European Communication Format – B2B

Environmental Product Declaration

Polybutene (PB-1) pipe system for hot and cold water in the building

1 DECLARATION OF GENERAL INFORMATION

Introduction

The European Plastics Pipes and Fittings Association (TEPPFA) deems it important to have an insight into the integral environmental impacts that are encountered during the life-span of particular pipe system applications. With this framework in mind, TEPPFA has set up an LCA/EPD project with the Flemish Institute for Technological Research (VITO). The present EPD outlines the various environmental aspects which accompany the Polybutene (PB-1) pipe system for hot and cold water distribution in the building, from the primary extraction of raw materials up to and including the end of life (EoL) treatment after its reference service life time.

Name and address of manufacturers

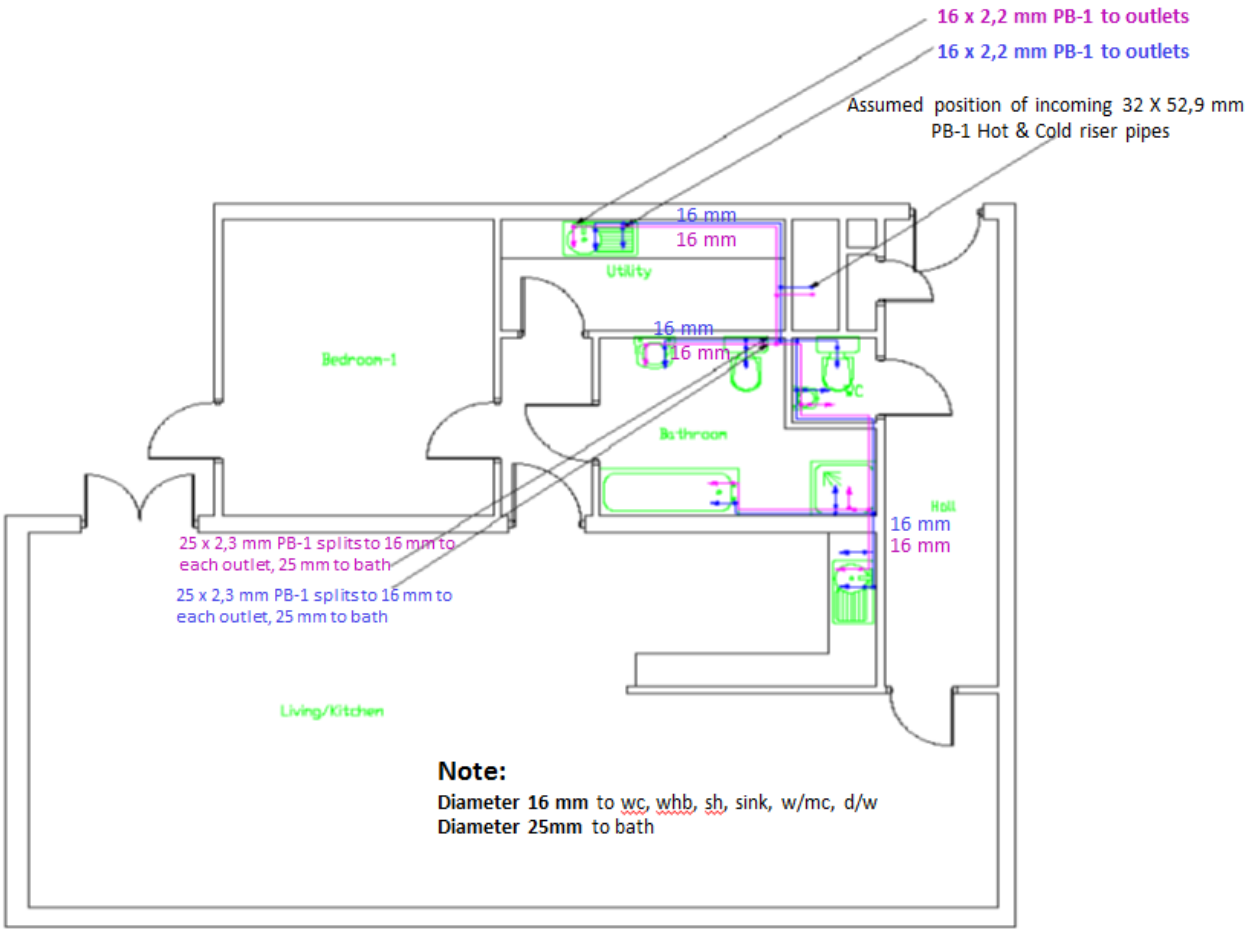
TEPPFA, Avenue de Cortenbergh, 71, B-1000 Brussels, Belgium, Tel: +32-2-736 24 06, Fax: +32-2-736 58 82, E-Mail: info@teppfa.org, Website: www.teppfa.org

