REHAU
Unlimited Polymer Solutions

ENVIRONMENTAL PRODUCT DECLARATION

Polymer/Al/Polymer Composite Pipe System

RAUTITAN HEATING AND PLUMBING SYSTEM

RAUTITAN Plumbing System for drinking water installation
Drinking water should come from the tap clean and fresh. RAUTITAN offers an extensive product range of polymer material pipes and fittings for this, as well as metall fittings high quality.

The system can also be used for heating applications
RAUTITAN brings comforting warmth to every room – with robust components, which are also impressive with their attractive appearance at all visible points. RAUTITAN has solutions for every type of installation – whether the radiator connection is through the wall, the floor or the skirting board.

Following EPD (environmental product declaration) applies for the multilayer pipe RAUTITAN stabil used in drinking water installations.

For RAUTITAN flex and RAUTITAN his in drinking water installation please consult the document DHI00288.

European Communication Format – B2B

Environmental Product Declaration

Polymer/Al/Polymer composite 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, in 2010 TEPPFA has set up an LCA/EPD project with the Flemish Institute for Technological Research (VITO) which resulted in an EPD. The present EPD is the update of the EPD issued in 2011 – foreground data remained the same, with only the datasets being updated to the latest available version (Ecoinvent 3.3 and Industry 2.0 replaced Ecoinvent 2 datasets). It outlines the various environmental aspects which accompany the Polymer/ Al/Polymer composite pipe system for hot and cold water 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

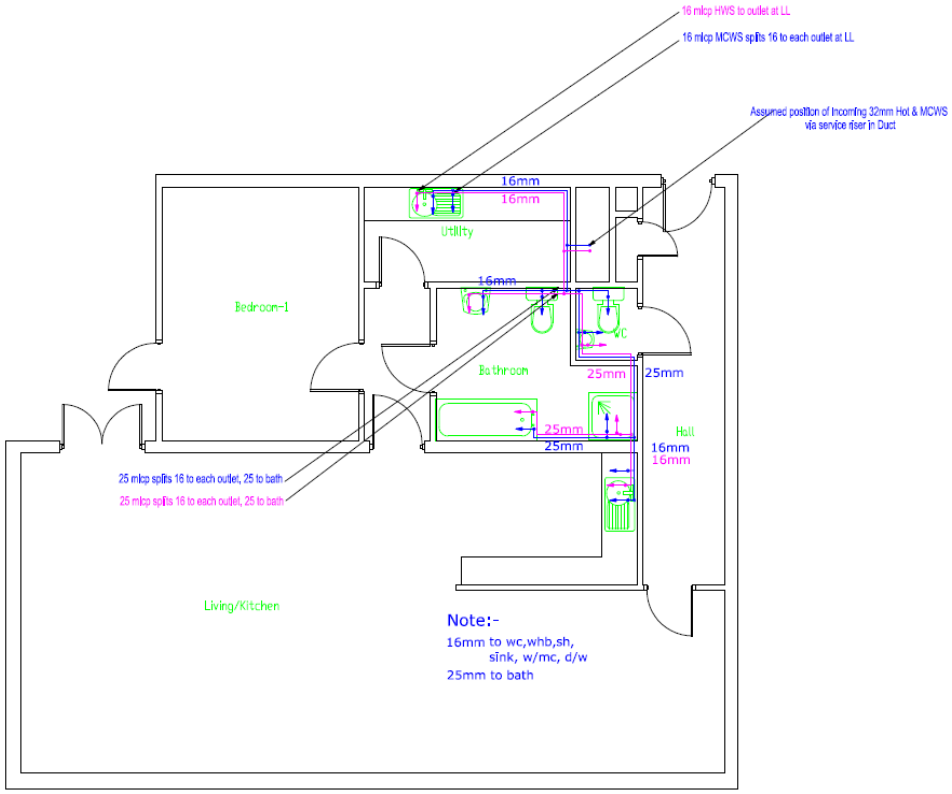
TEPPFA, Avenue de Cortenbergh, 71, B-1000 Brussels, Belgium, Tel: +32-2-736 24 06, Fax: +32-2-736 58 82, E-Mail: info@teppfa.eu, Website: www.teppfa.eu

