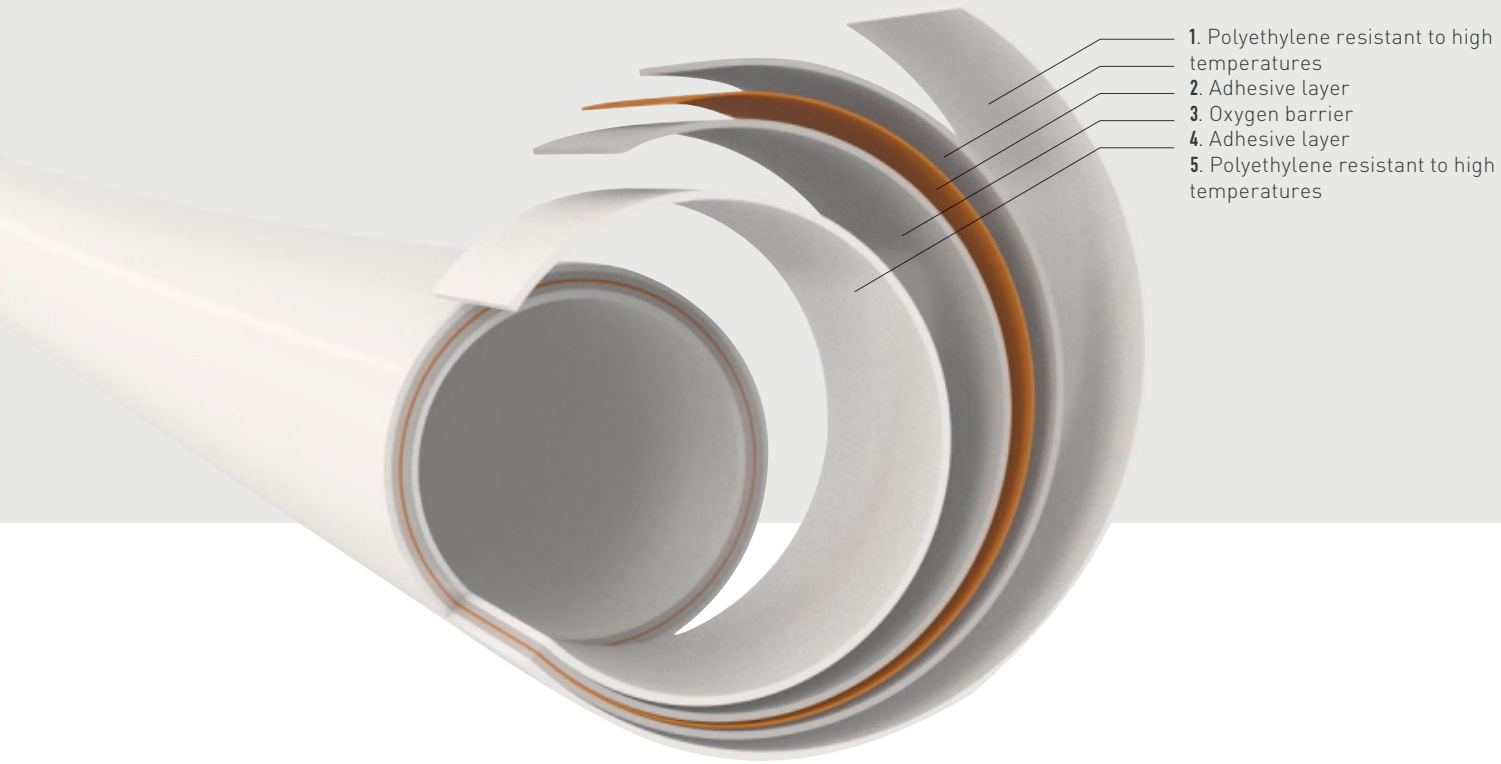
Environmental product declaration for ENEFLEX 5 layer pipes

PE-RT 5 layer pipes for heating & cooling applications

Issued 9.08.2021 / Valid until 9.08.2026 / Third party verified / Conform to EN 15804+A2 and NBN/DTD B08-001 / Cradle to gate with modules C1–C4 and module D / Modules included: A1-A3; C1-C4; D / **OWNER OF THIS ENVIRONMENTAL PRODUCT DECLARATION: Enetec Plastics GmbH**

