ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	REHAU Industries SE & Co. KG
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-REH-20240084-IBC1-EN
Issue date	06.08.2024
Valid to	05.08.2029

RAUTITAN flex

REHAU Industries SE & Co. KG

www.ibu-epd.com | https://epd-online.com

1. General Information

REHAU Industries SE & Co. KG

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-REH-20240084-IBC1-EN

This declaration is based on the product category rules:

Plastic pipe systems for hot and cold water installation in the building, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

06.08.2024

Valid to

05.08.2029

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

RAUTITAN flex

Owner of the declaration

REHAU Industries SE & Co. KG
Helmut Wagner Straße 1
95111 Rehau
Germany

Declared product / declared unit

1 kg "RAUTITAN flex" pipe

Scope:

The EPD applies to the 'RAUTITAN flex' pipe with the pipe sizes

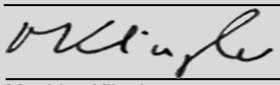
- 12 x 1,7 mm
- 16 x 2,2 mm
- 20 x 2,8 mm
- 25 x 3,5 mm
- 32 x 4,4 mm
- 40 x 5,5 mm
- 50 x 6,9 mm
- 63 x 8,6 mm

manufactured in plants of REHAU Industries SE & Co. KG in Triptis, Viechtach (both D) and Klaipeda (LT). This is an average EPD based on an average generic product variant.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR			
Independent verification of the declaration and data according to ISO 14025:2011			
☐	internally	☒	externally



Matthias Klingler,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The plastic pipe for hot and cold water installations in buildings covered by the study is a three-layer pipe consisting of a pressure-stable cross-linked PE XaInliner, a grey-coloured bonding agent and an oxygen barrier layer as an outer shell made of EVOH. The pipe can be used universally for drinking water and heating installations. The trade name is 'RAUTITAN flex'. The product is not subject to any EU harmonisation legislation, in particular the EU Construction Products Regulation.
The respective national regulations at the place of use apply to the use of the product. The pipes are manufactured in Germany. The products are used worldwide, with a focus on Europe

2.2 Application

The pipes in the 'RAUTITAN flex' product group can be used universally for drinking water and heating installations in building construction in accordance with EN ISO 15875. The pipes are also oxygen-tight in accordance with DIN 4726.

2.3 Technical Data

The values given in the following table apply to the product 'RAUTITAN flex' in all pipe sizes.

Bautechnische Daten

Name	Value	Unit
Permissible operating pressure PN of the pipe system in accordance with EN ISO 15875; class 1 to 4	10	bar
Permissible operating pressure PN of the pipe system system in accordance with EN ISO 15875; class 5	8	bar
Material 1 Inner layer	PEXa according to EN ISO 15875	
Material 2 Bonding agent	PE-based	-
Material 3 Outer layer	EVOH	-
Average density of the material according to EN ISO 11831, or 2; PEXa	0,93–0,97	g/cm^3
Average density of the material according to EN ISO 11831, or 2; PE-based bonding agent	0,91–0,93	g/cm^3
Average density of the material according to EN ISO 11831, or 2; EVOH	1,1–1,2	g/cm^3

Performance values of the product in relation to its characteristics according to the relevant technical specification (EN ISO 15875)

2.4 Delivery status

Bundle:

- 16 x 2.2 mm; 100 m
- 20 x 2.8 mm; 100 m
- 25 x 3.5 mm; 50 m
- 32 x 4.4 mm; 50 m
- 16 x 2.2 mm; 6 m
- 20 x 2.8 mm; 6 m
- 25 x 3.5 mm; 6 m
- 32 x 4.4 mm; 6 m
- 40 x 5.5 mm; 6 m
- 50 x 6.9 mm; 6 m
- 63 x 8.6 mm; 6 m

2.5 Base materials/Ancillary materials

Main product components and/or substances

Name	Value	Unit
PE-Xa	90–96	%
Bonding agent	2–5	%
EVOH	1–4	%

1) The product **does not** contain **any** substances on the ECHA list of Substances of Very High Concern (SVHC) (14.06.2023) for authorisation according to the Chemicals Regulation (EC) No. 1907/2006, above 0.1% by mass.

2) The product **does not** contain **any** other CMR substances of category 1A or 1B which are not on the candidate list according to the Chemicals Regulation (EC) No. 1907/2006, above 0.1% by mass in at least one sub-product.

3) **No** biocidal products have been added to this construction product and it has **not** been treated with biocidal products (it is therefore **not** a treated product within the meaning of the Biocidal Products Regulation (EU) No. 528/2012).

