ENVIRONMENTAL PRODUCT DECLARATION

According to ISO 14025

Declaration Holder	**EUMEPS – Expanded Polystyrene (EPS) Foam Insulation**
Editor	Environmental Construction Products Organisation (ECO)
Declaration number	ECO-EPS-00020101-1106
Date of issue	28.06.2011
Validity Date	27.06.2014

Expanded Polystyrene (EPS) Foam Insulation (density 20 kg/m³)

EUMEPS

www.eco-europe-org

01 Summary

EUMEPS – Expanded Polystyrene (EPS) Foam Insulation

This declaration is based on the PCR document:
Factory Made Insulation Material from Plastic Foams, 2011-05.

Declared product/Declared unit
1 m³ and 1 m² with R-value 1
with average density of 20 kg/m³

Program holder
ECO – Environmental Construction Products Organisation

Hans Peters, CEO

Verification
This declaration and the rules on which it is based have been examined by an independent expert committee in accordance with ISO 14025.

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LCA Practitioner
PE INTERNATIONAL AG

Declaration holder
EUMEPS

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EPDs of construction products may not be comparable, if they do not comply with the same PCR.

Declared unit: 1 m³ of expanded polystyrene foam (density: 20 kg/m³)

Environmental Parameters	Unit	Product Stage (A1-A3)	Construction Process Stage (A4-A5)	Use Stage (B)	End of Life Stage (C2-C4)		Benefits and loads beyond the system boundary (D)	
					Sc. A	Sc. B	Sc. A	Sc. B
PED (renewable)	[MJ]	12,1	1,1E-02	Module not assessed	3,7E-02	6,4E-01	-1,3E+01	-9,8E-02
PED (non ren.)	[MJ]	1712,6	10,2		22,2	23,7	-665,8	-5,1
ADP elements	[kg Sb eq]	1,2E-05	2,7E-08		2,7E-07	2,1E-07	-2,4E-06	-1,8E-08
ADP fossil fuels	[MJ]	1,7E+03	1,0E+01		2,2E+01	2,2E+01	-5,9E+02	-4,6E+00
GWP	[kg CO_2 eq]	57,2	1,3		68,1	1,5	-38,5	-0,3
ODP	[kg R11 eq]	1,4E-06	1,3E-09		8,9E-09	5,9E-08	-2,3E-06	-1,7E-08
AP	[kg SO_2 eq]	1,2E-01	3,2E-03		1,8E-03	5,2E-03	-8,9E-02	-6,7E-04
EP	[kg PO_4^{3-} eq]	1,2E-02	7,5E-04		1,1E-03	5,4E-03	-6,9E-03	-5,3E-05
POCP	[kg C_2H_4 eq]	3,5E-01	3,5E-04		6,3E-04	6,4E-04	-6,5E-03	-4,9E-05

02 Product

Product Description

This EPD describes Expanded Polystyrene foam (EPS). The closed cell structure is filled with air (98% air; only 2% polystyrene) and results in a light weight, tough, strong and rigid thermoplastic insulation foam. The products are mainly used for thermal and acoustical insulation of buildings. The foam is available in various dimensions and shapes. Boards can be supplied with different edge treatments such as butt edge, ship lap, tongue and groove. Density range is from about 18 to 22 kg/m³ corresponding to a compressive strength value of about 100 kPa.

This EPD is applicable to homogeneous EPS products without material combinations or facings. Most important properties are the thermal conductivity and compressive strength.

Scope of validity / Applicability of the EPD

The applicability of the document is restricted to EPS boards produced by manufacturing plants of EPS converters who are members of their national EPS association, which themselves are members of EUMEPS. The data have been provided by a representative mix of 22 converters from amongst the EUMEPS membership from all parts of Europe, based upon production during 2009.

Product standards

EPS foams are labelled with the CE-mark according to EN 13163. These products are controlled and certified by the relevant national Notified Bodies, e.g.: BFA/ FIW/ CSTB / AENOR / etc.

