ENVIRONMENTAL PRODUCT DECLARATION

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

Owner of the Declaration	Armacell Austria GmbH
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-ARM-20230409-IBA1-EN
Issue date	04.09.2024
Valid to	03.09.2029

AustroPEX

Armacell Austria GmbH

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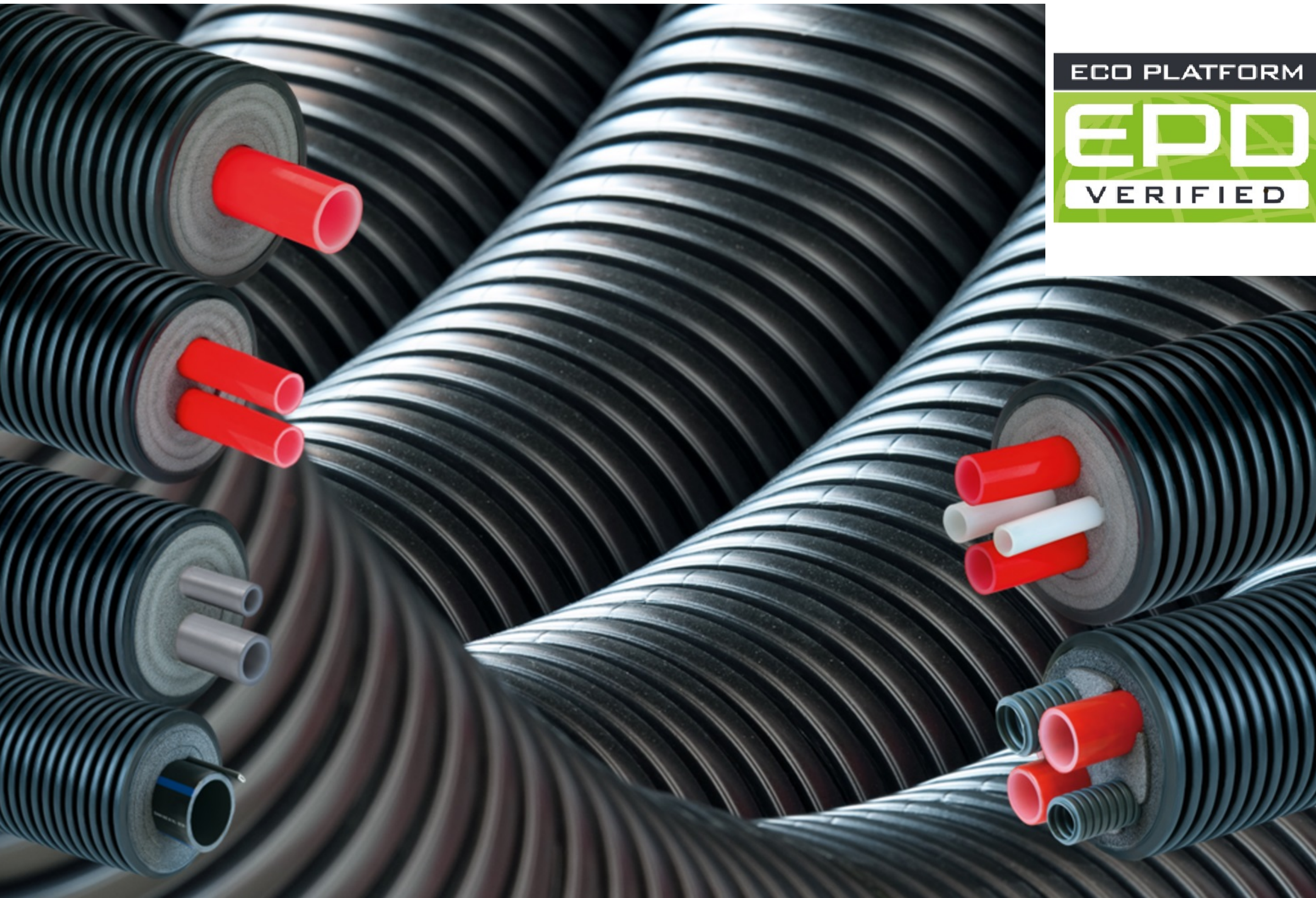