An organic peroxide is used to crosslink the polyethylene. This is consumed during the cross-linking reaction.

The product contains an antioxidant from the group of sterically hindered phenols.

2.6 Manufacture

The pipes are produced by REHAU Industries SE & Co. KG in European factories. In the pipe manufacturing process, the PE is cross-linked peroxide under high pressure to form PEXa and then coated with a bonding agent and outer layer.

2.7 Environment and health during manufacturing

All legal regulations with regard to exhaust air, waste water and waste as well as noise emissions are complied with or undercut. The health of the staff is not jeopardised during production.

2.8 Product processing/Installation

To connect the RAUTITAN flex pipes, use REHAU compression sleeves, fittings and compression fittings from the RAUTITAN universal system. For further important information on installation and pipe connections, please refer to the Technical Information on the RAUTITAN universal system (893621), available at https://www.rehau.com/qr/a0c6d6db5b.

2.9 Packaging

The pipes are produced as coils or bars. The pipe openings are sealed with PE plugs.

The pipe bundles are wrapped in PP tape and packed in cardboard. The cartons are secured to a EURO pallet with PE film.

Disposable product packaging can be recycled via local recycling collections.

2.10 Condition of use

The pipes are very durable and long-lasting. No special features of the material composition for the period of use (material changes during use, environmentally-relevant inherent

material properties) are known.

2.11 Environment and health during use

No negative effects on the environment and health are to be expected during use.

2.12 Reference service life

No reference service life is specified. The pipes are designed for a service life of 50 years in accordance with EN ISO 15875

2.13 Extraordinary effects

Fire

Flammability: Building material class E (according to EN 135011)

Due to the installation situation, burning droplets and flue gas development are not relevant.

Water

No consequences for the environment in the event of unforeseen exposure to water.

Mechanical destruction

No consequences for the environment in the event of unforeseen mechanical destruction.

2.14 Re-use phase

At the end of the utilisation phase, the pipes can be thermally recycled (recovery of thermal and electrical energy).

Recycling is only possible to a very limited extent, as the pipe consists mainly of thermoset cross-linked polyethylene. Mechanical recycling is therefore not possible. However, granulated pipe material can be used as a filler in other products.

The technology of chemical recycling of PEX is currently being advanced in close co-operation with the plastics industry. It is therefore to be expected that pipes installed today can be returned to a closed material cycle after their utilisation phase (50 years).

Thermal utilisation (scenario 1) and mechanical recycling with reuse (scenario 2) are discussed in section 3.2.

2.15 Disposal

At the end of its life cycle, RAUTITAN flex can be sent for thermal utilisation. Due to the high calorific value of polyethylene, the bound energy can be used for energy recovery.

Depending on local conditions, landfilling may take place under certain circumstances.

The possibility of landfilling (scenario 3) is discussed in section 3.2.

The waste code of the pipe according to the European Waste Catalogue is 07 02 13.

2.16 Further information

Further information can be found on the product page and in the catalogue at www.rehau.de/rautitan.

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is defined as '1 kg of pipe'. This corresponds to 0.99 kg of installed pipe (see scenario information on Module A5 in section 4).

An average product of the 'RAUTITAN flex' pipe was analysed. It is based on the production volumes for 2022 and therefore covers all product variants (listed in 2.4 'Delivery status'). The mass reference differs depending on the pipe size.

Declared unit

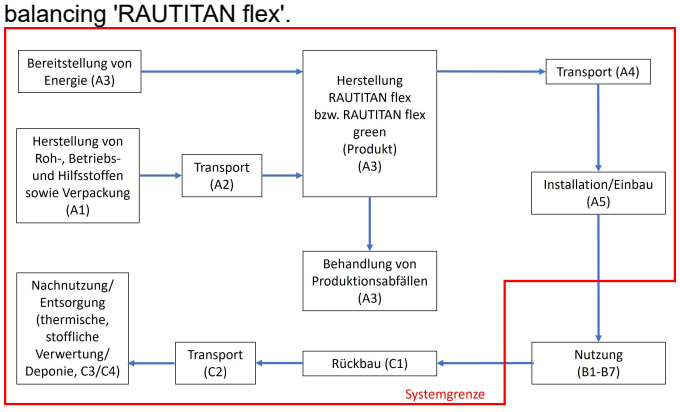
Name	Value	Unit
Declared unit	1	kg
Gross density	950	kg/m^3
Mass reference (12 x 1,7 mm)	0,056	kg/rm
Massenbezug (16 x 2,2 mm)	0,097	kg/lfm
Massenbezug (20 x 2,8 mm)	0,152	kg/lfm
Massenbezug (25 x 3,5 mm)	0,234	kg/lfm
Massenbezug (32 x 4,4 mm)	0,382	kg/lfm
Massenbezug (40 x 5,5 mm)	0,582	kg/lfm
Massenbezug (50 x 6,9 mm)	0,914	kg/lfm
Massenbezug (63 x 8,6 mm)	1,458	kg/lfm