PRODUCT NAME

ENEFLEX 5 layer pipes



Product description

The ENEFLEX 5 layer pipes consist of PE-RT (Polyethylene of Raised Temperature resistance), EVOH (Ethylene-vinyl alcohol copolymer), adhesive layer on polyolefine basis. Some of the pipes are coloured, so they contain a very small amount of colour as well. Enetec 5-layer PE-RT pipes are produced by Enetec Plastics GmbH in Germany according to the relevant standards DIN EN ISO 22391, ISO 24033, DIN EN ISO 21003 and the national guidelines BRL 5602, BRL 5607 and HR 3.16. The ENEFLEX 5 layer pipes are especially developed according to customer needs demanding highly flexible pipes with extraordinary long term resistance and are certified with several approvals like KIWA-KOMO, DIN-Certco, CE-ETA and SKZ. Additional production and product surveillance is performed by the Institute KIWA N.V. The oxygen permeation of the ENEFLEX 5 layer pipes is tested according ISO 17455 and meets the standards DIN 4726, BRL 5602, BRL 5607 and DIN EN 1264.

This is a specific EU-EPD for ENEFLEX 5 layer pipes produced by Enetec Plastics GmbH in Kleve, Germany.

Intended use

Enetec 5-layer PE-RT pipes are intended to be used for surface heating or cooling applications. For example, underfloor-heating, wall-heating, cooling ceiling systems, concrete core activation, geothermal applications, as well as radiator connection. The pipes are designed for a lifetime of 50 years, at an operating temperature profile according to class 4/5 of ISO 10508 and an allowable working pressure of maximum 6 bar and if applicable class 4 with maximum 10 bar.

Reference flow/declared unit

The declared unit consists of 0,100 kg of ENEFLEX 5 layer pipe with an outer diameter between 8-32 mm and a wall thickness of 1-4 mm, with an operating temperature profile according to class 4/5 of ISO 10508, an allowable working pressure of maximum 6 bar and a reference service lifetime of 50 years.

Packaging of raw materials and the finished product is included. The weight per reference flow is 0,1 kg.

COMPOSITION AND CONTENT

COMPONENTS	COMPOSITION / CONTENT / INGREDIENTS	QUANTITY (RANGE)
Product	PE-RT	90-95%
	EVOH	0-5%
	Adhesive	0-5%
	Colour	0,01-0,05%
Packaging	Cardboard boxes	3,00E-4 kg
	Wooden pallets	4,07E-3 kg
	Packaging film for pallets	9,46E-05 kg
	Packaging film for coil	9,72E-05 kg

The product does not contain materials listed in the "Candidate list of Substances of Very High Concern for authorization".

Reference service lifetime

The reference service lifetime is calculated for 50 years.

The RSL is based on next documents:
→ Enetec; "PE-RT pipes, radiant heating and cooling components OEM" (PDF-document); Provided by Enetec in March 2021; Online available at https://www.enetec.info/pipes see download documentation
→ Enetec; "Verarbeitungshinweise ENEFLEX 5-Lagen Rohre" (PDF-document); provided by Enetec in March 2021; Can be requested at Enetec

The conditions under which this RSL is valid are as following: the System needs to be adequately resistant to oxygen permeability. All joints need to be leak proof and sufficiently tight to endure external influences. All parts of the system are required to be designed to have a life expectancy of 50 years at a temperature profile in accordance to at least class 4 from ISO 10508, at an operating pressure of 4 bar or 6 bar. The installation has to be performed according to the applicable standards and installation-guidelines. After installation a leak-test shall be performed and passed, according DIN EN 1264-4.

Description of geographical representativity

The ENEFLEX 5 layer pipes are produced in Germany by the German company Enetec Plastics GmbH and are exported to different countries in Europe (Germany, The Netherlands, Belgium, Italy,..).
The EPD is representative for the European market. The composed datasets for this life cycle assessment are representative and relevant for an ENEFLEX 5 layer pipe produced by Enetec Plastics GmbH Germany.

