European Communication Format - B2B

Environmental Product Declaration

POLYPROPYLENE RANDOM COPOLYMER (PP-R) PIPE SYSTEM FOR HOT AND COLD WATER IN THE BUILDING
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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 lifespan 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 2013 – foreground data remained the same, with only the datasets being updated to the latest available version (Ecoinvent 3.4 and Industry 2.0 replaced Ecoinvent 2 datasets).

It outlines the various environmental aspects which accompany the Polypropylene – Random copolymer (PP-R) 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 lifetime.

Name and address of manufacturers

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

Polypropylene random copolymer (PP-R) pipe system’s use and functional unit

The EPD refers to a typical European Polypropylene random copolymer (PP-R) 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 Polypropylene random copolymer (PP-R) 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 Polypropylene random copolymer (PP-R) Hot & Cold drinking water pipe system installation supplying a 100 m² apartment, incorporating a bathroom, separate WC, kitchen and washroom (considering the service lifetime of the pipe system to be aligned with the 50 year service lifetime of the apartment), calculated per year”.

Product name & graphic display of product

Polypropylene random copolymer (PP-R) pipe system for hot and cold water in the building

![Diagram of Polypropylene random copolymer (PP-R) pipe system for hot and cold water in the building]
Description of the Polypropylene random copolymer (PP-R) pipe system’s components

The environmental burdens are calculated in relation to the functional unit, which resulted for the typical European Polypropylene random copolymer (PP-R) pipe system for hot and cold water in the building in the following basic pipe system components: Polypropylene random copolymer (PP-R) pipes, PP-R fittings and PP-R fittings with metal (brass) insert. The system consists of polypropylene random copolymer pipes, supplied in straight length of 4 meters.

Connections to the several sanitary appliances are considered (tap connectors). Risers and joints (welded) are included in the design. Tie-ins welding fittings in PP-R type material 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 storey building with all the facilities clearly positioned, like bath, shower etc.

The EPD is declared as the average environmental performance for the typical European Polypropylene random copolymer (PP-R) pipe system for hot and cold water in the building, over its reference service life cycle of 50 years (being the estimated reference lifetime of the apartment), in accordance to EN 806, EN 806-2, EN 806-3, EN ISO 15874-1, EN ISO 15874-2 and EN ISO 15874-3.

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, 2019
The EPD has a 5 year validity period (January, 2024)

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 Polypropylene random copolymer (PP-R) pipe system EPD

The present EPD outlines various environmental aspects which accompany a representative typical European Polypropylene random copolymer (PP-R) 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 lifetime of 50 years (considering the service lifetime of the pipe system to be aligned with the 50 year service lifetime of the apartment).

Group of manufacturers

The EPD for the Polypropylene random copolymer (PP-R) hot and cold pipe system is representative for an anticipated European typical Polypropylene random copolymer (PP-R) 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 12-14 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 Polypropylene random copolymer (PP-R) 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 Polypropylene random copolymer (PP-R) 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 of the Polypropylene random copolymer (PP-R) pipes
  - Transport of the polymer raw materials for Polypropylene random copolymer (PP-R) pipes to converter
  - Converting process for Polypropylene random copolymer (PP-R) Hot & Cold pipes (extrusion), including packing of the pipes
  - Production of the raw materials for PP-R fittings
  - Transport of the polymer raw materials for Polypropylene random copolymer (PP-R) fittings to converter
  - Converting process for PP-R fittings (injection moulding)
  - Production of brass inserts (elements) for the PP-R 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 Polypropylene random copolymer (PP-R) Hot & Cold pipe system to the building
  - Installation of Polypropylene random copolymer (PP-R) 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 Polypropylene random copolymer (PP-R) Hot & Cold pipe system
  - Maintenance is not relevant for the Polypropylene random copolymer (PP-R) Hot & Cold pipe system

- **End of life stage:** including all energy provisions during the end of life stage
  - Disassembly of the Polypropylene random copolymer (PP-R) Hot & Cold pipe system after 50 years of reference service lifetime at the building
  - Transport of Polypropylene random copolymer (PP-R) Hot & Cold pipe system after 50 years of reference service lifetime at the building to an end-of-life treatment
  - End-of-life treatment of the Polypropylene random copolymer (PP-R) Hot & Cold pipe system after 50 years of reference service lifetime at the building.
**PRODUCT STAGE**