3.2 System boundary

Consideration of the entire product life cycle if the utilisation phase is not taken into account, see figure.

Type of EPD: Cradle to factory gate with options (Modules A4, A5, C and D).

The following flow diagram shows the system limits when balancing 'RAUTITAN flex'.



The following is a detailed list of the life cycle stages and process modules taken into account for the production of the pipe:

A1 – A3 Production phase

- Production of raw materials, ancillary materials and consumables, including transport to the respective plant
- Production of the master batch, including transport
- Production of the sealing ring at the supplier, including transport
- Production of packaging materials for the end product
- Energy supply for production
- Production and packaging of the pipes

- Production of packaging materials for raw materials, including transport for recycling with subsequent utilisation
- Transport of reusable packaging for raw materials
- Transport of production waste and utilisation thereof

A4 and A5 construction phase

- Transport of the pipe to the construction site
- Transport of the pipe packaging for recycling with subsequent recycling
- Energy supply for the installation (e.g. electrical tools)
- Production of ancillary materials (cement)
- Transport and utilisation of offcuts
- Flushing the installed pipe with tap water

C1 – C4 Disposal
Three 100% disposal scenarios are assumed:

1. EoL scenario 1 (thermal utilisation): Dismantling the pipe, including transport to the recycling site with energy recovery (Modules C3/1 and D/1).
2. EoL scenario 2 (recycling): Dismantling the pipe, including transport to the recycling site with material recycling, i.e. grinding into filler (Modules C3/2 and D/2).
3. EoL scenario 3 (landfill): Dismantling the pipe, including transport to the disposal site. Disposal takes place at a local landfill (Modules C4/3 and D/3).

Deutsch	Englisch
Bereitstellung von Energie –(A3)	Energy supply – (A3)
Herstellung von Roh-, Betriebs- und Hilfsstoffen sowie Verpackung (A1)	Production of raw materials, consumables, ancillary materials and packaging (A1)
Nachnutzung/ Entsorgung (Thermische, stoffliche Verwendung/ Deponie, C3/C4)	Post-use / Disposal (thermal, material use / landfill, C3/C4)
Transport (A)	Transport (A)
Transport (C2)	Transport (C2)
Herstellung RAUTUTAN flex bzw. RAUTITAN flex green (Produkt) (A3)	Production of RAUTUTAN flex and RAUTITAN flex green (product) (A3)
Behandlung von Produktionsabfällen (A3)	Treatment of production waste (A3)
Rückbau (C1)	Dismantling (C1)
Transport (A4)	Transport (A4)
Installation/Einbau (A5)	Installation / Assembly
Nutzung (b1-B7)	Use (B1-B7)

D Reuse, recovery and/or recycling potentials

Reuse, recovery and/or recycling potentials are available in the disposal scenarios, as the pipe systems are recycled here for energy or materials, from which energy or secondary materials are recovered that can be used outside the system boundary. Energy recovered from the incineration of packaging waste in Module A5 is not taken into account. In EoL scenarios 1 and 2, on the other hand, there are effects from the recovery of energy from the incineration of waste. In EoL scenario 2, no advantages from the subsequent utilisation of secondary material as filler are taken into account.

3.3 Estimates and assumptions

REHAU Industries SE & Co. KG provides the primary data on the composition of the pipe as well as on energy utilisation and the transport routes and packaging of the raw materials.

No underlying data sets were available for the production of the antioxidant and the peroxide, so their production was approximated with the production of the reactants.

For the environmental impact, the use of green electricity was calculated taking into account the residual electricity mix for the remaining electricity. The share of electricity demand covered by green electricity in the total electricity demand in the REHAU plants is 100%.

While the pipes are manufactured in Germany, they can be used anywhere in the world. However, the focus is on Europe. Recycling at the end of life depends on the place of use. A European scenario at the end of life was therefore assumed for the assessment.