Many products are additionally controlled and certified according to national voluntary quality labels and in many cases the products are additionally approved for use in specific applications under European or national technical approvals.

Many converters are additionally certified according to ISO 9001 and/or ISO 14001.

Product Application

The performance properties of EPS thermal insulation foams make them suitable for use in many applications. The range of products described in this document is used in applications such as wall insulation, pitched roof insulation, ETICS, cavity wall insulation, ceiling insulation, insulation for building equipment and industrial installations.

Delivery conditions

Polystyrene is normally transported by lorry.

The product dimensions can vary depending on, for example, the product, the manufacturer, the application and the applicable quality label. Dimensional data: length: max. 8000 mm, width: max. 1300 mm, thickness: max.1000 mm.

Technical Properties

Density	18 -22 kg/m^3
Declared thermal conductivity [W/mK] according to EN 12667	0.035 W/mK
Compressive stress or compressive strength [kPa] at 10% deflection according to EN 826	100 kPa
Bending strength according to EN 12089	150 kPa
Water vapour transmission μ according to EN 12086	30-70

Declaration of Basic Materials

EPS foams are made of polystyrene (94 % by weight), blown with pentane up to 6 % by weight, which is released partly during or shortly after production. The flame retardant Hexabromocyclododecane (HBCD) is present at ca. 0.8 % by weight to provide fire performance. In addition to the basic materials, the manufacturers use secondary (recycled) material.

Typically no other additives are used. Polystyrene and pentane are produced from oil and gas therefore linked to the availability of these raw materials.

Manufacturing Process

The conversion process of EPS beads to foamed insulation consists of the following manufacturing stages: pre-foaming, conditioning and finally block moulding. During the pre-foaming and moulding stages heating by steam causes the foaming of the beads due to the pentane blowing agent. The final shape is achieved by hot wire cutting of the block to give the desired board dimensions. Finally, the board edges are trimmed by cutting or grinding to obtain the desired edge detail. Typically cut offs are 100% recycled in line.

Packaging

The products are packed loose, bundled by tape or packed on 4 or 6 sides with PE-film.

The polyethylene based packaging film is recyclable and recycled in those countries having a suitable return system.

Environment, Health and Safety during Production-Stage

No further health protection measures, beyond the regulated measures for manufacturing companies, are necessary during any of the conversion steps for EPS.

EPS insulation is already in use for more than 50 years. No negative effects are known to people, animals or the environment.

No ozone depleting substances as regulated by the EU, such as CFC or HCFCs, are used as blowing agents for the production of EPS. Such chemicals have never been used for the production of EPS since its invention.

Installation

There are no special instructions regarding personal precautions and environmental protection during product handling and installation.

Product specific handling recommendations can be found in product and application literature, brochures and data sheets provided by the suppliers.

Use Stage

Water pick up by capillarity does not occur with well manufactured EPS foams, due to the closed cell structure. The thermal insulation performance of EPS is practically unaffected by exposure to water or water vapour.

Properly installed EPS boards (see: Installation) are durable with respect to their insulation, structural and dimensional properties. They are water resistant, resistant against micro-organisms and against most chemical substances. EPS, however, should not be brought into contact with organic solvents.

If applied correctly the lifetime of EPS insulation is equal to the building life time, usually without requiring any maintenance. Durability studies on applied EPS show no loss of technical properties after 35 years. Additional tests with products under artificial aging show that “no deficiencies are to be expected from EPS fills placed in the ground over a normal life cycle of 100 years.”/Langzeitverhalten 2004/, /Long-term performance 2001/.

The application of insulation material has a positive impact on energy efficiency of buildings. Quantification is only possible in context with the construction system of the building.

Dependent on the specific material and the frame conditions of installation, residual pentane may diffuse. Quantified measurements and release profiles cannot be declared.