Polymer/Al/polymer composite pipe system's use and functional unit

The EPD refers to a typical European Polymer/Al/Polymer composite pipe system for hot and cold water in the building, from the cradle to the grave, including raw material extraction, transportation to converters, converting process, transport to apartment, construction, use and end of life. Environmental indicators are expressed for the complete life cycle, from the cradle to the grave, so for a typical European Polymer/Al/Polymer composite 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 Polymer/Al/polymer composite 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

Polymer/Al/Polymer composite pipe system for hot and cold water in the building



Description of the Polymer/Al/Polymer composite pipe system's components

The environmental burdens are calculated in relation to the functional unit, which resulted for the typical European Polymer/Al/Polymer composite pipe system for hot and cold water in the building in the following basic pipe system components: Polymer/Al/Polymer composite pipes, PPSU and brass fittings and metal compression rings.

The investigated system is a three layer composite pipe system with a core made out of aluminium. The average of two different composites has been taken for the modeling of environmental impacts:

- 50% crossed-linked polyethylene/aluminium/polyethylene – raised temperature (PEX/Al/PE-RT)
- 50% polyethylene – raised temperature/aluminium/polyethylene – raised temperature (PE-RT/Al/PE-RT)

Connections to the several sanitary appliances (e.g. siphons) are not considered. Plastic bodied press fittings in PPSU type material and metal (brass) tie-ins as well as metal compression rings are considered in the life cycle assessment. System components usage by weight is taken as the average of the weights of typical system designs of two major European suppliers. Since systems are normalized, no major weight differences occur. 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 Polymer/Al/Polymer composite pipe system for hot and cold water in the building, over its reference service life cycle of 50 years (being the estimated reference life time of the apartment), in accordance to EN 806, EN 806-2, EN 806-3, EN ISO 21003-1, EN ISO 21003-2 and EN ISO 21003-3.

EPD programme and programme operator
The present EPD is in line with the ongoing standardization work by CEN TC 350 (EN15804 and EN15942). A programme operator related to the CEN T 350 has not been established yet.

Date of declaration and validity
January, 2018
The EPD has a 5 year validity period (January, 2023)

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

Typical European Polymer/Al/Polymer composite pipe system EPD
The present EPD outlines various environmental aspects which accompany a representative typical European Polymer/Al/Polymer composite pipe system for hot and cold water 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 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).

Group of manufacturers
The EPD for the Polymer/Al/Polymer composite hot and cold pipe system is representative for an anticipated European typical Polymer/Al/Polymer composite 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 the last page 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.eu)

2 DECLARATION OF THE MATERIAL CONTENT

The European Polymer/Al/Polymer composite 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