1. General Information

Armacell Austria GmbH

Programme holder

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

Declaration number

EPD-ARM-20230409-IBA1-EN

This declaration is based on the product category rules:

preinsulated pipes for district heating and cooling, 01.06.2023
(PCR checked and approved by the SVR)

Issue date

04.09.2024

Valid to

03.09.2029

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

AustroPEX

Owner of the declaration

Armacell Austria GmbH
Finkensteiner Straße 7
9585 Gödersdorf-Villach
Austria

Declared product / declared unit

The specified product is AustroPEX. The declared unit is one tonne of pre-insulated pipe system.

Scope:

This document applies to AustroPEX. For the preparation of the Life Cycle Assessment, the production quantities of the company headquarters in Gödersdorf near Villach for the year 2022 were surveyed.
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

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

Angela Schindler,
(Independent verifier)

2. Product

2.1 Product description/Product definition

a) Company
Armacell Austria GmbH develops and produces energy-saving heating and cooling insulation solutions as well as flexible pre-insulated pipe systems for the following areas of application:
Mineral wool insulation systems for building technology, energy technology and industry
Flexible pre-insulated pipe systems for local and district heating, the connection of heat pumps and solar thermal energy, thermal water and cooling pipes, as well as cold water pipes with and without trace heating
In its 'Advanced Insulation' division, the Armacell Group develops flexible insulation materials to improve the energy efficiency of technical systems and in the 'Engineered Foams' division, it develops high-performance foams for various technical applications and lightweight construction solutions. Examples include products made from 100% recycled PET and next-generation aerogel technology.

b) Product
AustroPEX is a flexible pre-insulated district heating pipe system with single, double and multi-line pipe systems for direct underground installation.

Construction:
Medium pipe: crosslinked polyethylene PE-Xa (alternatively with PE100 for cold water)
Insulation: XPE foam
Casing pipe: flexible, parallel-corrugated HDPE casing pipe

PE-Xa refers to polyethylene, which forms bridges between the PE molecules due to the addition of hydrogen peroxide and crosslinking by the Engel process macromolecules. The closed microcell structure of the XPE insulation (XPE = crosslinked polyethylene) guarantees a minimum water absorption capacity of <1%, according to DIN 53428. The corrugated HDPE casing pipe (HDPE High Density Polyethylene) contributes to the very good flexibility of the overall system with XPE insulation and provides mechanical protection. Different combinations of medium pipes and insulation thicknesses are offered, which are adapted to the respective application.

The following products are grouped under the collective term AustroPEX and are included in this EPD (average EPD):

AustroPEX Single Tube
AustroPEX Double Tube
AustroPEX Cold Water Pipe
AustroPEX Combi
AustroPEX Heat Pump Pipe
Use of the product is subject to the respective national regulations at the place of use; in Germany, for example, the building codes of the federal states, and the technical regulations based on these regulations. The Declaration of Performance is based on DIN EN 15632-1:2022-08, District heating pipes – Factory-made flexible pipe systems – Part 1: Classification, general requirements and test methods and DIN EN 15632-3:2022-08, District heating pipes – Factory-made flexible piping systems – Part 3: Non-bonded systems with plastic service pipes; requirements and test methods. The respective national regulations apply for use.
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2.2 Application

AustroPEX pipes are used as local and district heating pipes, connection pipes for heat pumps, door-to-door pipes, thermal water and cooling pipes, as well as cold water pipes with and without trace heating.

2.3 Technical Data

Name	Value	Unit
Pre-insulated pipe – pipe assembly		
Thermal conductivity λ50	0.04	W/(mK)
Maximum operating temperature	95	°C
Continuous operating temperature	80	°C
Maximum operating pressure PN6	6.6	bar
Minimum bending radius - according to product documents	-	m
Casing tube		
Carbon black content (LDPE) HDPE pipe; min.	2	%
Thermal stability (OIT) testing at 2100C (LDPE) 210°C	20	min

The operating temperature and pressure specifications refer to PE-Xa medium pipes PN6. For medium pipes PE-Xa PN10, the operating pressure increases to 10 bar. For PE100 medium pipes, the information in the specific technical data sheets or the information in *EN 1741* applies.