- **Production** of raw materials for PP-R copolymer for hot and cold pipe system components

  **Transport** of these raw materials to pipe system component producers

  **Production** of PP-R copolymer hot and cold pipe system components

**CONSTRUCTION STAGE**

- **Transport** of PP-R copolymer hot and cold pipe system to the building

  **Installation** of PP-R copolymer hot and cold pipe system in the building

**USE STAGE**

- **Use** and maintenance of PP-R copolymer hot and cold pipe system in the building

**END-OF-LIFE STAGE**

- **Disassembly** of PP-R copolymer hot and cold pipe system after its reference service life time

  **Transport** of PP-R copolymer hot and cold pipe system after its reference service life time

  **End-of-life** waste treatment of complete PP-R copolymer hot and cold pipe system after its reference service life time
3.2 Parameters describing environmental impacts

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

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Abiotic depletion (non-fossil)</th>
<th>Abiotic depletion (fossil fuels)</th>
<th>Acidification</th>
<th>Eutrophication</th>
<th>Global warming</th>
<th>Ozone layer depletion</th>
<th>Photochemical oxidation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg Sb eq</td>
<td>MJ</td>
<td>kg S02 eq</td>
<td>kg PO4--- eq</td>
<td>kg CO2 eq</td>
<td>kg CFC-11 eq</td>
<td>kg C2H4 eq</td>
</tr>
<tr>
<td>Product stage</td>
<td>2,04E-05</td>
<td>1,92E+01</td>
<td>2,31E-03</td>
<td>6,25E-04</td>
<td>5,80E-01</td>
<td>3,36E-08</td>
<td>1,40E-04</td>
</tr>
<tr>
<td>Construction process stage</td>
<td>3,50E-07</td>
<td>8,84E-01</td>
<td>2,90E-04</td>
<td>4,57E-05</td>
<td>6,28E-02</td>
<td>8,77E-09</td>
<td>1,47E-05</td>
</tr>
<tr>
<td>Use stage</td>
<td>0,00E+00</td>
<td>0,00E+00</td>
<td>0,00E+00</td>
<td>0,00E+00</td>
<td>0,00E+00</td>
<td>0,00E+00</td>
<td>0,00E+00</td>
</tr>
<tr>
<td>End of life stage</td>
<td>6,47E-09</td>
<td>-2,47E-01</td>
<td>-1,02E-04</td>
<td>6,29E-06</td>
<td>8,77E-02</td>
<td>-1,61E-09</td>
<td>-4,92E-06</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,08E-05</td>
<td>1,98E+01</td>
<td>2,50E-03</td>
<td>6,64E-04</td>
<td>7,30E-01</td>
<td>4,08E-08</td>
<td>1,50E-04</td>
</tr>
</tbody>
</table>

3.3 Parameters describing resource input

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

<table>
<thead>
<tr>
<th>Environmental parameter</th>
<th>Use of renewable primary energy excluding renewable primary energy resources used as raw materials</th>
<th>Use of renewable primary energy resources used as raw materials</th>
<th>Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)</th>
<th>Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials</th>
<th>Use of non renewable primary energy resources used as raw materials</th>
<th>Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)</th>
<th>Use of secondary material</th>
<th>Use of renewable secondary fuels</th>
<th>Use of non renewable secondary fuels</th>
<th>Net use of fresh water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product stage</td>
<td>na</td>
<td>na</td>
<td>7,77E-00</td>
<td>na</td>
<td>na</td>
<td>2,17E+01</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>1,11E-02</td>
</tr>
<tr>
<td>Construction process stage</td>
<td>na</td>
<td>na</td>
<td>1,66E-01</td>
<td>na</td>
<td>na</td>
<td>2,53E+00</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>4,08E-03</td>
</tr>
<tr>
<td>Use stage</td>
<td>na</td>
<td>na</td>
<td>0,00E+00</td>
<td>na</td>
<td>na</td>
<td>0,00E+00</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>0,00E+00</td>
</tr>
<tr>
<td>End of life stage</td>
<td>na</td>
<td>na</td>
<td>-1,30E-01</td>
<td>na</td>
<td>na</td>
<td>-7,42E-01</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>-5,54E-04</td>
</tr>
<tr>
<td>TOTAL</td>
<td>na</td>
<td>na</td>
<td>8,13E-01</td>
<td>na</td>
<td>na</td>
<td>2,35E+01</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>1,47E-02</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Environmental parameter</th>
<th>Hazardous waste</th>
<th>Non-hazardous waste</th>
<th>Nuclear waste</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td>Product stage</td>
<td>2.98E-03</td>
<td>1.14E-01</td>
<td>2.22E-05</td>
</tr>
<tr>
<td>Construction stage</td>
<td>9.92E-06</td>
<td>6.33E-02</td>
<td>9.70E-06</td>
</tr>
<tr>
<td>Use stage</td>
<td>0.00E+00</td>
<td>1.00E+00</td>
<td>2.00E+00</td>
</tr>
<tr>
<td>End of life stage</td>
<td>-9.49E-07</td>
<td>1.98E-01</td>
<td>-4.11E-06</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2.99E-03</strong></td>
<td><strong>1.38E+00</strong></td>
<td><strong>2.00E+00</strong></td>
</tr>
</tbody>
</table>