Environment, Health and Safety in Use-Stage

EPS insulation products in most applications are neither in direct contact with the environment nor with indoor air. When tested for VOCs in countries where there are recommended levels, EPS products were found to be below these limits.

Singular Effects

Fire

Naked EPS products usually achieve the fire classification Euroclass E according to EN 13501-1. In their end use application, constructions with EPS can achieve a classification of B-s1,d0 according to EN13501-1. Ignition of the foam can only be observed after longer flame exposures. If the contact with the external heat source stops, the flame extinguishes and neither further burning nor smouldering can be observed. The combustion products from EPS foam are not more toxic than the combustion from common building material such as wood. /TNO 1980/

EPS contains the flame retardant HBCD in order to meet fire regulations. There is no significant release of HBCD from the installed product during its service life. The environmental effects of the flame retardant production can be determined from a literature review, as specifically conducted for establishing this EPD.

Water

EPS rigid foam is chemically neutral and not water soluble. No water soluble substances are released, which could lead to pollution of ground water, rivers or seas.

Because of the closed cell structure EPS insulation can be used even under moist conditions. In the case of unintended water ingress, e.g. through leakage, there is normally no need for replacement of EPS insulation. The insulation value of EPS remains almost unchanged in moist conditions.

End of Life

Deconstruction

Construction techniques should be employed to maximise the separation of EPS boards at the end of life of a building in order to maximise the potential for re-use.

Another option for re-use is to leave the EPS boards in place when the existing construction is thermally upgraded.

Recycling and energy recovery

It has not been taken into account in this EPD that clean EPS can be, and actually already is, recycled. Take back schemes are already in place in many countries, often as combined systems for EPS packaging.

Because recycling of EPS in many cases is technically and economically feasible, it is to be expected that EU waste regulation incentives for recycling will lead to high recycling percentages of more than 70% for EPS, e.g. in light weight concrete.

At the end of its life cycle an EPS product can be ultimately incinerated. Due to the high calorific value of polystyrene, energy embedded in EPS boards can be recovered in municipal waste incinerators equipped with energy recovery units for steam and electricity generation and for district heating.

Landfill

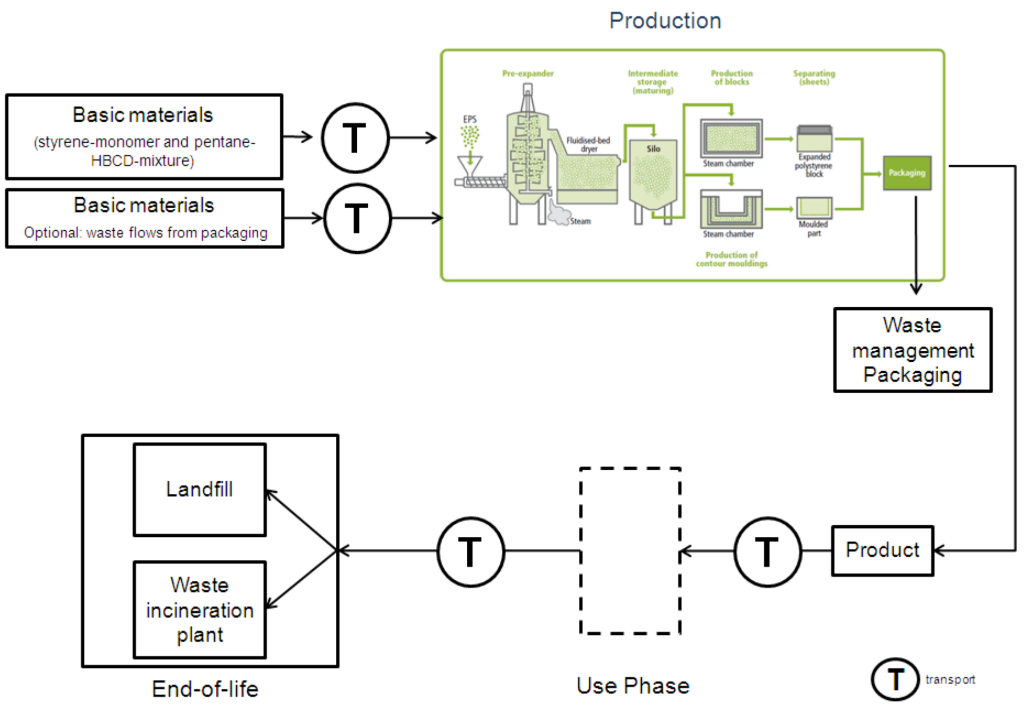
EPS manufacturers advise that their products should be treated according to the EU waste strategy. The first option is recycling and the second is incineration with energy recovery. Only if no other option is left should EPS boards be landfilled.