3.4 Cut-off criteria

In this EPD, all known inputs and outputs were included in the assessment. Due to the very low relevance, individual processes or materials for which no data was available were not taken into account:

- 3.3.1 internal transport in the plants
- 3.3.2 transport of raw material packaging
- 3.3.3 production of reusable packaging

They each account for less than 1% of the environmental impact of the overall analysis.

3.5 Background data

Only underlying data from the Sphera Managed LCA Content database (version 2023.2, formerly GaBi database) was applied for the LCA. The modelling was carried out using the LCA for Experts software from Sphera (version 10.7, formerly GaBi).

3.6 Data quality

The specific foreground data for the production of 'RAUTITAN flex' comes from REHAU Industries SE & Co. KG. The geographical, technical and temporal representativeness is rated as very good. Overall, well over 80% of the specific data is rated as good to very good.

The underlying data from the Managed LCA Content database, which together makes up at least 80% of the core indicators of the impact assessment, is on average well representative (geographically, technically, temporally).

3.7 Period under review

The specific data for the production of 'RAUTITAN flex' was collected for the production year 2022. Only the natural gas consumption refers to the production year 2021 due to the more detailed data available.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Germany

3.9 Allocation

No co-products are created during the manufacture (Modules A1-A3) of 'RAUTITAN flex' pipe. Therefore, no co-product allocation was necessary for foreground processes. Co-products are created in the upstream chain of energy generation and raw material production, so that allocations are available in the underlying data sets. The same applies to downstream processes, such as incineration processes for

waste utilisation.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account. Underlying database: Managed LCA Content from Sphera (version 2023.2, formerly GaBi database)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The biogenic carbon content quantifies the amount of biogenic carbon in a construction product that leaves the factory gate and must be stated separately for the product and the associated packaging. If the total mass of biogenic carbonaceous materials is less than 5% of the total mass of the product and its packaging, the biogenic carbon content may be omitted. The mass of packaging containing biogenic carbon must always be stated.

Biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon content in product	< 0,05	kg C
Biogenic carbon content in accompanying packaging	0.08	kg C

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

The following technical information forms the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment if modules are not declared (MND).

Transport from manufacturer to place of use (A4)

Name	Value	Unit
Transport to the dealer by truck (32 t)	800	km
Transport to the construction site by transporter (7.5 t)	30	km

Assembly (A5)

Name	Value	Unit
Auxiliary Zement	0.173	kg
Water consumption	0.019	m^3
Electricity consumption	0.062	kWh
Material loss	0.01	kg

Disposal stage (C1-C4)

Name	Value	Unit
Scenario 1: 100% thermal utilisation	0,99	kg
Scenario 2: 100% recycling	0,99	kg
Scenario 3: 100% landfill	0,99	kg

Reuse, recovery and recycling potential (D), relevant scenario information

In Module D, the energy recovered from the thermal and material utilisation of waste (thermal energy and electricity) or the resulting recycled material is credited. Depending on the EoL scenario, these are the following flows:

- EoL scenario 1: Electricity and heat from energy recovery (C3)
- EoL scenario 2: No credits for recovered material (C3), as this can only be used as a filler. However, there are effects from the energy recovery of waste from the recycling process.
- EoL scenario 3: No flows from C3/C4 to Module D.

Name	Value	Unit
Exported electrical energy (EoL-Scenario 1)	6,61	MJ
Exported thermal energy (EoL-Scenario 1)	11,8	MJ
Exported electrical energy (EoL-Scenario 2)	0,331	MJ
Exported thermal energy (EoL-Scenario 2)	0,588	MJ
PP recyclate EoL scenario 2, without credit	0,94	kg

5. LCA: Results

The results of the Life Cycle Assessment and the impact assessment for the 'RAUTITAN flex' pipe analysed are listed in detail below.

EoL scenario 1 (100% thermal utilisation) comprises Modules C1, C2/1, C3/1, C4/1 and D/1.

EoL scenario 2 (100% thermal utilisation) comprises Modules C1, C2/2, C3/2, C4/2 and D/2.