Polybutene (PB-1) pipe system's use and functional unit

The EPD refers to a typical European Polybutene (PB-1) pipe system for hot and cold water distribution in the buildings, from the cradle to the grave, including raw material extraction, transportation to converters, converting process, transport to apartment, construction, use and end-of-life treatment. Environmental indicators are expressed for the complete life cycle, from the cradle to the grave, so for a typical European Polybutene (PB-1) Hot & Cold pipe system. The functional unit is defined as "the pressure supply and transport of hot and cold drinking water, from the entrance of a well-defined apartment to the tap, by means of a Polybutene (PB-1) Hot & Cold drinking water pipe system installation supplying a 100 m² apartment, incorporating a bathroom, separate WC, kitchen and washroom (considering the service life time of the pipe system to be aligned with the 50 year service life time of the apartment), calculated per year".

Product name & graphic display of product

Polybutene (PB-1) pipe system for hot and cold water in the building



Description of the Polybutene (PB-1) pipe system's components

The environmental burdens are calculated in relation to the functional unit, which resulted for the typical European Polybutene (PB-1) pipe system for hot and cold water in the building in the following basic pipe system components: Polybutene (PB-1) pipes and several types of fittings made of PB-1, PVDF, PPSU, and containing PA-GF, other plastics, stainless steel, brass, and heating wire made of metal alloy.

The system consists of Polybutene pipes supplied in coils. Connections to the several sanitary appliances are considered (tap connectors). Risers and joints (welded) are included in the design. Tie-ins welding fittings with metal (brass) inserts are also considered in the design.

The building system represents 100 m² of a typical residential single family apartment in a 5-storeyed building with all the facilities clearly positioned, like bath, shower etc.

The EPD is declared as the average environmental performance for the typical European Polybutene (PB-1) pipe system for hot and cold water distribution in the buildings, over its reference service life cycle of 50 years (being the estimated reference life time of the apartment until its first refurbishment), in accordance with EN 806, EN 806-2, EN 806-3, EN ISO 15876-1 , EN ISO 15876-2 and EN ISO 15876-3 .

EPD programme and programme operator

The present EPD is in line with the EN15804:2012+A1 and EN15942 developed by CEN TC 350. A programme operator related to the CEN TC 350 has not been established yet.

Date of declaration and validity

Revision 0, January, 2015

The EPD has a 5 year validity period (January, 2020)

Comparability
EPDs of construction products may not be comparable if they do not comply with the CEN TC 350 (EN15804 and EN15942) standards.

Typical European Polybutene (PB-1) pipe system EPD
The present EPD outlines various environmental aspects which accompany a representative typical European Polybutene (PB-1) pipe system for hot and cold water distribution in the buildings, from the primary extraction of raw materials up to and including the end of life (EoL) treatment after its reference service life time of 50 years (considering the service life time of the pipe system to be aligned with the 50 year service life time of the apartment until its first refurbishment).

Group of manufacturers
The EPD for the Polybutene (PB-1) hot and cold pipe system is representative for an anticipated European typical Polybutene (PB-1) hot and cold pipe system. The TEPPFA member companies represent more than 50% of the European market for extruded plastic pipes. For an overview of all members and national associations within TEPPFA we refer to pages 12 and 13 of this EPD.

Content of the product system
The product system does not contain materials or substances that can adversely affect human health and the environment in all stages of the life cycle.