03 LCA Description

Declared unit

Reference value is 1 m³ of expanded polystyrene rigid foam. In addition, the results for the functional unit of a volume per square metre that leads to an R-value of 1 are considered.

System boundaries flow chart



Building assessment information (x = included in LCA)

Product Stage			Construction Process Stage		Use Stage							End-of-Life Stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport to building site	Installation into building	Use / application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport	Waste processing	Disposal	Reuse, recovery or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X			X	X									X	X	X	X

System Boundaries and Scenarios

The analysis of the product life cycle includes production of the basic materials, transport of the basic materials, manufacture of the product and the packaging materials and is declared in module A1-A3. Transport of the product is declared in module A4, and disposal of the packaging materials in module A5. Gained energy from packaging incineration is declared in module D.

The use stage is not taken into account in the LCA calculations. The positive impact on environment due to energy saving depends on the application system in the building. This needs to be considered on next level by the evaluation of buildings.

The end-of-life scenarios include the transport to end-of-life stage (C2)

EoL-scenario A: 100% incineration: The effort and emissions of an incineration process is declared in module C3. Resulting energy is declared in module D.

EoL-scenario B: 100% landfilling: The effort and emissions of the landfilling is declared in module C4.

Assumptions and Estimations

Research of the literature on the raw material HBCD has been carried out, to serve as a basis for an estimate on the manufacture of this material.

A transport distance of 100 km per lorry is assumed for the end-of-life scenario.

Cut-off criteria

All data from the production data acquisition are considered, i.e. all raw materials and their transport, water, thermal and electrical energy, packaging materials, and production waste. Thus, even minor material and energy flows with less than 1% are included.

Machines, facilities and infrastructure required during manufacture are not taken into account.

Data quality

For life cycle modelling of the considered products, the GaBi 4 Software System for Life Cycle Engineering and GaBi 4 database is used. All data used are less than 6 years old.

Relative to the upstream chain for the manufacturing of HBCD a dataset is estimated and integrated into the model.

The annual quantities for 2009 have been provided by the manufacturers and used as primary data.

Allocation

A1 – A3: In the calculation model the production waste is fed into an incineration process. The resulting energy (power and thermal energy) is considered as closed loop. Electrical energy is fed back into the grid; thermal energy from an incineration plant is used as process energy in industry or as heating energy. The quality of the thermal energy can be considered equal to the thermal energy needed for the production of EPS.

The disposal of the packaging is accounted for in module A5. The effort and emissions for incineration are assigned to module A5. Energy gained through the incineration process is declared in module D with respective equivalence processes.

The collected data from the manufacturers refer solely to EPS building products. The manufacturers allocated measured material and energy flows, if necessary to the respective datasets.