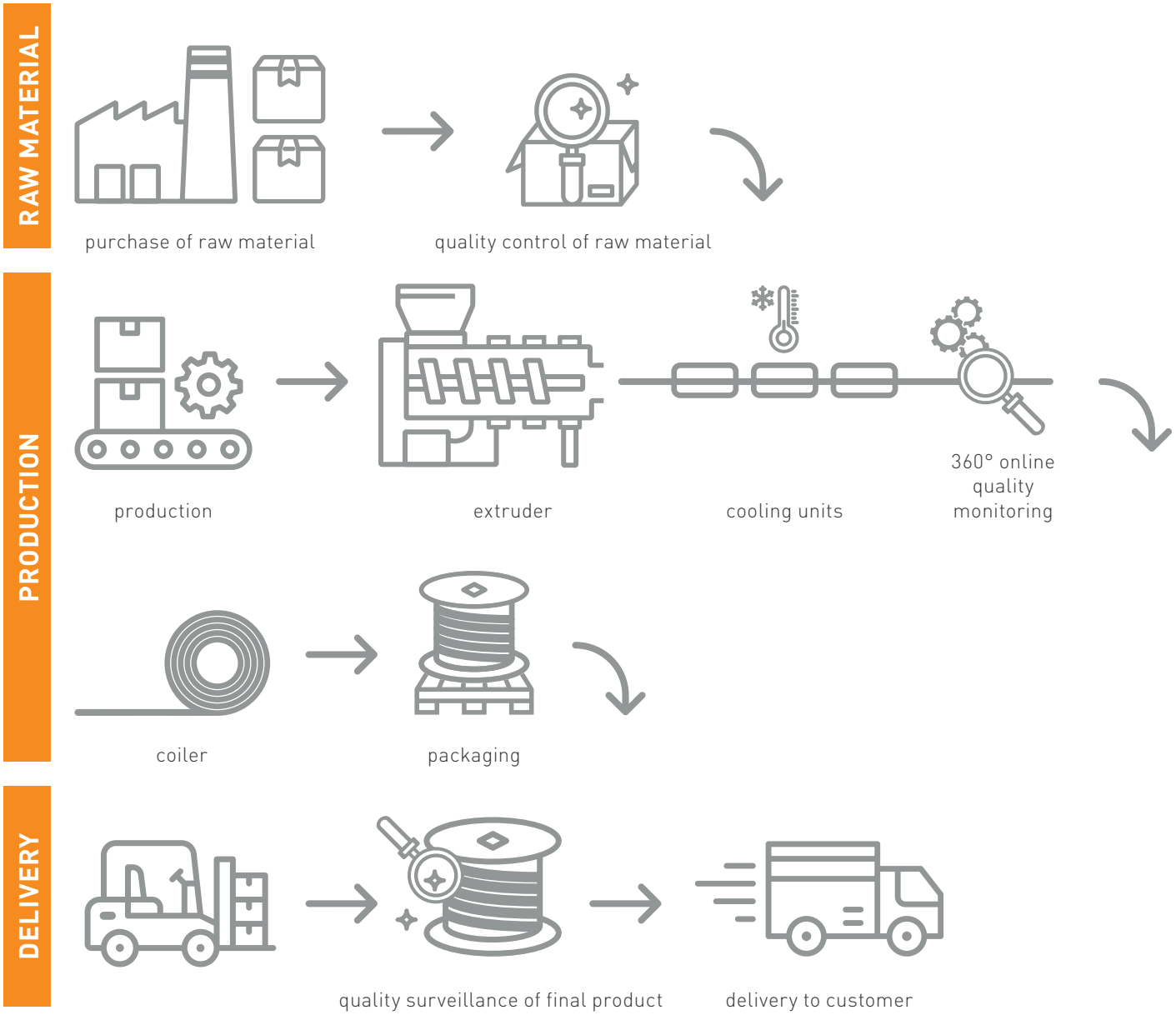
Description of the production process and technology

At the beginning of the production process all raw materials must successfully pass the quality checks, to ensure they meet all quality standards. After passing the quality checks, the raw materials get the clearance for the production.
The raw materials automatically transported to the extrusion machines, where they get melted and compacted before entering the 5-layer extrusion tool. After leaving the extrusion tool the pipe enters the first vacuum tank, including a calibration unit to achieve exactly the demanded dimension and the first cooling process is initiated. Furthermore, in this step, the next automated quality check is implemented, which is a 100% scan of the pipe by an ultrasonic device to check if the dimension is matching the given tolerances and no inclusions are occurring.

In the following the pipe is passing the cooling units to meet the desired temperature for the further processing. After passing the next automated quality check, which is a 360° camera system, checking for any kind of inclusions and surface failures, the pipe gets its printing and enters the coiling machine. Based on the customer needs, the pipe gets directly coiled and cut to the desired coil length and automatically transported to the packaging department.