Retrieve information
Explanatory material may be obtained by contacting TEPPFA (http://www.teppfa.org).

2 DECLARATION OF THE MATERIAL CONTENT

The European Polybutene (PB-1) Hot & Cold pipe system does not contain any substances as such or in concentration exceeding legal limits, which can adversely affect human health and the environment in any stages of its entire life cycle.

3 DECLARATION OF THE ENVIRONMENTAL PARAMETERS DERIVED FROM LCA

3.1 Life cycle flow diagram

The EPD refers to a typical European Polybutene (PB-1) Hot & Cold pipe system, from the cradle to the grave, including product stage, transport to construction site and construction process stage, use stage and end-of-life stage.

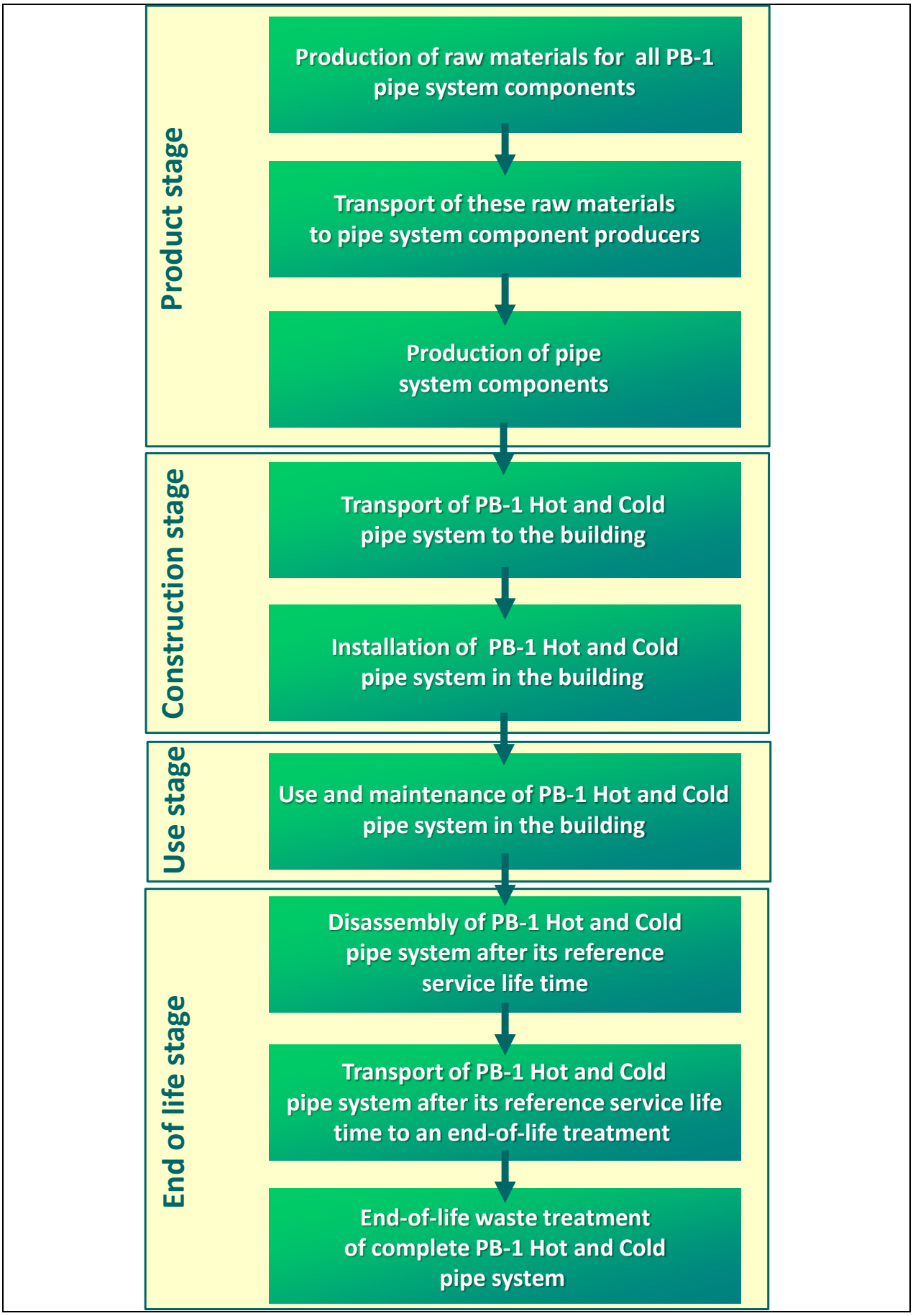
- **Product stage**: raw material extraction and processing, recycling processes for recycled material input, transport to the manufacturer, manufacturing (including all energy provisions, waste management processes during the product stage up to waste for final disposal):
  - Production of the raw materials for the PB-1 pipes;
  - Transport of the raw materials for pipes to converter;
  - Extrusion PB-1 pipes;
  - Production of the raw materials for PB-1 part fittings;
  - Transport of raw materials for PB-1 part fittings to converter;
  - Injection moulding PB-1-part fittings;