Performance data of the product with respect to the Declaration of Performance in relation to its essential characteristics in accordance with *DIN EN 15632-1:2022- 08, District heating pipes – Factory-made flexible pipe systems – Part 1: Classification, general requirements and test methods and DIN EN 15632-3:2022-08, District heating pipes – Factory-made flexible piping systems – Part 3: Non-bonded systems with plastic service pipes; requirements and test methods, and DIN EN 17414:2020-09, District cooling pipes – Factory-made flexible pipe systems.*

2.4 Delivery status

AustroPEX is produced in pipe bundles with coil lengths of 100 metres or customer-specific lengths. The tubes are available in various tube dimensions as single or double tubes. The PE100 pipe is used as a medium pipe when there is a risk of freezing in cold water applications.

2.5 Base materials/Ancillary materials

AustroPEX pipe systems consist of flexible PE-Xa with an oxygen barrier or PE100 medium pipes, a highly-flexible XPE insulation layer and the HDPE corrugated pipe as an outer jacket. The following table shows the composition, based on a weighted average over the product range produced.

Name	Value	Unit
Water-bearing PE-X/PE pipes		
Crosslinked polyethylene PE-Xa	37,73	%
Crosslinked polyethylene PE-Xa PN 10	4,37	%
HDPE PE100	1,71	%
Subtotal	43,80	%
Insulation		
PE foam	4,46	%
XPE foam	10,43	%
Subtotal	14,89	%
Outer casing		
HDPE	41,31	%
Total	100	%

Armacell sources the water-bearing PE pipes and the XPE insulation layer from upstream suppliers. The outer jacket made of HDPE is applied via a cross extruder and shaped with a corrugator.

The product/article/at least one partial product contains substances on the ECHA list of Substances of Very High Concern (SVHC) (20.11.2023) above 0.1% by mass: **no**

The product/article/at least one partial product contains other CMR substances of category 1A or 1B which are not on the Candidate List, above 0.1% by mass in at least one partial product: **no**

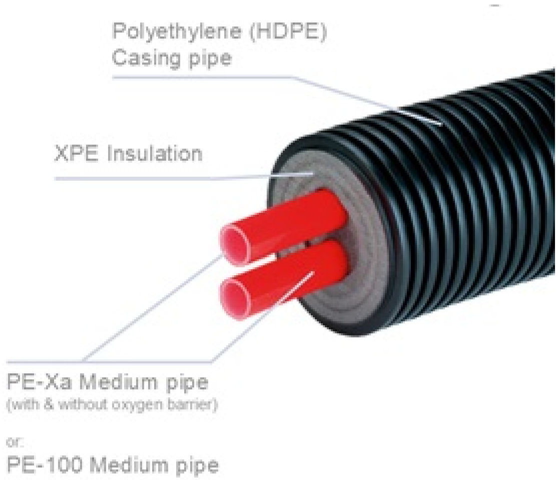
Biocidal products have been added to the construction product in question or it has been treated with biocidal products (it is therefore a treated product within the meaning of the Biocidal Products Regulation (EU) No. 528/2012): **no**

2.6 Manufacture

AustroPEX products are manufactured in a continuous production process.
Casing tube production is done on-site by placing HDPE granules in an extrusion line and forming them into a tube. In the next step, the medium pipes (PE-X or PE100) are pulled from the unwinding equipment, straightened and subjected to heat treatment.

At the same time,
the XPE insulation layers are supplied. They are closed and inserted into the cross extruder before being inserted. There, the outer casing made of HDPE is applied and the entire pipe, including medium pipes and insulation, is fed into the subsequent corrugator, where the final corrugated shape of the outer casing is formed. After that, the finished product receives its mark and is then applied to the production coiler.

Quality assurance is carried out in accordance with EN 15632 Parts 1 and 2. Quality management system in accordance with ISO 9001.