**Parameters describing further output material flows**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components for re-use**</td>
<td>kg</td>
<td>0</td>
</tr>
<tr>
<td>Materials for recycling**</td>
<td>kg</td>
<td>0.03296</td>
</tr>
<tr>
<td>Materials for energy recovery**</td>
<td>kg</td>
<td>0.03922</td>
</tr>
<tr>
<td>Exported energy**</td>
<td>MJ per energy carrier</td>
<td>0</td>
</tr>
</tbody>
</table>

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

4. SCENARIOS AND TECHNICAL INFORMATION

4.1 Construction process stage

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter unit expressed per functional unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel type consumption of vehicle or vehicle type used for transport e.g. long distance truck, boat etc.</td>
<td>The Polypropylene random copolymer (PP-R) Hot &amp; Cold pipe system is transported over an average distance of 450 km with a truck (about 16 ton) and 30 km by means of a van (&lt; 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 V3.4 data records “Transport, freight, lorry 16-32 metric ton, EURO4 (RER)” transport, freight, lorry 16-32 metric ton, EURO4</td>
</tr>
</tbody>
</table>
Construction (installation in building/apartment)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter unit expressed per functional unit</th>
</tr>
</thead>
<tbody>
<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 V3.4 datarecord “Tap water {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 installation (screw driver) Environmental burdens associated with this kind of energy are calculated by means of the Ecoinvent V3.4 datarecord “Electricity, low voltage {RER}</td>
</tr>
<tr>
<td>Waste on the building site, generated by the product's installation</td>
<td>0.006 kg of Polypropylene random copolymer (PP-R) pipe left over during installation: 80% to landfill, 15% to incineration and 5% to mechanical recycling. Transportation of Polypropylene random copolymer (PP-R) 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 v3.4 datarecord “Transport, freight, lorry 3.5-7.5 metric ton, EURO4 (REI)</td>
</tr>
<tr>
<td>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></td>
</tr>
<tr>
<td></td>
<td>Recycling</td>
</tr>
<tr>
<td>Plastic</td>
<td>27%</td>
</tr>
<tr>
<td>Paper and board</td>
<td>75%</td>
</tr>
<tr>
<td>Wood</td>
<td>38%</td>
</tr>
<tr>
<td>Metals</td>
<td>66%</td>
</tr>
<tr>
<td>Total</td>
<td>57%</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>
</tbody>
</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 Polypropylene random copolymer (PP-R) Hot & Cold pipe system.

### 4.3 End of life

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

- Estimated reference service lifetime of 50 years, being the service lifetime 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>
<thead>
<tr>
<th>Processes</th>
<th>Parameter unit expressed per functional unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection process</td>
<td>After a reference service lifetime of 50 years the Polypropylene random copolymer (PP-R) Hot &amp; Cold pipe system might be stripped for recoverable materials and products, and the remaining construction subsequently demolished. The Polypropylene random copolymer (PP-R) Hot &amp; Cold pipe system is demolished together with the total construction. So for the functional unit 0.255 kg of pipe system components are available at the apartment. The brass inserts (0.015 kg) are for 75% recycled (0.011 kg is transported over average distance of 600 km) and for 25% disposed to a landfill (0.004 kg transported over average distance of 50 km). The PP-R pipes and fittings (0.240 kg) follow the following scenario: 5% (0.012 kg) is transported over a distance of 600 km for mechanical recycling, 15% (0.036 kg) is transported over an average distance of 150 km to an incinerator and 80% (0.192 kg) is transported over an average distance of 50 km to a landfill.</td>
</tr>
<tr>
<td>Recycling system</td>
<td></td>
</tr>
<tr>
<td>Final deposition</td>
<td></td>
</tr>
</tbody>
</table>