EoL scenario 3 (100% landfill) comprises Modules C1, C2/3, C3/3, C4/3 and D/3.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MNR	MNR	MNR	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 kg RAUTITAN flex

Parameter	Unit	A1-A3	A4	A5	C1	C2/1	C2/2	C2/3	C3/1	C3/2	C3/3	C4/1	C4/2	C4/3	D/1	D/2	D/3
GWP-total	kg CO_2 eq	2.37E +00	9.54E-02	2.68E-01	5.06E-02	6.85E-03	1.94E-02	6.85E-03	3.1E+00	4.22E-01	0	0	0	2.91E-02	-1.35E +00	-6.77E-02	0
GWP-fossil	kg CO_2 eq	2.5E+00	9.47E-02	1.38E-01	5.06E-02	6.8E-03	1.92E-02	6.8E-03	3.1E+00	4.21E-01	0	0	0	2.91E-02	-1.35E +00	-6.74E-02	0
GWP-biogenic	kg CO_2 eq	-1.34E-01	0	1.3E-01	-2.24E-06	0	0	0	7.82E-05	8.08E-04	0	0	0	0	-5.82E-03	-2.91E-04	0
GWP-luluc	kg CO_2 eq	2.99E-03	1.58E-03	6.25E-05	1.21E-05	1.13E-04	3.2E-04	1.13E-04	6.2E-06	3.36E-05	0	0	0	1.07E-04	-1.22E-04	-6.12E-06	0
ODP	kg CFC11 eq	2.62E-11	1.38E-14	6.55E-14	2.92E-15	9.91E-16	2.81E-15	9.91E-16	1.64E-13	2.89E-14	0	0	0	9.6E-14	-1.2E-11	-5.98E-13	0
AP	mol H^+ eq	4.58E-03	2.08E-04	1.69E-04	5.73E-05	1.49E-05	4.23E-05	1.49E-05	3.09E-04	3.73E-04	0	0	0	1.74E-04	-1.41E-03	-7.04E-05	0
EP-freshwater	kg P eq	1E-05	4E-07	5.27E-08	4.88E-09	2.87E-08	8.13E-08	2.87E-08	3.54E-08	1.01E-06	0	0	0	1.67E-05	-2.24E-06	-1.12E-07	0
EP-marine	kg N eq	1.37E-03	8.84E-05	5.7E-05	1.79E-05	6.36E-06	1.8E-05	6.36E-06	6.64E-05	1.04E-04	0	0	0	3.75E-05	-4.31E-04	-2.15E-05	0
EP-terrestrial	mol N eq	1.53E-02	1.01E-03	6.54E-04	1.95E-04	7.28E-05	2.06E-04	7.28E-05	1.47E-03	1.13E-03	0	0	0	4.12E-04	-4.62E-03	-2.31E-04	0
POCP	kg NMVOC eq	5.68E-03	2.01E-04	1.58E-04	4.99E-05	1.45E-05	4.1E-05	1.45E-05	1.98E-04	2.86E-04	0	0	0	1.2E-04	-1.22E-03	-6.1E-05	0
ADPE	kg Sb eq	4.97E-07	8.17E-09	1.23E-09	3E-10	5.86E-10	1.66E-09	5.86E-10	1.71E-09	3.46E-09	0	0	0	1.93E-09	-1.17E-07	-5.83E-09	0
ADPF	MJ	8.18E +01	1.24E +00	7.83E-01	5.84E-01	8.86E-02	2.51E-01	8.86E-02	3.58E-01	3.73E +00	0	0	0	4.92E-01	-2.4E +01	-1.2E +00	0
WDP	m^3 world eq deprived	2.02E-01	1.45E-03	9.93E-02	2.36E-04	1.04E-04	2.95E-04	1.04E-04	2.86E-01	3.57E-02	0	0	0	3.76E-03	-1.44E-01	-7.22E-03	0

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential)

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 kg RAUTITAN flex

Parameter	Unit	A1-A3	A4	A5	C1	C2/1	C2/2	C2/3	C3/1	C3/2	C3/3	C4/1	C4/2	C4/3	D/1	D/2	D/3
PERE	MJ	1.43E +01	1.06E-01	1.65E +00	2.6E-03	7.63E-03	2.16E-02	7.63E-03	1.04E-01	1.81E-01	0	0	0	7.43E-02	-8E+00	-4E-01	0
PERM	MJ	1.6E+00	0	-1.6E+00	0	0	0	0	0	0	0	0	0	0	0	0	0
PERT	MJ	1.59E +01	1.06E-01	4.63E-02	2.6E-03	7.63E-03	2.16E-02	7.63E-03	1.04E-01	1.81E-01	0	0	0	7.43E-02	-8E+00	-4E-01	0
PENRE	MJ	8.18E +01	1.24E +00	1.43E +00	5.84E-01	8.86E-02	2.51E-01	8.86E-02	4.4E+01	3.73E +00	0	0	0	4.92E-01	-2.4E+01	-1.2E+00	0
PENRM	MJ	4.42E +01	0	-6.51E-01	0	0	0	0	-4.36E +01	-4.36E +01	0	0	0	0	0	0	0
PENRT	MJ	1.26E +02	1.24E +00	7.83E-01	5.84E-01	8.86E-02	2.51E-01	8.86E-02	3.58E-01	-3.99E +01	0	0	0	4.92E-01	-2.4E+01	-1.2E+00	0
SM	kg	1.94E-	0	0	0	0	0	0	0	0	0	0	0	0	0	9.4E-01	0

