



An Eco-profile and Environmental Product Declaration of the PET Manufacturers in Europe

# Polyethylene Terephthalate (PET) (Bottle Grade) CPME June 2017



## Introduction

This Environmental Product Declaration (EPD) is based upon life cycle inventory (LCI) data from PlasticsEurope's Eco-profile programme. It has been prepared according to **PlasticsEurope's Eco-profiles and Environmental Declarations – LCI Methodology and PCR for Uncompounded Polymer Resins and Reactive Polymer Precursors**

[PlasticsEurope, 2011a]. EPDs provide environmental performance data, but no information on the economic and social aspects that would be necessary for a complete sustainability assessment. Further, they do not imply a value judgment between environmental criteria.

This EPD describes the production of bottle grade polyethylene terephthalate (PET) from cradle to gate (from crude oil extraction to PET granulate at plant). **Please keep in mind that comparisons cannot be made on the level of the polymer or the polymer precursor alone:** it is necessary to consider the full life cycle of an application in order to compare the environmental performance of different materials and the effects of relevant processes during the whole life cycle. This EPD is intended to be used by member companies, to support product-orientated environmental management; by users of plastics, as a building block of life cycle assessment (LCA) studies of individual products; and by other interested parties, as a source of life cycle information.

## Meta Data

Data Owner	CPME aisbl
LCA Practitioner	IFEU Heidelberg, Germany
Programme Owner	PlasticsEurope aisbl
Programme Manager, Reviewer	Schulz Sustainability Consulting on behalf of DEKRA Assurance Services GmbH
Number of plants included in data collection	12

Representativeness	Good (85 % of installed production capacity covered)
Reference year	2015
Year of data collection and calculation	2016
Expected temporal validity	2020
Cut-offs	none
Data Quality	good
Allocation method	physical

## Description of the Product and the Production Process

This EPD represents the average industrial production of PET in Europe from cradle to gate.

### Production Process

PET production covered by this study is by esterification of ethylene glycol and terephthalic acid (PTA). The esterification process is carried out under moderate pressure (2.5-5.5 bar) and at high temperature (230-270 °C) whilst the water formed during the reaction is continuously removed via distillation.

In addition to these foreground processes, the following processes in the supply chain are considered: extraction and refinery of crude oil and natural gas, steam cracking of hydrocarbons (predominantly naphtha) into lower olefins and pygas, catalytic reforming of naphtha, and the extraction and production of p-xylene from both pygas and reformat (xylene loop) production of purified terephthalic acid (PTA) and production of ethylene glycol (MEG). Furthermore, all processes related to the production of electric and thermal energy including their upstream processes are considered as well as the treatment of wastes.

Impacts related to abnormal process conditions (e.g. accidents) are not considered in the present study.

## Data Sources and Allocation

Confidential input and output data for the PET production processes including on-site energy production was provided by 7 European PET producers for 12 production plants (primary data).

Data concerning the upstream processes PTA production, steam cracking, catalytic reforming, fossil fuels extraction and refinery were taken from the Eco-profiles of purified terephthalic acid [CPME, 2016] and steam cracker products [PlasticsEurope, 2012]. Country specific electricity mixes were used for grid electricity supply. On-site production of electricity and steam was partially modelled using primary data from the PET producers; data gaps in on-site energy production were closed using European average data of power plants and steam boilers. Representative literature data and the database Ecoinvent v3.3 have been used to fill gaps where no primary data was available and to crosscheck primary data.

Within the foreground system economic allocation was applied for off-spec PET (<0.2 % of total PET output). Concerning the background processes, allocation was intended to be avoided; where necessary, processes have been allocated by physical properties, such as mass, energy, or enthalpy.

## Use Phase and End-of-Life Management

The use phase and end-of-life processes of the investigated polymer precursor are outside the system boundaries of the cradle-to-gate system covered by the present study: the major object is the analysis of PET production, which is used in a broad range of applications. However, the treatment of waste from production processes is considered within the system boundaries of this Eco-profile.