**EOL scenario PP-R copolymer pipes**

<table>
<thead>
<tr>
<th>Recycling</th>
<th>75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td>25%</td>
</tr>
</tbody>
</table>

**EOL brass inserts of fittings**

<table>
<thead>
<tr>
<th>Recycling</th>
<th>75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td>25%</td>
</tr>
</tbody>
</table>

Environmental burdens associated with transportation are calculated by means of the following Ecoinvent v3.4 datarecord "Transport, freight, lorry 3.5-7.5 metric ton, EURO4 (RER) transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Cut-off, U"
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 Polypropylene random copolymer (PP-R) Hot & Cold pipe system does not contain any substances mentioned on the REACH-list.

Emissions to soil and water:
Since the Polypropylene random copolymer (PP-R) 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 ISO 15874-1, Plastics piping systems for hot and cold water installations. Polypropylene (PP). Part 1: General

Other technical product performances
For the full overview of the environmental benefits of plastic pipe systems please refer to the TEPPFA website: http://www.teppfa.eu
List of names and logos of TEPPFA member companies

Aliaxis

DYKA

Geberit International

Georg Fischer Piping Systems

LK

Nupi

Pipelife International

Polypipe

Rehau

Radius Systems

Uponor

Wavin
### List of National Associations of TEPPFA

<table>
<thead>
<tr>
<th>Association</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADPP</td>
<td>Czech Republic plastic pipes association</td>
</tr>
<tr>
<td>ASETUB</td>
<td>Asociación Española de Fabricantes de Tubos y Accesorios Plásticos</td>
</tr>
<tr>
<td>BPF</td>
<td>Plastic Pipes Group</td>
</tr>
<tr>
<td>BureauLeiding</td>
<td>Dutch Plastic Pipes Association</td>
</tr>
<tr>
<td>DPF</td>
<td>Danish Plastics Federation</td>
</tr>
<tr>
<td>FCIO</td>
<td>Fachverband der Chemischen Industrie Österreich</td>
</tr>
<tr>
<td>Essenscia PolyMatters</td>
<td>Belgian Federation for Chemistry and Life Sciences industries</td>
</tr>
<tr>
<td>FIPIF</td>
<td>Finnish Plastics Industries Federation</td>
</tr>
<tr>
<td>IPPMA</td>
<td>Irish Plastic Pipe Manufacturers Association</td>
</tr>
<tr>
<td>KRV</td>
<td>Kunststoffrohrverband e.V.- Fachverband der Kunststoffrohr-Industrie</td>
</tr>
<tr>
<td>MCsSz</td>
<td>Műanyag Csőgyártók Szövetsége</td>
</tr>
<tr>
<td>NPG Sweden</td>
<td>Swedish Plastic Pipe Association</td>
</tr>
<tr>
<td>PRIK</td>
<td>Polish Association of Pipes and Fittings</td>
</tr>
<tr>
<td>STR</td>
<td>Syndicat des Tubes et Raccords</td>
</tr>
<tr>
<td>VKR</td>
<td>Verband Kunststoffrohe und Rohrleitungstelle</td>
</tr>
</tbody>
</table>
List of names and logos of TEPPFA Associated Members

- Borealis
- ECVM
- LyondellBasell
- Lubrizol
- Molecor

List of names and logos of TEPPFA Supporting Members

- Rollepaal
7. REFERENCES

Ecoinvent, 2018. Ecoinvent database v3.4, 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 ISO 15874-1, Plastics piping systems for hot and cold water installations. Polypropylene (PP). Part 1: General


EN 15942: Sustainability of construction works – Environmental product declarations – Communication format – Business to Business


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

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

VITO
Flemish Institute for Technological Research
Boeretang 200,
B-2400 Mol, Belgium
Tel.: +32 1 433 55 11
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External critical review of underlying LCA by

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