2.7 Environment and health during manufacturing

During all manufacturing steps and in all Armacell production facilities, production follows national guidelines and regulations. The cooling water is stored in the cycle. The electrical energy is covered by electricity from renewable energies.

2.8 Product processing/Installation

The pipes are designed for direct burial in a sand bed and are rolled out and installed directly into the pipe trench. The water-bearing medium pipes are connected with clamping and press-fittings, for which rental equipment is offered. In addition, neither special tools nor special protective measures are necessary. The recommendations for installing the product depend on the product and system and are described in the respective documentation as well as in the safety data sheets (e.g. in the installation instructions). For more details, see www.austroflex.com.

2.9 Packaging

The AustroPEX pipe bundles are held together by tension straps and are provided with an outer PE protective film. The accessories are packed in boxes and attached directly to the tube bundles as well as transported on returnable pallets.

The polyethylene-based packaging elements and cardboard boxes are recyclable and recycled in the countries with a take-back system.

2.10 Condition of use

When the products are used for their intended purpose, no change in the material composition occurs during use, except in the case of extraordinary effects (see 2.13).

2.11 Environment and health during use

Ingredients: There are no particular aspects of material composition during use. The product does not release water-soluble substances that can be released into the environment. No energy is required to use AustroPEX.

2.12 Reference service life

AustroPEX products are durable products. The results show that their useful life can be more than 50 years if used and installed properly. The PE-Xa pipe used is manufactured in accordance with *DIN 16892* and *DIN 16893* and quality monitored. Designed for an operating time of 24 hours a day, 365 days a year (8760 h/year), the service life cycle of 30 years required by *EN 15632* at 80 °C is fulfilled. At application temperatures < 75 °C, service life values of > 50 years are achieved.

The thermal insulation performance is maintained almost without restriction over the entire service life. Impairments of the thermal insulation performance are only caused by extraordinary effects and damage during the construction phase.

2.13 Extraordinary effects

Fire

Fire protection

Name	Value
Building material class	E

Water
The outer jacket and the post-insulation systems are designed in such a way that the penetration of water vapour through soil moisture is permanently limited to a minimum.

Mechanical destruction
AustroPEX is designed for direct installation in the ground. The outer sheath is dimensioned in such a way that the earth and traffic loads can be fully absorbed at a minimum cover height of 0.8 metres above the pipe apex and sand bedding if the Armacell installation guidelines are complied with.

2.14 Re-use phase

After proper dismantling, the product can be thermally recycled or recycled in a reprocessing process for proper separation of the components.

2.15 Disposal

The materials must be disposed of in accordance with local regulations, regulated by the European Waste Catalogue: waste code 07 02 13 (plastic waste). Note: Please refer to Commission Decision *2001/118/EC.*

2.16 Further information

Further information and detailed specifications of AustroPEX® products can be found on the manufacturer's website: www.austroflex.com.

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit of one tonne refers to the average production volume of AustroPEX in 2022. This methodology was chosen to present the different versions of the product on a balance sheet.

Declared unit

Name	Value	Unit
Declared unit	1000	kg
Mass percentage of pipes	438.03	kg
Mass percentage of insulation	148.89	kg
Mass percentage of the outer sheath	413.09	kg
Mass reference	2.33	kg/rm
Gross density	60	kg/m^3

Other declared units are allowed if the conversion is transparent.

The robustness of the data is shown in section 3.6.

3.2 System boundary

The data collected refers to the annual production of 2022. Type of EPD: Cradle to factory gate with options

The following stages of the use cycle are taken into account:

Production A1–A3: The LCA calculation includes production of the AustroPEX components (raw material supply – A1), transport to the production facility in Gödersdorf, Austria (A2) and production of the pipes on site, as well as assembly and packaging. For the environmental impact, the use of green electricity in A3 was calculated taking into account the electricity mix. The share of electricity demand covered by green electricity within total electricity demand is 99.40% (A3). The aggregated module also includes the waste treatment of the waste from the manufacturing process.

Transport A4: Transport from the factory to the construction site

Installation A5: Includes the disposal scenario for the packaging material and installation of the pipes with an excavator.

Use B1–B7: No relevant environmental impacts are expected in the course of normal use, so the use phase is not accounted for.