		01															
RSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FW	m^3	1.11E-02	1.19E-04	2.41E-03	8.81E-05	8.5E-06	2.41E-05	8.5E-06	6.7E-03	8.59E-04	0	0	0	1.12E-04	-6.12E-03	-3.06E-04	0

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 = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2:
1 kg RAUTITAN flex

Parameter	Unit	A1-A3	A4	A5	C1	C2/1	C2/2	C2/3	C3/1	C3/2	C3/3	C4/1	C4/2	C4/3	D/1	D/2	D/3
HWD	kg	4.48E-08	4.73E-11	9E-11	5.37E-12	3.39E-12	9.61E-12	3.39E-12	2.16E-10	4.4E-10	0	0	0	1.22E-10	-1.61E-08	-8.07E-10	0
NHWD	kg	2.98E-02	2.02E-04	5.24E-03	1.81E-04	1.45E-05	4.1E-05	1.45E-05	1.23E-02	3.07E-03	0	0	0	9.86E-01	-1.25E-02	-6.25E-04	0
RWD	kg	4.11E-04	2.25E-06	3.66E-05	2.81E-05	1.61E-07	4.57E-07	1.61E-07	2.06E-05	3.02E-04	0	0	0	6.94E-06	-1.76E-03	-8.81E-05	0
CRU	kg	3.92E-04	0	1.1E-01	0	0	0	0	0	0	0	0	0	0	0	0	0
MFR	kg	1.07E-01	0	0	0	0	0	0	0	9.9E-01	0	0	0	0	0	0	0
MER	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EEE	MJ	3.63E-02	0	3.01E-01	0	0	0	0	6.61E+00	3.31E-01	0	0	0	0	0	0	0
EET	MJ	8.35E-02	0	5.42E-01	0	0	0	0	1.18E+01	5.88E-01	0	0	0	0	0	0	0

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional:
1 kg RAUTITAN flex

Parameter	Unit	A1-A3	A4	A5	C1	C2/1	C2/2	C2/3	C3/1	C3/2	C3/3	C4/1	C4/2	C4/3	D/1	D/2	D/3
PM	Disease incidence	5.34E-08	1.69E-09	1.61E-09	5.71E-10	1.21E-10	3.43E-10	1.21E-10	1.8E-09	3.41E-09	0	0	0	1.8E-09	-1.15E-08	-5.77E-10	0
IR	kBq U235 eq	6.6E-02	3.26E-04	3.56E-03	2.18E-03	2.34E-05	6.63E-05	2.34E-05	3.29E-03	2.79E-02	0	0	0	9.51E-04	-2.9E-01	-1.45E-02	0
ETP-fw	CTUe	4.53E+01	9.17E-01	1.85E-01	8.23E-02	6.58E-02	1.86E-01	6.58E-02	1.48E-01	5.63E-01	0	0	0	1.07E+00	-3.38E+00	-1.69E-01	0
HTP-c	CTUh	1.13E-09	1.85E-11	8.57E-12	2.49E-12	1.33E-12	3.76E-12	1.33E-12	2.02E-11	2.62E-11	0	0	0	1.58E-11	-2.75E-10	-1.37E-11	0
HTP-nc	CTUh	3.64E-08	8.31E-10	5.71E-10	1.67E-10	5.96E-11	1.69E-10	5.96E-11	1.33E-10	1.24E-09	0	0	0	3.31E-10	-6.46E-09	-3.23E-10	0
SQP	SQP	1.43E+01	6.08E-01	5.58E-02	7.1E-03	4.36E-02	1.23E-01	4.36E-02	1.16E-01	3.26E-01	0	0	0	8.35E-02	-4.69E+00	-2.35E-01	0

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Limitation note 1 - applies for the indicator 'Potential effect of human exposure to U235'. This impact category deals mainly with the possible effect of low-dose ionising radiation on human health in the nuclear fuel cycle. It does not take into account effects attributable to possible nuclear accidents and occupational exposure, or to the disposal of radioactive waste in underground facilities. The potential ionising radiation emitted by soil, radon and some building materials is also not measured by this indicator.