- Production of other plastics for fittings;
- Production of PVDF for fittings (raw materials and converting process);
- Production of PPSU for fittings (raw materials and converting process);
- Production of PA-GF for fittings (raw materials and converting process);
- Production of stainless steell inserts for fittings (raw materials and converting process);
- Production of brass inserts (elements) for fittings (raw materials and converting process);
- Production of alloy (heating wire) for fittings (raw materials and converting process).

- **Construction process stage**: including all energy provisions, waste management processes during the construction stage up to waste for final disposal.
  - Transport of the complete PB-1 pipe system to the building (apartment);
  - Installation of the PB-1 pipe pipe system in the apartment.

- **Use stage** (maintenance and operational use): including transport and all energy provisions, waste management processes up to waste for final disposal during this use stage.
  - Operational use is not relevant for the Polybutene (PB-1) Hot & Cold pipe system
  - Maintenance is not relevant for the Polybutene (PB-1) Hot & Cold pipe system.

- **End of life stage**: including all energy provisions during the end of life stage.
  - Disassembly of complete PB-1 pipe system;
  - Transport of complete PB-1 pipe system to EOL;
  - EoL treatment PB-1 pipe system.


Product stage
Production of raw materials for all PB-1 pipe system components
Transport of these raw materials to pipe system component producers
Production of pipe system components
Construction stage
Transport of PB-1 Hot and Cold pipe system to the building
Installation of PB-1 Hot and Cold pipe system in the building
Use stage
Use and maintenance of PB-1 Hot and Cold pipe system in the building
End of life stage
Disassembly of PB-1 Hot and Cold pipe system after its reference service life time
Transport of PB-1 Hot and Cold pipe system after its reference service life time to an end-of-life treatment
End-of-life waste treatment of complete PB-1 Hot and Cold pipe system

3.2 Parameters describing environmental impacts

The following environmental parameters are expressed with the impact category parameters of the life cycle impact assessment (LCIA).

Impact category		Abiotic depletion - non fossil	Abiotic depletion fossil	Terrestrial acidification	Eutrophication	Climate change	Ozone layer depletion	Photochemical oxidation
		kg Sb eq	MJ, net cal	kg SO2 eq	kg PO4--- eq	kg CO2 eq	kg CFC-11 eq	kg C2H4
Product stage	A1-3	2,24E-05	1,88E+01	5,68E-03	1,53E-03	8,28E-01	5,71E-08	3,00E-04
Transport to installation	A4	4,07E-08	2,27E-01	5,98E-05	1,18E-05	1,52E-02	2,29E-09	5,02E-06
Installation	A5	1,36E-07	1,33E+00	3,01E-04	4,45E-05	1,02E-01	4,09E-09	3,51E-05
Use	B1-B7	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Disassembly	C1	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Transport to end-of-life treatment	C2	6,95E-08	2,42E-01	5,98E-05	1,20E-05	1,61E-02	2,52E-09	2,10E-06
End-of-life treatment	C3-C4	-5,39E-08	-4,95E-01	-1,10E-04	-9,59E-06	4,92E-02	-1,43E-09	-5,65E-06
Total		**2,25E-05**	**2,01E+01**	**5,99E-03**	**1,59E-03**	**1,01E+00**	**6,46E-08**	**3,36E-04**

3.3 Parameters describing resource input

The following environmental parameters apply data based on the life cycle inventory (LCI).