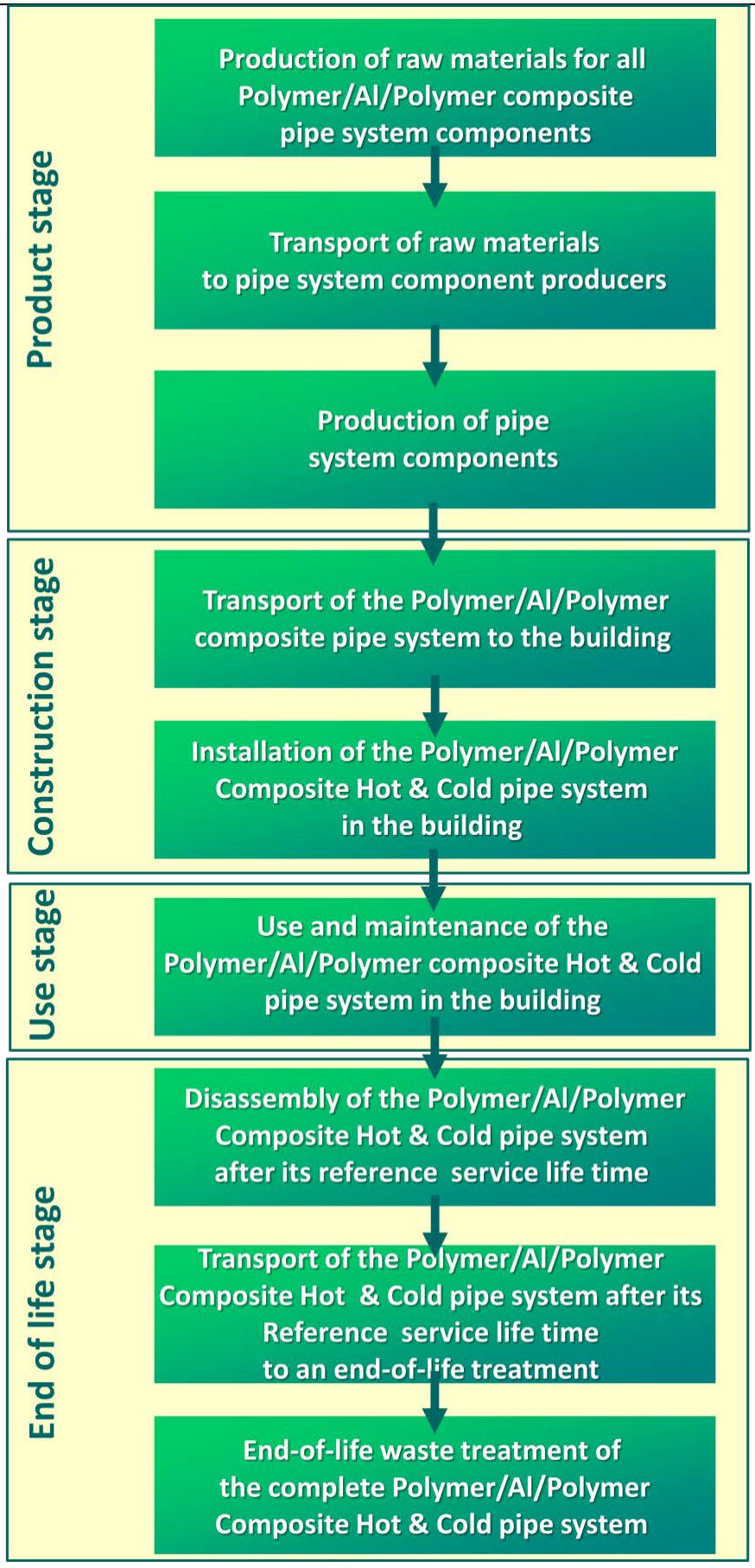
The EPD refers to a typical European Polymer/Al/Polymer composite Hot & Cold pipe system, from the cradle to the grave, including product stage, transport to construction site and construction process stage, use stage and end of life stage.

- **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 raw materials for the polymer part of the Polymer/Al/Polymer composite pipes
  - Transport of the polymer raw materials for Polymer/Al/Polymer composite pipes to converter
  - Production of the aluminium part of the Polymer/Al/Polymer composite pipes
  - Transport of the aluminium part of the Polymer/Al/Polymer composite pipes
  - Converting process for Polymer/Al/Polymer composite Hot & Cold pipes (extrusion), including packing of the pipes
  - Production of PPSU fittings
  - Production of brass fittings
  - Production of metal compression rings

- **Construction process stage**: including all energy provisions, waste management processes during the construction stage up to waste for final disposal
  - Transport of Polymer/Al/Polymer composite Hot & Cold pipe system to the building
  - Installation of Polymer/Al/Polymer composite Hot & Cold pipe system to the building

- **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 Polymer/Al/Polymer composite Hot & Cold pipe system
  - Maintenance is not relevant for the Polymer/Al/Polymer composite Hot & Cold pipe system