Limitation note 2 - applies for the indicators: 'Abiotic depletion potential for non-fossil resources', 'Abiotic depletion potential for fossil fuels', 'Water depletion potential (users)', 'Potential toxicity comparison unit for ecosystems', 'Potential toxicity comparison unit for humans (carcinogenic)', 'Potential toxicity comparison unit for humans (non-carcinogenic)', 'Potential soil quality index'.

The results of this environmental impact indicator must be used with caution, as the uncertainties of these results are high or there is limited experience with the indicator.

6. LCA: Interpretation

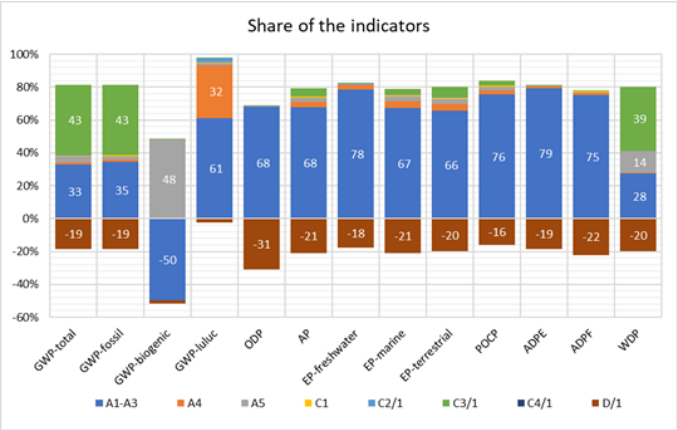
In the following section, the LCA results for scenario 1 (100% thermal utilisation) are presented graphically and interpreted. The illustrations show the percentage shares of the modules in the indicators.

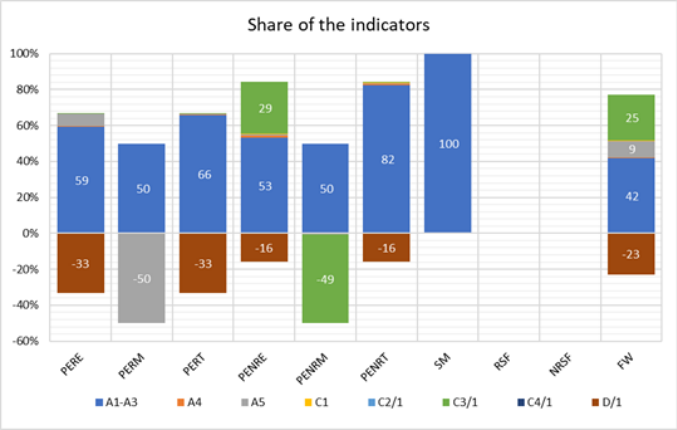
The majority of the indicators on environmental impact and resource consumption are dominated by the production phase (Modules A1-A3) in scenario 1. Waste treatment (Module C3) also plays a significant role in the indicators.

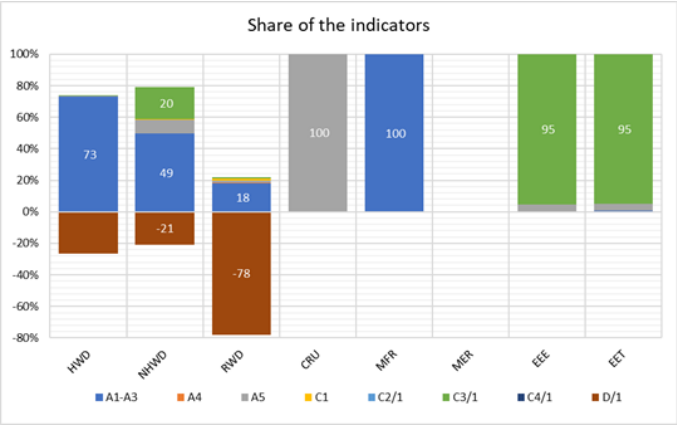
Furthermore, the effects within the system boundaries can be partially compensated by utilisation potentials outside the system boundaries (Module D). Within modules A1-A3, the production of polyethylene dominates the indicators. The thermal utilisation of the pipe is decisive for the environmental impacts in Module C3. The advantages in Module D result from

the substitution of electrical and thermal energy.