Here are further manual quality checks performed, e.g., visual checks, coil measurements, marking, and so on. After passing these controls, the finished product gets packaged according to customer needs and prepared for the transportation.

Before being released for shipment, the whole production lot must successfully pass the inhouse laboratory controls to ensure all requirements of the standards and certifications are reached.



TECHNICAL DATA/PHYSICAL CHARACTERISTICS

TECHNICAL PROPERTY	STANDARD	VALUE	UNIT	COMMENT
Thermal conductivity	DIN 52612	0.41	W/mK	at 20 °C
Coefficient of linear thermal expansion	DIN 52328	0.195	mm/mK	
Surface roughness inside	acc. Prandl/Colebrook	0.007	mm	
Oxygen diffusion barrier at 80°C	DIN 4726 and ISO 17455	≤ 3,6	O_2 mg/m².day	at 80°C (ISO 21003-2)
Oxygen diffusion barrier at 40°C	DIN 4726 and ISO 17455	≤ 0,32	O_2 mg/m².day	
Tensile modulus	DIN 16833	580 – 950	MPa	at 40°C (ISO 21003-2)
Building material class	DIN 16833	B2		
Pipe outer diameter	/	8-32	mm	
Pipe wall thickness	/	1-4	mm	

Date of LCA study

August 2021.

Software

For the calculation of the LCA results, the software program SimaPro 9.1.1.1 (PRé Consultants, 2021) has been used.

Information on allocation

For the use of energy and the use of the surface area, only facility-level data were available. Energy consumed, and the surface area used during the manufacturing stage have been allocated to the analysed product based on the amount of kg that is produced (physical relationship).

Information on cut off

The following processes are considered to be below cut-off and are not included in the LCA:

→ Heating or cooling of the plants in order to ensure a comfortable indoor climate for the personnel.

→ Environmental impacts caused by the personnel of the production plants, e.g. waste from the cafeteria and sanitary installations, accidental pollution caused by human mistakes, or environmental effects caused by commuter traffic.

→ Module D of packaging materials.

→ The total of neglected input flows is less than 5% of energy usage and mass as prescribed by EN15804+A2.

Information on excluded processes

Only the processes considered below cut-off are excluded from the study. No additional processes are excluded.

Information on biogenic carbon modelling

The product does not contain biogenic carbon. The packaging wooden pallets and octabin that are used to package the finished product contain biogenic carbon.

BIOGENIC CARBON CONTENT (KG C / FU)	
Biogenic carbon content in product (at the gate)	0
Biogenic carbon content in accompagnying packaging (at the gate)	1,36E-04 kg C/FU

Information on carbon offsetting

Carbon offsetting is not allowed in the EN 15804 and hence not taken into account in the calculations.

Additional or deviating characterisation factors

The characterization factors from EC-JRC were applied according to EN15804+A2. No additional or deviating characterization factors were used.

Description of the variability

A variability study is performed in the background report that illustrates that the overall environmental impact of the different colours is small. That's why an average amount of colour for the worst case colour pigment is used for the reference LCA model in this study.

Specificity

The data used for the LCA are specific for this product which is manufactured by Enetec Plastics GmbH at their production site in Kleve, Germany.

Period of data collection

Manufacturer specific data have been collected for the year 2019.

Information on data collection

Company specific data for the product stage have been collected from Enetec Plastics GmbH and were provided to ENPERAS /VITO through an online data collection questionnaire. The LCI data for the product stage have been checked by the EPD verifier (Bernd Brandt). ENPERAS uses publicly available generic data for all background processes such as the production of electricity, transportation by means of a specific truck, etc.

Database used for background data

The main LCI source used in this study is the Ecoinvent 3.6 database (Wernet et al., 2016).

Energy mix

The German electricity mix (consumption mix + import) has been used to model electricity use in life cycle stage A3. The used record is the Ecoinvent record "Electricity low voltage {DE}| market for | Cut-off, U" (Wernet et al., 2016). The electricity use in module D is modelled using the record "Electricity low voltage {RER}| market group for | Cut-off, U".

Production sites

The production site is located at Kalkarer Str. 81, 47533 Kleve, Germany.