04 LCA Results

LCA results resource input [density: 20 kg/m³ (range: 18 – 22 kg/m³)]

Table 1: Results per declared unit (1 m³)

white, 20kg/m³		Product stage	Construction Process Stage		Use Stage	End-of-Life Stage					Benefits and loads beyond the system boundary	
Resource Input Parameters	Unit	Raw material supply, transport and manufacturing	Transport	Construction installation process	Use stage	Transport	Waste processing		Disposal		Reuse, recovery or recycling potential	
		A1 - A3	A4	A5	B	C2	C3		C4		D	
							Sc. A	Sc. B	Sc. A	Sc. B	Sc. A	Sc. B
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	[MJ]	12,1	1,1E-02	5,4E-04		1,5E-03	3,5E-02	0,0E+00	0,0E+00	6,4E-01	-1,3E+01	-9,8E-02
Use of renewable primary energy resources used as raw materials	[MJ]	0	0	0		0	0	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	[MJ]	12,1	1,1E-02	5,4E-04		1,5E-03	3,5E-02	0,0E+00	0,0E+00	6,4E-01	-1,3E+01	-9,8E-02
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	[MJ]	920,6	10,0	0,2	not considered	1,4	20,8	0,0	0,0	22,3	-665,8	-5,1
Use of non renewable primary energy resources used as raw materials	[MJ]	792,0	0	0		0	0	0	0	0	0	0
Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)	[MJ]	1712,6	10,0	0,2		1,4	20,8	0,0	0,0	22,3	-665,8	-5,1
Use of secondary material	[kg]	0,1	0	0		0	0	0	0	0	0	0
Use of renewable secondary fuels	[kg]	0	0	0		0	0	0	0	0	0	0
Use of non renewable secondary fuels	[kg]	0	0	0		0	0	0	0	0	0	0
Use of net fresh water	[kg]	219,5	0,2	0,7		2,5E-02	74,7	0,0	0,0	2,0	-83,2	-0,6

Table 2: Results per 1 m² with R-value 1 (λ = 0.036 W/mK, thickness 3.6 cm)

		A1 - A3	A4	A5	B	C2	C3		C4		D	
							Sc. A	Sc. B	Sc. A	Sc. B	Sc. A	Sc. B
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	[MJ]	0,4	3,8E-04	1,9E-05		5,3E-05	1,2E-03	0,0E+00	0,0E+00	2,2E-02	-4,7E-01	-3,4E-03
Use of renewable primary energy resources used as raw materials	[MJ]	0	0	0		0	0	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	[MJ]	0,4	3,8E-04	1,9E-05		5,3E-05	1,2E-03	0,0E+00	0,0E+00	2,2E-02	-4,7E-01	-3,4E-03
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	[MJ]	32,2	0,4	0,0	not considered	4,8E-02	7,3E-01	0,0E+00	0,0E+00	7,8E-01	-2,3E+01	-1,8E-01
Use of non renewable primary energy resources used as raw materials	[MJ]	27,7	0	0		0	0	0	0	0	0	0
Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)	[MJ]	59,9	0,4	0,0		4,8E-02	7,3E-01	0,0E+00	0,0E+00	7,8E-01	-2,3E+01	-1,8E-01
Use of secondary material	[kg]	2,9E-03	0	0		0	0	0	0	0	0	0
Use of renewable secondary fuels	[kg]	0	0	0		0	0	0	0	0	0	0
Use of non renewable secondary fuels	[kg]	0	0	0		0	0	0	0	0	0	0
Use of net fresh water	[kg]	7,7	6,4E-03	2,4E-02		8,9E-04	2,6E+00	0,0E+00	0,0E+00	7,1E-02	-2,9E+00	-2,1E-02

LCA results impact categories, waste categories and other environmental information describing output flows [acc. to CML 2009; density: 20 kg/m³ (range: 18 – 22 kg/m³)]

Table 3: Results per declared unit (1 m³)