Declaration of environmental paramaters derived from LCI								
Parameters describing resource use, primary energy								
			Use of renewable primary energy excluding renewable primary energy resources used as raw materials	Use of renewable primary energy resources used as raw materials	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	Use of non renewable primary energy resources used as raw materials	Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)
			MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value
Product stage	Total (of product stage)	A1-3	na	na	8,71E-01	na	na	1,99E+01
Construction process stage	Transport	A4	na	na	6,14E-03	na	na	2,51E-01
	Construction installation process	A5	na	na	4,56E-02	na	na	1,18E+00
Use stage	Use	B1	0	0	0	0	0	0
	Maintenance	B2	0	0	0	0	0	0
	Repair	B3	0	0	0	0	0	0
	Replacement	B4	0	0	0	0	0	0
	Refurbishment	B5	0	0	0	0	0	0
	Operational energy use	B6	0	0	0	0	0	0
	Operational water use	B7	0	0	0	0	0	0
End of life	De-construction, demolition	C1	0	0	0	0	0	0
	Transport	C2	na	na	5,45E-03	na	na	2,63E-01
	Waste processing	C3	na	na	-3,49E-01	na	na	-3,72E+00
	Disposal	C4	na	na	2,37E-04	na	na	3,67E-02

na: not available

Declaration of environmental paramaters derived from LCI						
Parameters describing resource use, secondary materials and fuels, and use of water						
			Use of secondary material*	Use of renewable secondary fuels*	Use of non renewable secondary fuels*	Net use of fresh water
			kg	MJ, net calorific value	MJ, net calorific value	m3
Product stage	Total (of product stage)	A1-3	0	0	0	9,21E-03
Construction process stage	Transport	A4	na	na	na	5,93E-05
	Construction installation process	A5	na	na	na	4,29E-03
Use stage	Use	B1	0	0	0	0
	Maintenance	B2	0	0	0	0
	Repair	B3	0	0	0	0
	Replacement	B4	0	0	0	0
	Refurbishment	B5	0	0	0	0
	Operational energy use	B6	0	0	0	0
	Operational water use	B7	0	0	0	0
End of life	De-construction, demolition	C1	0	0	0	0
	Transport	C2	0	0	0	6,82E-05
	Waste processing	C3	0	0	0	-1,55E-03
	Disposal	C4	0	0	0	4,11E-06

*only for foreground process from which LCI data are made available by TEPPFA - the number does not include processes and materials modelled by means of background data, eg transportation, electricity, ancillary materials...

3.4 Parameters describing different waste categories and further output material flows

The parameters describing waste categories and other material flows are output flows derived from the life cycle inventory (LCI).

Parameters describing different waste categories

Declaration of environmental paramaters derived from LCI					
Other environmental information describing waste categories					
			Hazardous waste disposed	Non hazardous waste disposed	Radioactive waste disposed
			kg	kg	kg
Product stage	Total (of product stage)	A1-3	1,13E-03	1,02E-01	3,06E-05
Construction process stage	Transport	A4	3,21E-06	1,10E-03	4,06E-07
	Construction installation process	A5	5,45E-06	1,93E-02	2,66E-06
Use stage	Use	B1	0	0	0
	Maintenance	B2	0	0	0
	Repair	B3	0	0	0
	Replacement	B4	0	0	0
	Refurbishment	B5	0	0	0
	Operational energy use	B6	0	0	0
	Operational water use	B7	0	0	0
End of life	De-construction, demolition	C1	0	0	0
	Transport	C2	3,04E-07	1,40E-03	3,43E-07
	Waste processing	C3	-4,61E-06	-4,86E-03	-2,16E-05
	Disposal	C4	1,82E-08	8,50E-01	1,69E-08

Parameters describing further output material flows

Other environmental information describing output flows		
Components for re-use*	0,00E+00	kg
Materials for recycling*	4,11E-02	kg
Materials for energy recovery**	0,00E+00	kg
Exported energy**	0,00E+00	MJ per energy carrier

*only for foreground process from which LCI data are made available by TEPPFA - the number does not include processes and materials modelled by means of background data, eg transportation, electricity, ancillary materials...