- **End of life stage**: including all energy provisions during the end of life stage
  - Disassembly of the Polymer/Al/Polymer composite Hot & Cold pipe system after 50 years of reference service life time at the building
  - Transport of Polymer/Al/Polymer composite Hot & Cold pipe system after 50 years of reference service life time at the building to an end-of-life treatment
  - End-of-life treatment of the Polymer/Al/Polymer composite Hot & Cold pipe system


Product stage
Production of raw materials for all Polymer/Al/Polymer composite pipe system components
Transport of raw materials to pipe system component producers
Production of pipe system components
Construction stage
Transport of the Polymer/Al/Polymer composite pipe system to the building
Installation of the Polymer/Al/Polymer Composite Hot & Cold pipe system in the building
Use stage
Use and maintenance of the Polymer/Al/Polymer composite Hot & Cold pipe system in the building
End of life stage
Disassembly of the Polymer/Al/Polymer Composite Hot & Cold pipe system after its reference service life time
Transport of the Polymer/Al/Polymer Composite Hot & Cold pipe system after its Reference service life time to an end-of-life treatment
End-of-life waste treatment of the complete Polymer/Al/Polymer Composite Hot & 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	Acidification	Eutrophication	Global warming	Ozone layer depletion	Photochemical oxidation
	kg Sb eq	kg SO2 eq	kg PO4--- eq	kg CO2 eq	kg CFC-11 eq	kg C2H4 eq
Product stage	4,45E-05	5,18E-03	1,16E-03	8,66E-01	8,42E-08	4,77E-04
Construction process stage	2,48E-07	5,16E-04	6,54E-05	1,30E-01	8,32E-09	5,20E-05
Use stage	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
End of life stage	-1,40E-09	-7,95E-05	6,00E-07	8,00E-02	-1,63E-09	-1,73E-06
Total	**4,47E-05**	**5,62E-03**	**1,22E-03**	**1,08E+00**	**9,09E-08**	**5,27E-04**

3.3 Parameters describing resource input

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

Environmental parameter	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)	Use of secondary material	Use of renewable secondary fuels	Use of non renewable secondary fuels	Net use of fresh water
	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	kg	MJ, net calorific value	MJ, net calorific value	m3
Product stage	n.a.	n.a.	2,37E+00	n.a.	n.a.	1,86E+01	n.a.	n.a.	n.a.	2,07E-02
Construction process stage	n.a.	n.a.	8,60E-02	n.a.	n.a.	1,95E+00	n.a.	n.a.	n.a.	3,75E-03
Use stage	n.a.	n.a.	0,00E+00	n.a.	n.a.	0,00E+00	n.a.	n.a.	n.a.	0,00E+00
End of life stage	n.a.	n.a.	-9,24E-02	n.a.	n.a.	-5,91E-01	n.a.	n.a.	n.a.	-4,01E-04
Total	**n.a.**	**n.a.**	**2,36E+00**	**n.a.**	**n.a.**	**2,00E+01**	**n.a.**	**n.a.**	**n.a.**	**2,41E-02**

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

Environmental parameter	Hazardous waste	Non-hazardous waste	Nuclear waste
	kg	kg	kg
Product stage	1,48E-03	2,63E-01	3,53E-05
Construction stage	6,91E-06	3,71E-02	6,51E-06
Use stage	0,00E+00	1,00E+00	2,00E+00
End of life stage	-5,94E-07	1,68E-01	-3,18E-06
Total	**1,48E-03**	**1,47E+00**	**2,00E+00**

Parameters describing further output material flows

Parameter	Parameter unit expressed per functional unit
Components for re-use	0 kg
Materials for recycling	0,022 kg
Materials for energy recovery	0,028 kg

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 Polymer/Al/Polymer composite Hot & Cold pipe system is transported over an average distance of 640 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 V3.3 datarecords "Transport, freight, lorry 16-32 metric ton, EURO4 {RER}| transport, freight, lorry 16-32 metric ton, EURO4 | Alloc Rec, U" and "Transport, freight, light commercial vehicle {Europe without Switzerland}| processing | Alloc Rec, U".
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)