Environmental impact categories		A1 - A3	A4	A5	B	C2	C3		C4		D	
							Sc. A	Sc. B	Sc. A	Sc. B	Sc. A	Sc. B
Abiotic depletion potential (ADP elements)	[kg Sb eq]	1,2E-05	2,4E-08	3,3E-09		3,3E-09	2,7E-07	0,0E+00	0,0E+00	2,1E-07	-2,4E-06	-1,8E-08
Abiotic depletion potential (ADP fossil fuels)	[MJ]	1,7E+03	1,0E+01	1,9E-01	not considered	1,4E+00	2,0E+01	0,0E+00	0,0E+00	2,0E+01	-5,9E+02	-4,6E+00
Global warming potential (GWP)	[kg CO_2 eq]	5,7E+01	7,2E-01	5,6E-01		9,9E-02	6,8E+01	0,0E+00	0,0E+00	1,4E+00	-3,9E+01	-3,0E-01
Ozone depletion potential (ODP)	[kg R11 eq]	1,4E-06	1,3E-09	8,3E-11		1,7E-10	8,7E-09	0,0E+00	0,0E+00	5,9E-08	-2,3E-06	-1,7E-08
Acidification potential (AP)	[kg SO_2 eq]	1,2E-01	3,2E-03	5,1E-05		4,4E-04	1,3E-03	0,0E+00	0,0E+00	4,8E-03	-8,9E-02	-6,7E-04
Eutrophication potential (EP)	[kg PO_4^{3-} eq]	1,2E-02	7,3E-04	1,7E-05		1,0E-04	1,0E-03	0,0E+00	0,0E+00	5,3E-03	-6,9E-03	-5,3E-05
Photochemical Ozone Creation Potential (POCP)	[kg C_2H_4 eq]	3,5E-01	3,4E-04	9,1E-06		4,3E-05	5,8E-04	0,0E+00	0,0E+00	6,0E-04	-6,5E-03	-4,9E-05
Waste categories		A1 - A3	A4	A5		C2	C3		C4		D	
							Sc. A	Sc. B	Sc. A	Sc. B	Sc. A	Sc. B
Hazardous waste disposed	[kg]	1,3E-01	0	8,1E-04		0	2,4E-04	0,0E+00	0	0	0	0
Non hazardous waste disposed	[kg]	3,7E+01	4,9E-02	3,1E-03		6,8E-03	1,0E+00	0,0E+00	0,0E+00	2,2E+01	-3,3E+01	-2,4E-01
Radioactive waste disposed	[kg]	1,8E-02	1,6E-05	1,0E-06		2,2E-06	1,1E-04	0,0E+00	0	0,0007405	-2,8E-02	-2,1E-04
Other environmental information describing output flows											Sc. A	Sc. B
Components for re-use	[kg]										0	0
Materials for recycling	[kg]										0	0
Materials for energy recovery	[kg]										0	0
Exported energy (electrical enery)	[MJ]										-55,6	-4,1E-01
Exported energy (thermal energy)	[MJ]										-469,4	-3,7E+00

Table 4: Results per 1 m² with R-value 1 (λ = 0.036 W/mK, thickness 3.6 cm)