System boundaries

The system boundaries of this EPD are cradle-to-gate with modules C1-C4 and module D.
See the table below:

PRODUCT			CON-STRUCTION		USE STAGE							END-OF-LIFE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
					RELATED TO THE BUILDING FABRIC					RELATED TO THE BUILDING OPERATION						
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse / Recovery / Recycling potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

X = included in the LCA and EPD
MND = module not declared

POTENTIAL ENVIRONMENTAL IMPACTS PER REFERENCE FLOW

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GWP total = total Global Warming Potential (Climate Change); GWP-luluc = Global Warming Potential (Climate Change) land use and land use change; ODP = Ozone Depletion Potential; AP = Acidification Potential for Soil and Water; EP = Eutrophication Potential; POCP = Photochemical Ozone Creation; ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential – Fossil Fuels; WDP = water use (Water (user) deprivation potential, deprivation-weighted water consumption)

	PRODUCTION				END-OF-LIFE STAGE				D REUSE, RECOVERY, RECYCLING
	A1 RAW MATERIAL	A2 TRANSPORT	A3 MANUFACTU-RING	TOTAL A1-A3	C1 DECON-STRUCTION/ DEMOLITION	C2 TRANSPORT	C3 WASTE PROCESSING	C4 DISPOSAL	
GWP-total (kg CO^2 equiv/ FU)	2,29E-01	3,14E-03	3,67E-02	2,69E-01	0,00E+00	4,23E-03	6,35E-05	1,11E-01	-6,91E-02
GWP-fossil (kg CO^2 equiv/ FU)	2,28E-01	3,14E-03	3,58E-02	2,67E-01	0,00E+00	4,23E-03	6,27E-05	1,11E-01	-6,89E-02
GWP-bio-genic (kg CO^2 equiv/FU)	4,62E-04	1,30E-06	7,85E-04	1,25E-03	0,00E+00	1,72E-06	8,12E-07	2,51E-06	-1,48E-04
GWP-luluc (kg CO^2 equiv/ FU)	6,60E-05	1,12E-06	4,64E-05	1,14E-04	0,00E+00	1,48E-06	5,98E-08	3,95E-07	-4,67E-05
ODP (kg CFC 11 equiv/FU)	5,59E-09	7,15E-10	1,57E-09	7,88E-09	0,00E+00	9,60E-10	4,88E-12	2,18E-10	-4,80E-09
AP (kg mol H+ equiv/FU)	8,40E-04	9,07E-06	1,11E-04	9,60E-04	0,00E+00	1,73E-05	2,88E-07	1,57E-05	-2,25E-04
EP-fresh water (kg P equiv/FU)	5,92E-06	2,51E-08	5,16E-06	1,11E-05	0,00E+00	3,32E-08	7,37E-09	1,84E-08	-2,21E-06
EP-marine (kg N – equiv/ FU)	1,52E-04	1,81E-06	1,80E-05	1,71E-04	0,00E+00	5,13E-06	8,55E-08	7,73E-06	-3,55E-05
EP-terrestrial (mol N – equiv/FU)	1,62E-03	2,03E-05	2,78E-04	1,92E-03	0,00E+00	5,67E-05	1,04E-06	7,54E-05	-4,12E-04
POCP (kg NMVOC equiv/FU)	7,56E-04	7,72E-06	5,57E-05	8,19E-04	0,00E+00	1,74E-05	2,60E-07	2,18E-05	-1,64E-04
ADP minerals & metals (kg Sb equiv/FU)	4,35E-07	6,24E-09	6,38E-08	5,05E-07	0,00E+00	8,24E-09	8,72E-11	1,27E-09	-8,33E-08
ADP fossil (MJ/FU)	7,71E+00	4,75E-02	4,96E-01	8,25E+00	0,00E+00	6,38E-02	8,52E-04	1,52E-02	-1,8E+00
WDP (m^3 world eq. deprived/FU)	1,94E-01	1,34E-04	2,64E-03	1,97E-01	0,00E+00	1,77E-04	2,97E-06	6,36E-04	-3,06E-02