## Environmental Performance

The tables below show the environmental performance indicators associated with the production of 1 kg of PET. **Due to changes in datasets and methodology a direct comparison of the current Eco-profile results with the previous ones (published in 2011) is not possible!** Please refer to the full Eco-profile report for details.

### Input Parameters

Indicator	Unit	Value
Non-renewable energy resources <sup>1)</sup>	MJ	69.6
• Fuel energy	MJ	35.5
• Feedstock energy	MJ	34.1
Renewable energy resources (biomass) <sup>1)</sup>	MJ	1.6
• Fuel energy	MJ	1.6
• Feedstock energy	MJ	0.0
Abiotic Depletion Potential		
• Elements	kg Sb eq	2.41E-04
• Fossil fuels	MJ	62.0
Water use	kg	95.8
• for process	kg	6.7
• for cooling	kg	89.0
Water consumption	kg	48.8

<sup>1)</sup> Calculated as upper heating value (UHV)

### Output Parameters

Indicator	Unit	Value
Global Warming Potential (GWP)	kg CO <sub>2</sub> eq	2.19
Ozone Depletion Potential (ODP)	g CFC-11 eq	0.018
Acidification Potential (AP)	g SO <sub>2</sub> eq	6.47
Photochemical Ozone Creation Potential (POCP)	g Ethene eq	2.31 <sup>3)</sup>
Eutrophication Potential (EP)	g PO <sub>4</sub> eq	1.49
Dust/particulate matter (≤ 10 µm) <sup>2)</sup>	g PM10	5.64
Total particulate matter <sup>2)</sup>	g	5.94
Waste	g	9.1
• Non-hazardous	g	8.8
• Hazardous	g	0.3
• Unspecified	g	0.0

<sup>2)</sup> Including secondary PM10

<sup>3)</sup> Including NMVOC (1.80 g Ethene eq./kg PET)

## Additional Environmental and Health Information

CPME has continued to fully support initiatives to improve the safety and environmental performance of PET production. Changes in production methods have led to near zero human exposure to process chemicals. The environmentally sound treatment of process effluents is being continuously upgraded and now represents the best available technology.

## Additional Technical Information

Production technology of PET and its precursors is constantly improved. New production processes and catalyst recovery methods lead to better products quality produced in a more efficient way. Advanced European PET products meet all of the strict existing and upcoming regulatory requirements particularly for food contact applications such as beverage bottles.

## Additional Economic Information

Constant product and process innovation of PET has led to energy savings in production, transportation and use of resources. PET is a globally traded commodity and the European PET production facilities provide essential support to local and European economy and can theoretically meet 100% of European demand; the import quota of PET is currently at 20%.



## Information

### Data Owner

#### **Committee of PET Manufacturers in Europe (CPME aisbl)**

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### Programme Manager & Reviewer

**DEKRA Assurance Services GmbH** This Environmental Product Declaration has been reviewed by DEKRA Assurance Services GmbH. It was approved according to the Product Category Rules PCR version 2.0 (2011-04) and ISO 14025:2006.

Registration number: PlasticsEurope 2016-003, validation expires on 30 November 2018 (date of next revalidation review).

### Programme Owner

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For copies of this Eco-Profile, for the underlying LCI data (Eco-profile); and for additional information, please refer to

<http://www.plasticseurope.org/>.

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### References

PlasticsEurope 2011: Eco-profiles and environmental declarations – LCI methodology and PCR for uncompounded polymer resins and reactive polymer precursor (version 2.0, April 2011).

PlasticsEurope 2012: Eco-profiles and Environmental Product Declarations of the European Plastics Manufacturers - Ethylene, Propylene, Butadiene, Pyrolysis Gasoline, Ethylene Oxide (EO), Ethylene Glycols (MEG, DEG, TEG), November 2012.

CPME 2016: Eco-profiles and Environmental Product Declarations of the PET Manufacturers in Europe - Purified Terephthalic Acid (PTA). CPME, February 2016