Environmental impact categories		A1 - A3	A4	A5	B	C2	C3		C4		D	
							Sc. A	Sc. B	Sc. A	Sc. B	Sc. A	Sc. B
Abiotic depletion potential (ADP elements)	[kg Sb eq]	4,1E-07	8,4E-10	1,2E-10		1,2E-10	9,3E-09	0,0E+00	0,0E+00	7,3E-09	-8,3E-08	-6,4E-10
Abiotic depletion potential (ADP fossil fuels)	[MJ]	5,8E+01	3,5E-01	6,6E-03	not considered	4,8E-02	7,2E-01	0,0E+00	0,0E+00	7,1E-01	-2,1E+01	-1,6E-01
Global warming potential (GWP)	[kg CO_2 eq]	2,0E+00	2,5E-02	1,9E-02		3,5E-03	2,4E+00	0,0E+00	0,0E+00	4,8E-02	-1,3E+00	-1,0E-02
Ozone depletion potential (ODP)	[kg R11 eq]	5,0E-08	4,4E-11	2,9E-12		6,1E-12	3,1E-10	0,0E+00	0,0E+00	2,1E-09	-7,9E-08	-5,8E-10
Acidification potential (AP)	[kg SO_2 eq]	4,3E-03	1,1E-04	1,8E-06		1,5E-05	4,6E-05	0,0E+00	0,0E+00	1,7E-04	-3,1E-03	-2,3E-05
Eutrophication potential (EP)	[kg PO_4^{3-} eq]	4,4E-04	2,6E-05	5,9E-07		3,5E-06	3,5E-05	0,0E+00	0,0E+00	1,9E-04	-2,4E-04	-1,9E-06
Photochemical Ozone Creation Potential (POCP)	[kg C_2H_4 eq]	1,2E-02	1,2E-05	3,2E-07		1,5E-06	2,0E-05	0,0E+00	0,0E+00	2,1E-05	-2,3E-04	-1,7E-06
Waste categories		A1 - A3	A4	A5		C2	C3		C4		D	
							Sc. A	Sc. B	Sc. A	Sc. B	Sc. A	Sc. B
Hazardous waste disposed	[kg]	4,4E-03	0	2,8E-05		0	8,5E-06	0,0E+00	0	0	0	0
Non hazardous waste disposed	[kg]	1,3E+00	1,7E-03	1,1E-04		2,4E-04	3,5E-02	0,0E+00	0,0E+00	7,8E-01	-1,2E+00	-8,5E-03
Radioactive waste disposed	[kg]	6,2E-04	5,5E-07	3,6E-08		7,6E-08	3,8E-06	0,0E+00	0	2,592E-05	-9,9E-04	-7,3E-06
Other environmental information describing output flows											Sc. A	Sc. B
Components for re-use	[kg]										0	0
Materials for recycling	[kg]										0	0
Materials for energy recovery	[kg]										0	0
Exported energy (electrical enery)	[MJ]										-1,9	-1,4E-02
Exported energy (thermal energy)	[MJ]										-16,4	-1,3E-01

LCA results interpretation

Table 1/2:

The **primary energy demand** is basically determined by the requirements for the basic material production (polystyrene granules with HBCD, and pentane).

Considering the pure production phase ("cradle-to-gate") of the products manufactured using the block moulding process, the basic materials make up approximately 85% of primary energy demand. The primary energy used during the foaming process has a share of approximately 15% in relation to the whole production phase (A1-A3).

Due to the high calorific value of the product, incineration during the end-of-life stage in scenario A results in an energy gain.

In addition to the primary material polystyrene granules (with its additives), waste from polystyrene foam packaging is used as **secondary material**. No secondary fuels are used for the manufacture of EPS rigid foam.

Water is mainly needed for the manufacture of the polystyrene granules in the upstream chain, the steam in the foaming process, the generation of electrical energy, and in the waste incineration plant of the end-of-life scenario.

The declared water amount refers to the input flow of water, without consideration of circulating/cooling water.

Table 3/4:

All **impact categories**, with the exception of POCP, are dominated by the influence of the basic material (polystyrene granules mix) production. The polystyrene deployed in the production process already contains a large part of the environmental burdens.

The foaming process for the declared product polystyrene rigid foam also contributes significantly to the environmental impacts. The emission of pentane during that process makes a contribution to the Photochemical Ozone Creation Potential (POCP).

The effort (input of additional energy and material) for the end-of-life scenarios (C3 and C4) and the resulting credits of electricity and steam in scenario A (module D), due to the combustion, is separated. This results in negative values in module D.

Transportation has a low influence on all impact categories compared to the contributions from other areas.

The analysis of waste generation is done separately for the three fractions: hazardous waste, non-hazardous waste and radioactive waste. The major part of the non-hazardous waste is stockpile material from the upstream chain of the polystyrene manufacture and from the supply of primary energy carriers for the generation of electrical energy.

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