**the benefits from waste incineration are accounted for within the system boundaries. Therefore no energy nor materials for energy recovery are leaving the system boundaries

4 SCENARIOS AND TECHNICAL INFORMATION

4.1 Construction process stage

Transport from the production gate to the construction site (apartment)

Parameter	Parameter unit expressed per functional unit
Fuel type consumption of vehicle or vehicle type used for transport e.g. long distance truck, boat etc.	The Polybutene (PB-1) Hot & Cold pipe system is transported over an average distance of 95 km with a truck (about 16 ton) and 30 km by means of a van (< 3,5 ton) from the producers of the different pipe system components via customers to the building. Environmental burdens associated with this kind of transport are calculated by means of the Ecoinvent V2.2 datarecords "Transport, lorry 16-32t, EURO4/tkm/RER" and "Transport, van <3.5t, RER".
Capacity utilisation (including empty returns)	
Bulk density	
Volume capacity utilisation factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaged product)	

Construction (installation in building/apartment)

Parameter	Parameter unit expressed per functional unit
Ancillary materials for installation	**3 liter of water** for testing, flushing and cleaning. **0,04 kg fast fixing cement** (ratio water/cement 0,3) of which 0,028 kg cement and 0,012 kg water **0,03 kg of wall fixing metals**, considered to be made out of galvanised steel Environmental burdens associated with this kind of input flows are calculated by means of the Ecoinvent V2.2 data record "Tap water, at user, RER", "Cement, unspecified at plant, RER" and "Steel, converter, unalloyed, at plant, RER", in

<table>
<tr><td></td><td>combination with “Steel product manufacturing, average metal working, RER”</td></tr>
<tr><td>Other resource consumption</td><td>Not relevant</td></tr>
<tr><td>Quantitative description of energy type (regional mix) and consumption during the installation process</td><td>0,01 kWh of electrical energy is needed for the operation of the screw driver during installation and 0,0014 kWh of electrical energy is used for electrofusion of the fittings.
Environmental burdens associated with this kind of energy are calculated by means of the Ecoinvent V2.2 data record “Electricity, low voltage, production RER, at grid (European average mix of production)”</td></tr>
<tr><td>Waste on the building site, generated by the product’s installation

Output materials as result of waste management processes at the building site e.g. of collection for recycling, for energy recovery, final disposal</td><td>0,00123 kg of Polybutene (PB-1) pipe left over during installation: 80% to landfill, 15% to incineration and 5% to mechanical recycling. Transportation of Polybutene (PB-1) pipe left over to waste management treatment facilities is included: 600 km for mechanical recycling, 150 km to incineration with energy recovery and 50 km to landfill. Environmental burdens are calculated by means of the Ecoinvent v2.2 data record “Transport, lorry 3.5-7.5t, EURO4/tkm/RER”.
0,0423 kg of packaging waste: treated according to European average packaging waste scenarios (Eurostat, 2011):

<table>
<tr><th></th><th>Recycling</th><th>Energy recovery</th><th>Landfill</th></tr>
<tr><td>Plastic</td><td>34,3%</td><td>29,1%</td><td>36,6%</td></tr>
<tr><td>Paper and board</td><td>83%</td><td>8,5%</td><td>8,5%</td></tr>
<tr><td>Wood</td><td>37,7%</td><td>29,9%</td><td>32,4%</td></tr>
<tr><td>Metals</td><td>72,3%</td><td>0,6%</td><td>27,1%</td></tr>
<tr><td>TOTAL</td><td>63,6%</td><td>13,7%</td><td>22,7%</td></tr>
</table>
(Source: Eurostat)</td></tr>
<tr><td>Emissions to ambient air, soil and water</td><td>No direct emissions at the building site. Emissions are related to the upstream processes (transportation processes and mechanical energy) and downstream processes (waste management and treatment) and are included in the Ecoinvent datarecords that are used for modelling the environmental impacts.</td></tr>
</table>

4.2 Use stage: operation and maintenance

Operation and maintenance:

Operational use (pumping energy) is not relevant for the EPD, since it falls outside the system boundaries of the LCA project. Maintenance is not needed for the Polybutene (PB-1) Hot & Cold pipe system.