Disposal C1–C4: C1 (demolition) includes demolition with an excavator. C2 takes into account the transport to the waste treatment plant and C3 considers treatment of the removed materials by thermal waste treatment (R1 value > 0.6).

Module D: Advantages and burdens for the next product system: electrical and thermal energy generation from the waste incineration process of the packaging (A5) and the product (C3).

3.3 Estimates and assumptions

A5: For the recycling routes, a realistic scenario for Europe is assumed, according to the EPRC and BMK. According to the manufacturer, the cardboard boxes and pallets are recycled or reused, but this cannot be traced exactly, which is why no advantages or burdens are declared in module D and are therefore sent to a sink. The PE packaging is sent for thermal recycling. The useful energy produced during waste treatment is declared as exported energy in A5 (EEE and EET indicators) and the advantages and burdens associated with the useful energy generated are declared in module D. Material losses during collection and recycling are neglected. For the installation of one tonne of pipe (excavation and subsequent filling of the pipe trench), the manufacturer assumed a working time of 22 hours. The assumed excavator model has an engine output of 120 hp and a fuel consumption of 15 l/h.

For C1 (demolition), the same assumptions apply for working time and excavator model as for module A5 Installation.

C2: An average of 250 km is assumed for transport from the place of use to a waste incineration plant.

C3: Based on the current situation, it is assumed that 100% of the quantity of AustroPEX sold is used for thermal recycling. The useful energy produced during waste treatment is declared as exported energy in C3 (EEE and EET indicators) and the advantages and burdens associated with the useful energy generated are declared in module D.

C4: In module C4, no material, energy and mass flows are balanced, as 100% of these are fed into waste treatment (C3)

D: The waste in module A5 is partly recycled (except cardboard boxes and pallets) and 100% in C3 in a waste incineration plant. The useful energy produced is declared as exported energy in A5 and C3 and the advantages and burdens associated with the useful energy produced in module D. According to the data set used for incineration of the PE films and PE bags in module A5 'Treatment of waste polyethylene, municipal incineration [RoW]', 5.55 MJ/kg of electrical energy and 10.69 MJ/kg of thermal energy are recovered. For the incineration of AustroPEX in module C3, 3.92 MJ/kg of electrical energy and 7.66 MJ/kg of thermal energy are recovered, according to the data set used ('Treatment of waste plastic, mixture, municipal incineration [RoW]').

3.4 Cut-off criteria

The cut-off criteria according to PCR are taken into account.

For the input and output data acquisition of the pipe production process, all material flows above 1% of the total mass flow and all energy flows above 1% of the total energy input were used. For the LCA calculation, all available inputs and outputs, even below the 1% threshold, were taken into account.

Raw materials: the EVOH (oxygen diffusion layer): the quantities are below the mass-related cut-off limit of 1%. The cooling water used is circulated and can therefore be neglected.

Packaging: tension straps: the quantities are below the mass-related cut-off limit of 1%. The packaging in the form of cardboard boxes and PE films of delivered products is also neglected or considered only as a conservative approach to transport to a recycling plant. Overall, the unbalanced processes per module A1–A3 are less than 5% of the energy and mass input.

Buildings, machines and production infrastructure in the manufacturing plant: buildings and infrastructure of background data sets are taken into account. In addition, no specific buildings, machines and production infrastructures are recorded and taken into account in accordance with the cut-off criteria at the manufacturing plant.

3.5 Background data

The LCA model was created using *SimaPro* software (version 9.5). The '*EN 15804+A2 Method*' was used to calculate the core indicators (except 'Climate Change – biogenic') for the environmental impacts and the additional environmental indicators. This method takes into account the characterisation factors of the Ecological Footprint Method, version 3.1. The *Ecoinvent database* (version 3.9.1) provides the LCA data from the underlying system for various raw and process materials. The database was last updated in 2022.