<table>
<tr><th>Parameter</th><th>Parameter unit expressed per functional unit</th></tr>
<tr><td>Ancillary materials for installation</td><td>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 V3.3 datarecord “Tap water {RER}| market group for | Alloc Rec, U”, “Cement, Portland {Europe without Switzerland}| market for | Alloc Rec, U” and “Steel, converter, unalloyed, at plant, RER”, in combination with “Metal working, average for steel product manufacturing {RER}| processing | Alloc Rec, U”</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 installation (screw driver)
Environmental burdens associated with this kind of energy are calculated by means of the Ecoinvent V3.3 datarecord “Electricity, low voltage {RER}| market group for | Alloc Rec, U (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>0,0012 kg of Polymer/Al/Polymer composite pipe left left over during installation: 85% to landfill and 15% to incineration. Transportation of Polymer/Al/Polymer composite pipe left over to waste management treatment facilities is included: 150 km to incineration with energy recovery and 50 km to landfill. Environmental burdens are calculated by means of the Ecoinvent V3.3 datarecord “Transport, freight, lorry 3.5-7.5 metric ton, EURO4 {RER}| transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Alloc Rec, U”.
0,015 kg of packaging waste: treated according to European average packaging waste scenarios (Eurostat, 2006):
<table>
<tr><th></th><th>Recycling</th><th>Energy Recovery</th><th>Landfill</th></tr>
<tr><td>Plastic</td><td>27%</td><td>26%</td><td>47%</td></tr>
<tr><td>Paper and board</td><td>75%</td><td>10%</td><td>15%</td></tr>
<tr><td>Wood</td><td>38%</td><td>23%</td><td>39%</td></tr>
<tr><td>Metals</td><td>66%</td><td></td><td>34%</td></tr>
<tr><td>Total</td><td>57%</td><td>12%</td><td>31%</td></tr>
</table></td></tr>
<tr><td>Emissions to ambient air, soil and water</td><td>No direct emissions at the trench. Emissions are related to the upstream processes (mining of sand, transportation processes and mechanical energy) and downstream processes (waste</td></tr>
</table>

	management and treatment) and are included in the Ecoinvent datarecords that are used for modelling the environmental impacts.

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 Polymer/Al/Polymer composite 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
- EoL approach for landfill, 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 Polymer/Al/Polymer composite Hot & Cold pipe system is stripped for recoverable materials and products, and the remaining construction subsequently demolished. The Polymer/Al/Polymer composite Hot & Cold pipe system is demolished together with the total construction. So for the functional unit 0,2155 kg of pipe system components are available at the apartment. The brass fittings (0,030 kg) are for 75% recycled (0,0225 kg is transported over average distance of 600 km) and for 25% disposed to a landfill (0,0075 kg transported over average distance of 50 km). The Polymer/Al/Polymer composite pipes, PPSU fittings, including compression rings (0,1855 kg) follow the following scenario: 15% (0,0278 kg) is transported over an average distance of 150 km to an incinerator and 85% (0,1577 kg) is transported over an average distance of 50 km to a landfill.

<table>
<tr><th colspan="2">EOL scenario Polymer/Al/Polymer composite pipes</th></tr>
<tr><td>Mechanical recycling</td><td>0%</td></tr>
<tr><td>Incineration</td><td>15%</td></tr>
<tr><td>Left in ground</td><td>85%</td></tr>
</table>

Environmental burdens associated with transportation are calculated by means of the following Ecoinvent V3.3 datarecord “Transport, freight, lorry 3.5-7.5 metric ton, EURO4 {RER}| transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Alloc Rec,</td></tr>
</table>

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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 Polymer/Al/Polymer composite Hot & Cold pipe system does not contain any substances mentioned on the REACH-list.