Scenario 1, 100% thermal utilisation:



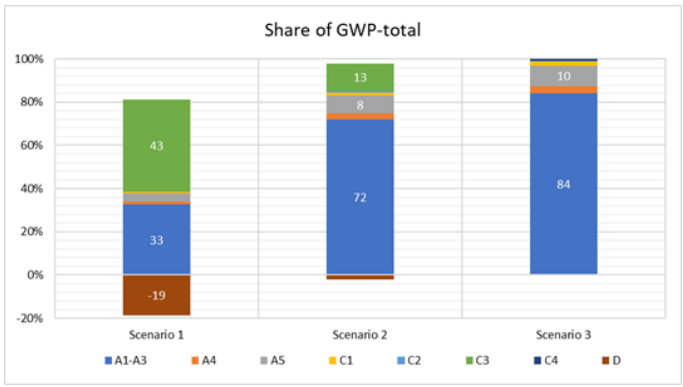


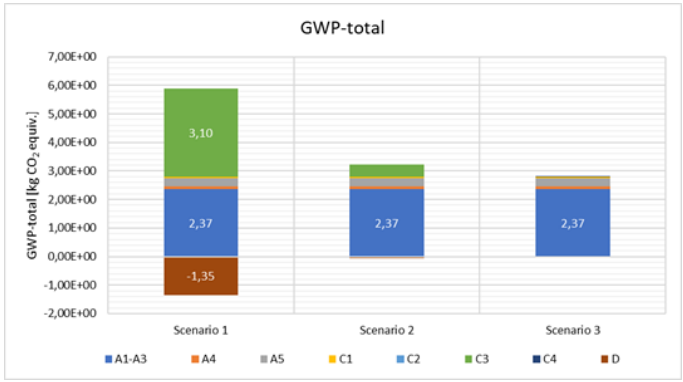


In scenario 2 (100% material recycling), the influence of Module C3 on the indicators decreases. The benefits from Module D also decrease. However, secondary materials from material recycling (SM) can be accessed outside the system boundaries.

In scenario 3 (100% landfill), the influence of Module C3 is completely reduced. Instead, disposal (Module C4) plays a limited role.

The two figures below show the LCA results for the 'GWP-total' (greenhouse gas potential). The diagram shows both the percentage shares of the modules in the indicator and the absolute values (kg CO2 equivalents).





In scenario 1 (100% thermal utilisation), 'GWP-total' is dominated by waste treatment (Module C3). The effects within the system boundaries can be partially offset by utilisation potentials outside the system boundaries (Module D).

In scenario 2 (100% material recycling), the influence of Module C3 on 'GWP-total' decreases. The benefits from Module D also decrease. The production phase is dominant.

In scenario 3 (100% landfill), the influence of Module C3 is completely reduced. Instead, disposal (Module C4) plays a limited role. The production phase is dominant.

7. Requisite evidence

RAUTITAN flex fulfils the requirements of the EN ISO 15875 standard and the corresponding certificates are available from REHAU on request.

8. References

Standards:

EN 15804
EN 15804:2012+A2:2019+AC:2021, Sustainability of construction works - Environmental product declarations - Basic rules for the product category construction products

ISO 14025
EN ISO 14025:2011, Environmental labels and declarations - Type III environmental declarations - Principles and procedures.

EN ISO 15875
DIN EN ISO 158752:202103, Plastic piping systems for hot and cold water installations - Cross-linked polyethylene (PEX); Part 2: Pipes

Further literature:

Programme guide
Institut Bauen und Umwelt e.V.: General instructions for the EPD programme of Institut Bauen und Umwelt e.V., Version 2.1, Berlin: Institut Bauen und Umwelt e.V., 2022 http://www.ibu-epd.com

PCR, Part A
Institut Bauen und Umwelt e.V.: Product category rules for building-related products and services. Part A: Calculation rules for the Life Cycle Assessment and requirements for the project report in accordance with EN 15804+A2:2019, version 1.3, 2022

PCR, Part B
Institut Bauen und Umwelt e.V.: Product category rules for building-related products and services. Part B: EPD requirements for plastic pipe systems for hot and cold water installations in buildings, 2021

Software/Database:

Database
Managed LCA Content (formerly GaBi- Database), version 2023.2. Chicago (USA): Sphera Solutions, Inc. (last accessed on 26.10.2023).

Software
LCA for Experts (formerly GaBi), version 10.7. Chicago (USA): Sphera Solutions, Inc. (last accessed on 26.10.2023).

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