4.3 End of life

The following end of life scenarios have been taken into account:

- Estimated reference service life time of 50 years, being the service life time of the apartment until the first refurbishment
- EoL approach for recycling, landfill and incineration with energy recovery (impacts and credits are assigned to the life cycle that generates the waste flows)
- Recycled content approach for recycling and use of recyclates (= impact of recycling and credits for recyclates, because less virgin materials are needed is assigned to the life cycle that uses the recyclates)

<table>
<tr><th>Processes</th><th>Parameter unit expressed per functional unit</th></tr>
<tr><td>Collection process
Recycling system
Final deposition</td><td>After a reference service life time of 50 years the Polybutene (PB-1) Hot & Cold pipe system might be stripped for recoverable materials and products, and the remaining construction subsequently demolished. The Polybutene (PB-1) Hot & Cold pipe system is demolished together with the total construction. So for the functional unit 0,21243 kg of pipe system components are available at the apartment.
The PB-1 pipes and the plastic parts of the fittings (0,16983 kg) follow the following scenario: 15% (0,02547 kg) is transported over an average distance of 150 km to an incinerator, 80% (0,13586 kg) is transported over an average distance of 50 km to a landfill and 5% (0,00849 kg) is transported over an average distance of 600 km for mechanical recycling.
The brass inserts, stainless steel parts and heating wire (0,04261 kg) are for 75% recycled (0,03195 kg is transported over average distance of 600 km) and for 25% disposed to a landfill (0,01065 kg transported over average distance of 50 km).

<table>
<tr><th colspan="2">EoI Scenario PB-1 pipes and plastic parts of fittings</th></tr>
<tr><td>Mechanical recycling</td><td>5%</td></tr>
<tr><td>Incineration</td><td>15%</td></tr>
<tr><td>Landfill</td><td>80%</td></tr>
<tr><th colspan="2">EoL metal parts</th></tr>
<tr><td>Recycling</td><td>75%</td></tr>
<tr><td>Landfill</td><td>25%</td></tr>
</table>

Environmental burdens associated with transportation are calculated by means of the following Ecoinvent v2.2 data record “Transport, lorry 3.5-7.5t, EURO4/tkm/RER”</td></tr>
</table>

5 ADDITIONAL INFORMATION ON EMISSIONS TO INDOOR AIR, SOIL AND WATER DURING USE STAGE

Emissions to indoor air:
Despite there is no approved European measurement method available, we can confirm that the Polybutene (PB-1) Hot & Cold pipe system does not contain any substances mentioned on the REACH-list.

Emissions to soil and water:
Since the Polybutene (PB-1) Hot & Cold system is installed in the apartment we can confirm that emissions to soil and water are not relevant.

6 OTHER ADDITIONAL INFORMATION

Product certification, conformity, marking

EN 806-1, Specifications for installations inside buildings conveying water for human consumption. Part 1: General

EN 806-2, Specification for installations inside buildings conveying water for human consumption. Part 2: Design

EN 806-3, Specifications for installations inside buildings conveying water for human consumption. Part 3: Pipe sizing. Simplified method

EN ISO 15876-1, Plastics piping systems for Hot & Cold water installations. Polybutylene (PB). Part 1: General

EN ISO 15876-2, Plastics piping systems for Hot & Cold water installations — Polybutylene (PB) — Part 2: Pipes

EN ISO 15876-3, Plastics piping systems for Hot & Cold water installations — Polybutylene (PB) — Part 3: Fittings

Other technical product performances

For the full overview of the environmental benefits of plastic pipe systems we refer to the TEPPFA website: http://www.teppfa.org