RESOURCE USE

	PRODUCTION				END-OF-LIFE STAGE				D REUSE, RECOVERY, RECYCLING
	A1 RAW MATERIAL	A2 TRANSPORT	A3 MANUFACTU-RING	TOTAL A1-A3	C1 DECON-STRUCTION/ DEMOLITION	C2 TRANSPORT	C3 WASTE PROCESSING	C4 DISPOSAL	
PERE (MJ equiv/FU)	1,71E-01	6,66E-04	2,15E-01	3,86E-01	0,00E+00	8,81E-04	1,19E-04	4,47E-04	-3,34E-02
PERM (MJ equiv/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT (MJ equiv/FU)	1,71E-01	6,66E-04	2,15E-01	3,86E-01	0,00E+00	8,81E-04	1,19E-04	4,47E-04	-3,34E-02
PENRE (MJ equiv/FU)	3,49E+00	4,78E-02	6,60E-01	4,20E+00	0,00E+00	6,42E-02	1,08E-03	1,63E-02	-1,95E+00
PENRM (MJ equiv/FU)	4,53E+00	0,00E+00	0,00E+00	4,53E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT (MJ equiv/FU)	8,02E+00	4,78E-02	6,60E-01	8,73E+00	0,00E+00	6,42E-02	1,08E-03	1,63E-02	-1,95E+00
SM (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,09E-02
RSF (MJ equiv/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF (MJ equiv/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW (m^3 water eq/FU)	3,23E-03	4,78E-06	2,32E-04	3,46E-03	0,00E+00	6,31E-06	3,10E-07	3,00E-05	-5,17E-04

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

WASTE CATEGORIES & OUTPUT FLOWS

	PRODUCTION				END-OF-LIFE STAGE				D REUSE, RECOVERY, RECYCLING
	A1 RAW MATERIAL	A2 TRANSPORT	A3 MANUFACTU-RING	TOTAL A1-A3	C1 DECON-STRUCTION/ DEMOLITION	C2 TRANSPORT	C3 WASTE PROCESSING	C4 DISPOSAL	
Hazardous waste disposed (kg/FU)	9,61E-07	1,24E-07	7,57E-07	1,84E-06	0,00E+00	1,67E-07	1,40E-09	4,36E-08	-7,41E-07
Non-hazardous waste disposed (kg/FU)	7,56E-03	2,31E-03	2,76E-03	1,26E-02	0,00E+00	3,05E-03	3,31E-06	4,39E-02	-1,76E-03
Radioactive waste disposed (kg/FU)	4,43E-06	3,24E-07	1,94E-06	6,69E-06	0,00E+00	4,35E-07	3,96E-09	7,84E-08	-2,47E-06
Components for re-use (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling (kg/FU)	0,00E+00	0,00E+00	6,96E-03	6,96E-03	0,00E+00	0,00E+00	2,25E-02	0,00E+00	-3,09E-02
Materials for energy recovery (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy (MJ/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,44E-01	-4,67E-01

IMPACT CATEGORIES ADDITIONAL TO EN 15804

		PRODUCTION				END-OF-LIFE STAGE				D REUSE, RECOVERY, RECYCLING
		A1 RAW MATERIAL	A2 TRANSPORT	A3 MANUFACTU-RING	TOTAL A1-A3	C1 DECON-STRUCTION/ DEMOLITION	C2 TRANSPORT	C3 WASTE PROCESSING	C4 DISPOSAL	
	PM (disease incidence eq/ FU)	9,00E-09	2,00E-10	5,23E-10	9,72E-09	0,00E+00	2,94E-10	4,39E-12	1,67E-10	-1,18E-09
	IRP (kg U235 eq/ FU)	4,93E-03	2,08E-04	1,53E-03	6,66E-03	0,00E+00	2,79E-04	2,88E-06	5,55E-05	-2,34E-03
	ETP-fw (CTUe/FU)	3,40E+00	3,83E-02	4,21E-01	3,86E+00	0,00E+00	5,10E-02	6,98E-04	3,57E-02	-3,66E-01
	HTP-c (CTUh/FU)	6,44E-11	1,07E-12	1,04E-11	7,58E-11	0,00E+00	1,43E-12	2,44E-14	1,29E-11	-1,47E-11
	HTP-nc (CTUh/FU)	2,07E-09	4,03E-11	3,74E-10	2,48E-09	0,00E+00	5,56E-11	6,48E-13	1,05E-10	-3,70E-10
	SQP (/)	4,66E-01	3,32E-02	1,14E+00	1,63E+00	0,00E+00	4,39E-02	5,19E-04	2,71E-02	-9,33E-02

HTCE = Human Toxicity – cancer effects; HTnCE = Human Toxicity – non cancer effects; ETF = Ecotoxicity – freshwater; (potential comparative toxic unit); PM = Particulate Matter (Potential incidence of disease due to PM emissions); IRHH = Ionizing Radiation – human health effects (Potential Human exposure efficiency relative to U235)

DETAILS OF THE UNDERLYING SCENARIOS USED TO CALCULATE THE IMPACTS

A1 – raw material supply

This module takes into account the extraction and processing of all raw materials (PE-RT, EVOH, adhesive and colour) and energy which occur upstream to the studied manufacturing process.