Emissions to soil and water:
Since the Polymer/Al/Polymer composite 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 21003-1, Multilayer piping systems for hot and cold water installations inside buildings. Part 1: General

EN ISO 21003-2, Multilayer piping systems for hot and cold water installations inside buildings. Part 2: Pipes

EN ISO 21003-3, Multilayer piping systems for hot and cold water installations inside buildings. Part 3: Fittings

In compliance with European Construction Products Directive (89/106/EEC)

Other technical product performances

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

List of names and logos of TEPPFA member companies

Aliaxis	**Aliaxis**
GEBERIT	**Geberit International**
+GF+	**Georg Fischer Piping Systems**
PIPELIFE	**Pipelife International**
Polypipe	**Polypipe**
REHAU Unlimited Polymer Solutions	**Rehau**
RADIUS Systems	**Radius Systems**
Tessenderlo Group EVERY MOLECULE COUNTS	**Tessenderlo Group**
uponor	**Uponor**
wavin CONNECT TO BETTER	**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
BureauLeiding	-	Dutch Plastic Pipes Association
DPF	-	Danish Plastics Federation
FCIO	-	Fachverband der Chemischen Industrie Österreich
Federplast	-	De Belgische producenten van kunststof-en rubberartikels, lid bij Agoria of essenscia.
FIPIF	-	Finnish Plastics Industries Federation
KRV	-	Kunstoffrohrverband e.V.- Fachverband der Kunstoffrohr-Industrie
MCsSz	-	Műanyag Csőgyártók Szövetsége
IKEM	-	Swedish Plastics and Chemical Federation
PRiK	-	Polish Association of Pipes and Fittings
STR	-	Syndicat des Tubes et Raccords
VKR	-	Verband Kunststoffrohre und Rohrleitungstelle
Unionplast	-	Federazione Gomma Plastica – Pipes Sector Group

List of names and logos of TEPPFA Associated Members

Borealis

LyondellBasell

Vynova

Lubrizol

List of names and logos of TEPPFA Supporting Members

Rollepaal

Molecor

REFERENCES

Ecoinvent, 2016. Ecoinvent database v3.3, Swiss Centre for Life Cycle Inventories, Switzerland. From: www.ecoinvent.org

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 21003-1, Multilayer piping systems for hot and cold water installations inside buildings. Part 1: General

EN ISO 21003-2, Multilayer piping systems for hot and cold water installations inside buildings. Part 2: Pipes

EN ISO 21003-3, Multilayer piping systems for hot and cold water installations inside buildings. Part 3: Fittings

Eurostat, 2006. Packaging waste scenarios (EU27, 2006). From: http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/packaging_waste

ISO 14025: Environmental Labels and Declarations Type III

ISO 14040: Environmental management – Life cycle assessment – Principles and framework

ISO 14044: Environmental management – Life cycle assessment – Requirements and guidelines

EN 15804: Sustainability of construction works – Environmental product declarations – core rules for the product category of construction products (draft, 2008)

EN 15942: Sustainability of construction works – Environmental product declarations – Communication format – Business to Business (draft, April 2009)

