



Environmental Product Declarations of the European Plastics Manufacturers

## Low density polyethylene (LDPE)

## 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 ISO 14025 and PlasticsEurope's **Product Category Rules (PCR) for Uncompounded Polymer Resins and Reactive Polymer Precursors** (June 2006). EPDs provide environmental performance data, but no information on the economic and social aspects which would be necessary for a complete sustainability assessment. Furthermore, they do not imply a value judgment between environmental criteria.

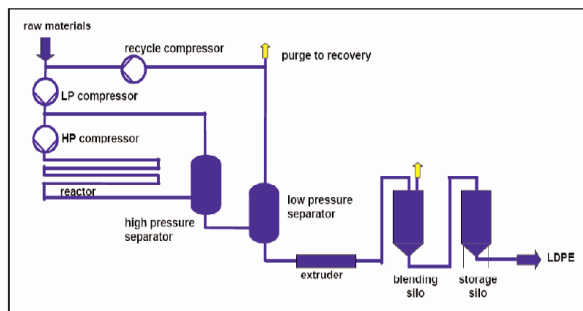
This EPD describes the production of the LDPE polymer from cradle to gate (from crude oil extraction to pellets coming out the manufacturing plant). **It is important to note that comparisons cannot be made on the level of the polymer material alone:** it is necessary to consider the full life cycle of an application in order to compare the performance of different materials and the effects of relevant life cycle parameters. 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.

## Description of the product and the production process

This EPD is designed for low density polyethylene (LDPE). LDPE is part of the polyolefins family. The LDPE and LLDPE volumes in 2007 account for 35% (roughly 7.8 million tonnes per year) of Western Europe's total polyolefins production which is 22.1 million tonnes/year. Polyolefins represent 40% of total plastics production in Western Europe, which is 55 million tonnes/year. The functional unit, to which all data given in this EPD refers to, is **1kg of LDPE polymer**.

### Production process

**LDPE** is a polyethylene with a density < 940 kg/m, produced by a high pressure process, and is therefore often referred to as high pressure polyethylene. Polyolefins are produced from olefin (alkene) monomers because the olefins contain a reactive double bond. The starting material, ethylene, is called the monomer and the final product consisting of many thousands of bound ethylene units is called the polymer. Co-monomers (such as vinyl acetate, butyl acetate, methyl methacrylate) are used to control the density and other physical properties. The main technique which is used for the production of LDPE: **Autoclave and tubular high pressure technology:** When the monomer is held at high pressures of up to 300



MPa and temperatures above the polymer melting point of up to 300°C, the monomer/polymer mixture can act as a polymerisation medium. This technology is typical for LDPE and LDPE co-polymers production. The obtained polymer can be mixed with additives and is extruded into pellets.

### Data sources and allocation

All data refer to a European industry average (reference year 2005); all calculations were updated in 2006. PlasticsEurope's member companies supplied information on the production of hydrocarbon precursors. Information on the production of fuels, energy and the main hydrocarbon resources was derived from the reports of the *International Energy Agency*. Data for ancillary operations and transport were obtained from other manufacturers and operators as well as publicly available LCI databases. Mass allocation was used for multi-output processes. Vertical averaging was performed to take into account company- and site-specific production routes and to protect confidentiality.

### Use phase and end-of-life management

**Benefits of LDPE:** Because of its versatility (large range of density, molecular weight (MW) and MW distribution, and chemical inertness), LDPE remains a popular plastic in use today. LDPE resins can be tailored to be used in many applications such as film applications (e.g. collation shrink film, carrier bags, agricultural film), pharmaceutical packaging, liquid paper board coatings, electrical cable coatings, injection moulding parts, pipes, etc. For responsible end-of-life management, PlasticsEurope recommends recycling (whether mechanical or feedstock) as far as economically feasible and environmentally sensible. Alternatively, for residual streams energy recovery can be conducted in special designed plants. In LCA studies, credits for recovered products should be awarded on the basis of substituted virgin materials, if functionally equivalent.

## Environmental performance

The tables below show the environmental performance indicators associated with the production of 1 kg of low density polyethylene (LDPE).

### Input parameters

Indicator	Unit	Value
Non-renewable materials		
• Minerals	g	4.2
• Fossil fuels	g	1,591.3
• Uranium	g	0.009
Renewable materials (biomass)	g	10.787
Water use <sup>1)</sup>	g	2,934
Non-renewable energy resources <sup>2)</sup>		
• for energy	MJ	25.3
• for feedstock	MJ	51.6
Renewable energy resources (biomass) <sup>2)</sup>		
• for energy	MJ	1.2
• for feedstock	MJ	0
<sup>1)</sup> This indicator comprises only process water. Cooling water is not included.		
<sup>2)</sup> Calculated as upper heating value (UHV).		

