



Eco-profiles and Environmental Product Declarations of the European Plastics Manufacturers

General-Purpose Polystyrene (GPPS) and High-Impact Polystyrene (HIPS)

PlasticsEurope
November 2012

Environmental Product Declaration

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** (PCR version 2.0, April 2011). EPDs provide environmental performance data, but no information on the economic and social aspects which would be necessary for a complete sustainability assessment. EPDs do not imply a value judgment between environmental criteria. This EPD describes the production of the General Purpose Polystyrene (GPPS) and High Impact Polystyrene (HIPS) polymer from cradle to gate (from crude oil extraction to granules or resin at plant, i.e. polystyrene production site output). **Please keep in mind 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.

Meta Data

Data Owner	PlasticsEurope aisbl, Product Group Styrenics
LCA Practitioner	PE International AG
Programme Owner	PlasticsEurope aisbl
Programme Manager, Reviewer	DEKRA Consulting GmbH
Number of plants included in data collection	13 (GPPS) 11 (HIPS)
Representativeness	95%
Reference year	2010
Year of data collection and calculation	2012
Expected temporal validity	2022
Cut-offs	No significant cut-offs
Data Quality	Very good
Allocation method	Price allocation

Description of the Product and the Production Process

General Purpose Polystyrene (GPPS) is a hard, transparent material with a high gloss. High Impact Polystyrene (HIPS) is a white, non-shiny and basically opaque, but relatively flexible, rubber-modified polystyrene, that has high impact strength, high stiffness and excellent moldability, but reduced transparency.

Production Process

Polystyrene is produced by polymerisation of styrene monomer, a chain-growth reaction which is induced by any known initiation techniques such as heat, free radical organic initiator, anionic or cationic initiating systems, or coordination-insertion organometallic initiating complexes. Both GPPS and HIPS are produced by continuous-mass radical polymerisation of styrene; in case of HIPS, it is a polymerisation of polybutadiene rubber in a styrene solution. The reference flows, to which all data given in this EPD refer, are 1 kg of GPPS and 1 kg of HIPS pellets, respectively.

Data Sources and Allocation

The main data source was a primary data collection from European producers of GPPS and HIPS, providing site-specific gate-to-gate production data for processes under operational control of the participating companies: six GPPS producers with thirteen plants in nine different European countries; six HIPS producers with eleven plants in eight European countries. This covers 95 % of the European GPPS and HIPS production capacity (EU-27) in 2010, respectively. With the exception of one company which delivered primary data for styrene due to specific technology, the data for the upstream supply chain until the precursors are taken from the database of the software system GaBi 5 [GaBi 5 2011]. Two different routes for the production of styrene (EBSM and POSM) were modelled as per the actual supply situation. All relevant background data, such as energy and auxiliary materials, is from the GaBi 5

database, but is also publicly available and documented [GABI 5 2011]. Price allocation was applied where off-grade GPPS and HIPS was relevant.

Use Phase and End-of-Life Management

GPPS and HIPS are used in many applications such as food and non-food packaging, disposable cups and cutlery, furniture, toys and consumer goods, as well as electronics and appliances. Polystyrene is also easily foamed in order to manufacture insulation boards and lightweight foamed packaging. The packaging market is the main market and accounts for around one half of the European polystyrene market. Extrusion can be in form of plates, sheet, or foam boards. In a secondary process step extruded sheet can be thermoformed, for example into disposables such as trays and containers. Typical injection moulding applications are televisions housing and toys. HIPS is also used to make engineering resin blends with polyphenylene oxide for the automotive industry, electrical appliances, and electronics. Polystyrene can be recycled mechanically several times without deteriorating physical properties; furthermore, energy recovery is also possible.

Environmental Performance

The tables below show the environmental performance indicators associated with the production of 1 kg GPPS and 1 kg of HIPS.

Input Parameters

Indicator	Unit	Value	
		GPPS	HIPS
Non-renewable energy resources ¹⁾	MJ	82.26	86.43
• Fuel energy	MJ	33.96–37.96	38.13–42.13
• Feedstock energy	MJ	44.3–48.3	49.3–48.3
Renewable energy resources (biomass) ¹⁾	MJ	0.52	0.56
• Fuel energy	MJ	0.52	0.56
• Feedstock energy	MJ	—	—
Abiotic Depletion Potential			
• Elements	kg Sb eq	9.21E-07	1.04E-06
• Fossil fuels	MJ	74.70	78.46
Renewable materials (biomass)	kg	—	—
Water use (key foreground process level)	kg		
• for process	kg	0.51	0.78
• for cooling	kg	12.93	11.38

¹⁾ Calculated as upper heating value (UHV)

Output Parameters

Indicator	Unit	Value	
		GPPS	HIPS
GWP	kg CO ₂ eq	2.25	2.43
ODP	g CFC-11 eq	1.63E-05	1.72E-05
AP	g SO ₂ eq	5.38	5.65
POCP	g Ethene eq	0.85	0.90
EP	g PO ₄ eq	0.48	0.51
Dust/particulate matter ²⁾	g PM ₁₀	0.15	0.15
Total particulate matter ²⁾	g	0.17	0.18
Waste			
• Radioactive waste	kg	5.50E-04	5.82E-04
• Non-radioactive waste ³⁾	kg	1.5E-02	1.4E-02

²⁾ Including secondary PM₁₀

³⁾ Non-radioactive wastes include: spoil, tailings, and waste, deposited

Additional Environmental and Health Information

Polystyrene can be safely used for food packaging applications.

Additional Technical Information

The main properties of polystyrenes are high stiffness, low density, excellent processability and a low heat capacity value leading to process energy reduction. They also exhibit superior thermal and electrical insulation properties. Further, GPPS offers excellent optical clarity, and HIPS good mechanical properties, such as toughness.

Additional Economic Information

Due to high stiffness and low density, all articles made from polystyrene have excellent strength-to-weight ratio, offering many environmental benefits such a reduction of weight, non-renewable resource savings, transportation costs and carbon footprint. Polystyrene foaming can reduce density by a factor of 35 that allows significant savings on resources and cost of packaging. Building insulation using polystyrene foam boards enables energy savings within one year which exceed the energy used to manufacture the insulation products, but which last more than 50 years.

Information

Data Owner

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Programme Manager & Reviewer

DEKRA Consulting GmbH

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

Registration number: PlasticsEurope 2012-004, validation expires on 30 November 2015 (date of next revalidation review).

Programme Owner

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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

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