Background LCA report (ISO 14040 and ISO 14044) prepared by

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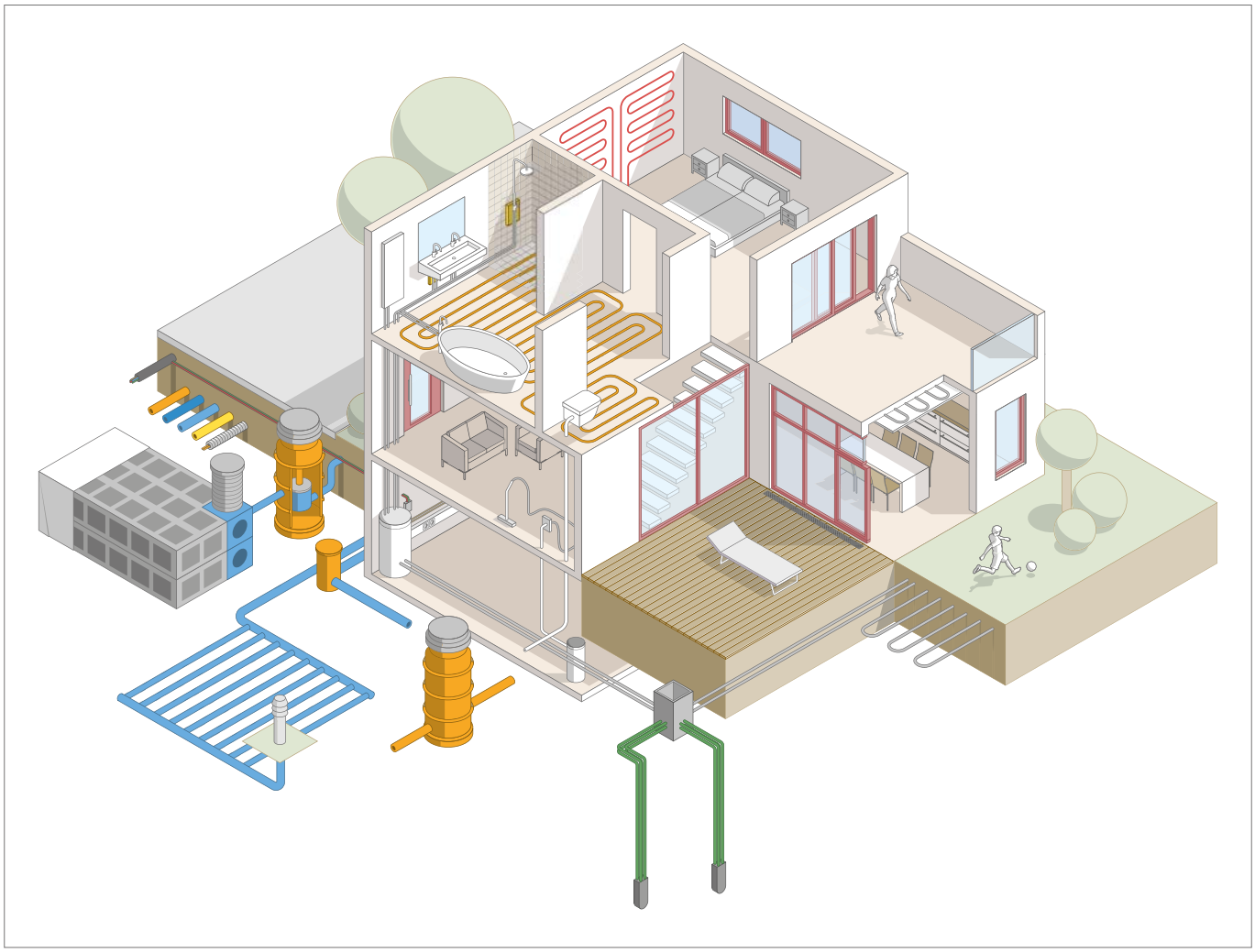
External critical review of underlying LCA by

Denkstatt GmbH, Hietzinger Hauptstraße 28, A-1130 Wien, Austria, Tel.: +43-1 786 89 00, Email: office@denkstatt.at



Our verbal and written advice with regard to usage is based on years of experience and standardised assumptions and is provided to the best of our knowledge. The intended use of REHAU products is described comprehensively in the technical product information. The latest version can be viewed at www.rehau.com/TI. We have no control over the application, use or processing of the products. Responsibility for these activities therefore remains entirely with the respective user/processor.
Where claims for liability nonetheless arise, they shall be governed exclusively according to our terms and conditions, available at www.rehau.com/conditions, insofar as nothing else has been agreed upon with REHAU in writing. This shall also apply for all warranty claims, with the warranty applying to the consistent quality of our products in accordance with our specifications. Subject to technical changes.

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