List of names and logos of TEPPFA member companies

Aliaxis	**Aliaxis**
ALPHACAN ARKEMA GROUP	**Alphacan**
GEBERIT	**Geberit International**
+GF+ GEORG FISCHER PIPING SYSTEMS	**Georg Fischer Piping Systems**
PIPELIFE	**Pipelife International**
REHAU Unlimited Polymer Solutions	**Rehau**
TESSENDERLO GROUP	**Tessenderlo Group**
uponor	**Uponor**
wavin	**Wavin**

List of National Associations of TEPPFA

ADPP	-	Czech Republic plastic pipes association
ASETUB	-	Asociación Española de Fabricantes de Tubos y Accesorios Plásticos
BPF	-	Plastic Pipes Group
BPPMA	-	Bulgarian Plastic Pipes Manufacturers Association
BureauLeiding	-	Dutch Plastic Pipes Association
DPF	-	Danish Plastics Federation
FCIO	-	Fachverband der Chemischen Industrie Österreich
Federplast.be	-	Belgische Vereniging van Producenten van Kunststof- en Rubberartikelen bij Agoria en Assenscia
FIPIF	-	Finnish Plastics Industries Federation
IPPMA	-	Irish Plastic Pipe Manufacturers Association
KRV	-	Kunstoffrohrverband e.V.- Fachverband der Kunstoffrohr-Industrie
MCsSz	-	Műanyag Csőgyártók Szövetsége
P&K	-	Swedish Plastics and Chemical Federation
PRIK	-	Polish Association of Pipes and Fittings
STR	-	Syndicat des Tubes et Raccords
VKR	-	Verband Kunststoffrohre und Rohrleitungstelle

REFERENCES

CEN TC 350 framework documents, 2013

- EN 15804:2012+A1: Sustainability of construction works – Environmental product declarations – core rules for the product category of construction products (2013)
- EN 15942: Sustainability of construction works – Environmental product declarations – Communication format – Business to Business (2011)

Ecoinvent, 2011. Ecoinvent database v2.0, Swiss Centre for Life Cycle Inventories, Switzerland. From:

www.ecoinvent.org

ISO, 2006

- ISO 14025, (2006), Environmental labels and declarations -- General principles.
- ISO 14040, (2006), Environmental management – Life cycle assessment – Principles and framework.
- ISO 14044, (2006) Environmental management – Life cycle assessment – Requirements and guidelines.

EN 806, Specifications for installations inside buildings conveying water for human consumption. Part 1: General
EN 806-2, Specification for installations inside buildings conveying water for human consumption. Part 2: Design
EN 806-3, Specifications for installations inside buildings conveying water for human consumption. Part 3: Pipe sizing. Simplified method

EN ISO 15876-1, Plastics piping systems for Hot & Cold water installations. Polybutylene (PB). Part 1: General
EN ISO 15876-2, Plastics piping systems for Hot & Cold water installations — Polybutylene (PB) — Part 2: Pipes
EN ISO 15876-3, Plastics piping systems for Hot & Cold water installations — Polybutylene (PB) — Part 3: Fittings

Eurostat, 2011. Packaging waste scenarios (EU27, 2011). From: http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/packaging_waste

PlasticsEurope, 2011. The association of plastics manufacturers. From: http://www.plasticseurope.org/plastics-sustainability/eco-profiles.aspx

SimaPro, 2013. SimaPro LCA Software v.8.3.0, PRé consultants bv, Amersfoort, The Netherlands

TNO report, 2008. Quality of PVC sewage pipes in the Netherlands
MT-RAP-2008-01066/mso / 2; Author(s) J. Breen - Assignor BureauLeiding

Background LCA report (ISO 14040 and ISO 14044) prepared by
VITO – Flemish Institute for Technological Research, Boeretang 200, B-2400 Mol, Belgium, Tel.: +32-14-33 55 11, Email: vito@vito.be

External critical review of underlying LCA by
Denkstatt GmbH, Hietzinger Hauptstraße, AU-1130 Wien, Austria, Tel.: +43-1 786 89 00, Email: office@denkstatt.at