A2 – transport to the manufacturer

The raw materials are transported to the manufacturing site.

A3 – manufacturing

This module takes into account the production process being melting and compacting of resins with extrusion screw, cooling in vacuum bath and coiling the product.

C – end of life

End-of-life scenarios are based on data of the Product Environmental Footprint project (Annex C of PEF Guidance 6.3). The ENEFLEX 5 layer pipe consists almost entirely of polyethylene, so it is considered to be 42,6% landfilled, 34,9% incinerated and 22,5% recycled.

C1: The demolition of PE and PP products does not have any impact.

C2: Transport scenarios for the transport to the End-of-life treatment are derived from internal data coming from previous projects.

MODULE C2 – TRANSPORT TO WASTE PROCESSING		
End-of-life treatment	Type of vehicle (truck/boat/etc.)	Distance (km)
Landfilling	Truck 16-32 ton	50
Incineration	Truck 16-32 ton	150
Recycling	Truck 16-32 ton	800

C3: 22,5% of the ENEFLEX 5 layer pipe (polyethylene) is recycled. Module C3 includes sorting of this waste. The end-of-waste state is reached after sorting.

C4: 42,6% of the ENEFLEX 5 layer pipe (polyethylene) is landfilled and 34,9% is incinerated. Module C4 includes the sorting of this waste, as well as the landfilling and incineration process.

END-OF-LIFE MODULES – C3 AND C4		
Parameter	Unit	Value
Wastes collected separately	kg	0
Wastes collected as mixed construction waste	kg	0,100 kg
Waste for re-use	kg	0
Waste for recycling	kg	0,0225 kg
Waste for energy recovery	kg	0,0349 kg
Waste for final disposal	kg	0,0426 kg

D – benefits and loads beyond the system boundaries

In module D, the benefits and loads beyond the system boundaries are quantified.

Following waste streams are considered after their end-of-waste: 22,5% (0,0225 kg) recycled polyethylene and 34,9% (0,0349 kg) incinerated polyethylene of the final product at its end-of-life.

The loads beyond the system boundaries include the recycling process of the product waste. The benefits beyond the system boundaries include the avoided production of virgin material (polyethylene granulates) recycled during end-of-life of the main product; as well as heat and electricity generated during the incineration of part of the product waste.

QUANTITATIVE DESCRIPTION OF THE LOADS BEYOND THE SYSTEM BOUNDARIES	Recycling of 0,0225 kg polyethylene
QUANTITATIVE DESCRIPTION OF THE BENEFITS BEYOND THE SYSTEM BOUNDARIES	0,01701 kg avoided virgin polyethylene granulates; 0,296 MJ heat generated; 0,148 MJ electricity generated

ADDITIONAL INFORMATION ON RELEASE OF DANGEROUS SUBSTANCES TO INDOOR AIR, SOIL AND WATER DURING THE USE STAGE

Indoor air

Not applicable.

Soil and water

Not applicable.

DEMONSTRATION OF VERIFICATION	
CEN standard EN 15804 serves as the core PCR[a]	
Independent verification of the declaration and data according to EN ISO 14025:2010 ☐ Internal ☑ External	
Third party verifier[b]: Bernd Brandt	
LCA Consultant	Verifier
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a) Product category rules
b) Optional for business-to-business communication; mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4)

This LCA study points out the stages that have dominant impact throughout the whole production process and end of life of the ENEFLEX PE-RT pipe produced by Enetec Plastics GmbH. Based on the results we can conclude that the used raw materials have overall the highest relative contribution to the total environmental impact of the ENEFLEX PE-RT pipe. Second, the manufacturing process has a significant relative contribution to the total environmental impact of this product as well. Overall transportation and the end of life stages have minor contribution to the total environmental impact of the ENEFLEX PE-RT pipe.

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