### Output parameters

Indicator	Unit	Value
GWP	kg CO <sub>2</sub> eq	2.13
ODP	g CFC-11 eq	n/a <sup>3)</sup>
AP	g SO <sub>2</sub> eq	7.74
POCP	g Ethene eq	1.19
NP	g PO <sub>4</sub> eq	0.50
Dust/particulate matter	g PM <sub>10</sub>	0.69
Total particulate matter	g	0.70
Waste		
• Non-hazardous	kg	0.034
• Hazardous	kg	0.005
<sup>3)</sup> Relevant LCI entries are below quantification limit.		

## Additional environmental and health information

LDPE is a well recognized material in extrusion coating for multilayer packaging providing sealability, adhesion and moisture protection.

Ethylene, the monomer of LDPE, can be produced from a petrochemical source or from alternative sources like syngas and biomass

LCA is the preferred tool to analyse and conclude about all environmental parameters for a specific LDPE application.

## Additional technical information

Due to its unique properties, LDPE is used in critical applications where stress cracking resistance is an issue, such as wire and cable.

LDPE has a high intrinsic thermal stability and therefore requires a minimum amount or even no stabilizers at all.

LDPE maintains its physical and mechanical properties after recycling and is increasingly being recycled in several European schemes.

## Additional economic information

LDPE allows significant cost savings in greenhouse applications and provides a higher efficiency of harvest

LDPE in blown film applications allow the reduction of energy addition due to lowering the processing temperatures and conditions (e.g. pressure).

Foamed LDPE is used in insulation applications, providing significant energy savings.

## Information

### Company/Association

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### Programme manager

#### Five Winds International

This Environmental Product Declaration has been reviewed by *Five Winds International*. It is approved according to the Product Category Rules PCR 2006-06 for Uncompounded Polymer Resins and Reactive Polymer Precursors and ISO FDIS 14025.  
Registration number: PlasticsEurope-2008-0006; validation expires on 31 December 2011.

### Programme owner

#### PlasticsEurope

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For copies of this EPD, for the underlying LCI data (eco-profile), and for additional information, please refer to <http://www.plasticseurope.org/>.

### References

Product photographs on cover with kind permission by PlasticsEurope  
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Eco-profiles of the European Plastics Industry. Brussels, March 2005.  
PlasticsEurope: Product Category Rules (PCR) for Uncompounded Polymer Resins and Reactive Polymer Precursors. Brussels, June 2006.  
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European Commission (EC): IPPC Reference Document on Best Available Techniques in the Production of Polymers. Sevilla, October 2006.

## Glossary

**Acidification potential, AP** — An environmental impact category (“acid rain”). Emissions (e.g. sulphur oxides, nitrous oxides, ammonia) from transport, energy generation, combustion processes, and agriculture cause acidity of rainwater and thus damage to woodlands, lakes and buildings. Reference substance: sulphur dioxide.

**Environmental product declaration, EPD** — A standardised method (ISO 14025) of communicating the environmental performance of a product or service based on LCA data.

**Global warming potential, GWP** — An environmental impact category (“greenhouse effect”). Energy from the sun drives the earth’s weather and climate, and heats the earth’s surface. In turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapour, carbon dioxide, and other gases) are influencing the energy balance in a way that leads to an increased average temperature on earth’s surface. Problems arise when the atmospheric concentration of greenhouse gases increases due to the “man-made” (or anthropogenic) greenhouse effect: this additional greenhouse effect caused by human activities may further increase the average global temperature. The index GWP is calculated as a multiple equivalent of the absorption due to the substance in question in relation to the emission of 1 kg of carbon dioxide, the reference substance, over 100 years.

**Life cycle assessment, LCA** — A standardised management tool (ISO 14040–44) for appraising and quantifying the total environment impact of products or activities over their entire life cycle of particular materials, processes, products, technologies, services or activities.

**Low density polyethylene, LDPE** — A high-pressure polyethylene with a density < 940 kg/m<sup>3</sup>. Thermoplastic polymers consisting of bound ethylene units (C<sub>2</sub>H<sub>4</sub>)

**Nutrication potential, NP** — An environmental impact category (“over-fertilisation”). Emissions such as phosphate, nitrate, nitrous oxides, and ammonia from transport, energy generation, agriculture (fertilisers) and wastewater increase the growth of aquatic plants and can produce algae blooms that consume the oxygen in water and thus smother other aquatic life. This is called eutrophication and causes damage to rivers, lakes, plants, and fish. Reference substance: phosphate.

**Ozone depletion potential, ODP** — An environmental impact category (“ozone hole”). The index ODP is calculated as the contribution to the breakdown of the ozone layer that would result from the emission of 1 kg of the substance in question in relation to the emission of 1 kg of CFC-11 as a reference substance.

**Photochemical ozone creation potential, POCP** — An environmental impact category (“summer smog”). The index used to translate the level of emissions of various gases into a common measure to compare their contributions to the change of ground-level ozone concentration. The index POCP is calculated as the contribution to ozone formation close to the ground due to the substance in question in relation to the emission of 1 kg of ethene as a reference substance.

**Product category rules, PCR** — A set of rules for the preparation of LCA and EPD within a functionally defined class of products. A PCR document is a necessary component of any Type III Environmental Declaration programme (ISO 14025).