaction leading to the production of ozone in the troposphere. The indicator is the Photochemical Ozone Creation Potential (POCP), including mainly VOC (volatile organic compounds) and is expressed as grams of equivalent ethylene (g C_2H_4eq).

The **Eutrophication** is the excessive growth of aquatic plant organisms, due to the presence in the water ecosystem of excessive quantities of nourishing substances like nitrogen, phosphorus or sulphur from either natural or anthropic sources (fertilizers, some types of detergents, civil or industrial wastes) and the consequent degradation of the environment, becoming asphyxiated. The indicator is the Eutrophication Potential (EP) and is expressed in terms of impoverishment in PO_4^{---} (phosphate).