3.6 Data quality

The foreground data collected by the manufacturer is based on production volumes and sales volumes in 2022 and extrapolations of measurements for specific machines and equipment at the production site.
The pipes within the AustroPEX product group vary in diameter, thickness of the individual layers, and design (double, single, cold water, combi and heat pump pipes). Since the average environmental performance of the product brand is calculated using site-specific production volumes, the results also provide a representative picture of site-specific production technologies. Most of the necessary Life Cycle Inventories (LCI) of the basic materials are available in the *Ecoinvent* database. LCA data not available in *Ecoinvent* is approximated using LCIs of similar materials or estimated by combining available LCIs. There is a valid certificate for the green electricity, as well as proof of the composition of the sources. For thermal energy, the region-specific natural gas supply is taken into account. The data is plausible, i.e. the deviations from comparable results (other manufacturers, literature, similar products) are comprehensible. A detailed assessment of the data quality according to *EN 15804* (Annex E) was carried out and presented in the associated project report.

3.7 Period under review

The production data refers to an average value from 2022.

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: Austria

3.9 Allocation

In addition to AustroPEX, other products are manufactured at the factory under review.

For those inputs and outputs for which precise data is not available, a mass-based allocation (based on the raw materials used) is used.

The following allocations are carried out:

A1–A3 Energy: The electricity is needed for production, warehouse, charging station for electric forklifts, compressed air system, lighting and administration. For production, the electricity consumption is calculated on the basis of the machine output and the running metres produced. In the case of AustroPEX, the extrusion line is taken into account. Mass-based allocation is used to allocate the electricity consumption for the warehouse, charging station for electric forklifts, compressed air system, lighting and administration, as well as natural gas for heating and hot water to the individual products.

A1–A3 Outputs: The distribution of outputs from production follows mass-based allocation.

A1–A3: The transport of outputs for waste treatment is also accounted for on the basis of the allocated output quantities. The intermediate packaging of the inputs is fed into a recycling plant and used as a conservative supplement to the transports.

A4: For transport from the factory to the construction site, distances at home and abroad are weighted according to turnover. The average transport distance is estimated on the basis of order processing.

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. The underlying database used is *Ecoinvent*.

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Biogenic carbon content at the factory gate

In the product itself, the biogenic carbon content is well below the cut-off limit of 5%.
The proportion of biogenic carbon contained in the packaging per tonne of AustroPEX is:

Name	Value	Unit
Biogenic carbon in the associated packaging	35,2	kg C

The biogenic carbon contained leaves the system in module A5.

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

The following technical information serves as the basis for the declared modules.

Transport from manufacturer to place of use (A4)

Name	Value	Unit
Litres of fuel	40	l/100km
Average transport distance	1031	km
Capacity utilisation (including empty runs)	80	%
Bulk density of transported products	60	kg/m^3

Installation in the building (A5)

The figures refer to one tonne of AustroPEX.

Name	Value	Unit
Other energy sources Diesel consumption	11630.5	
Output substances as a result of waste treatment on the construction site (= packaging)	76.66	kg
Collection for energy recovery Product packaging – plastic	3	kg
Collection for recycling Product packaging – cardboard boxes	21,19	kg
Collection for reuse Product packaging – pallets	52,47	kg

The service life declared by the manufacturer applies to the assumptions and conditions of use, which are described in section 2.12.

Reference service life

Name	Value	Unit
Service life according to the manufacturer's specifications	50	

End of Life (C3)

The figures refer to one tonne of AustroPEX.

Name	Value	Unit
Collected as mixed construction waste	1000	kg
For energy recovery	1000	

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

Module D covers the advantages and burdens of the incineration process of A5 (packaging waste) and C3 (thermal utilisation of the product). A waste incineration plant with an R1 value > 0.6 is assumed.

The following values refer to one tonne of AustroPEX.

Name	Value	Unit
Thermal recycling A5	3	kg
Thermal recycling C3	1000	kg

5. LCA: Results

The results of the indicators of impact assessment, resource use, waste and other output streams related to one tonne of AustroPEX are presented below. To calculate the core indicators of environmental impact and additional environmental indicators, the 'EN 15804+A2 Method' of the *Simapro* software was used. This method takes into account the characterisation factors of the Ecological Footprint Method, version 3.1.

The results of the biogenic global warming potential (GWP-biogenic) only take into account the greenhouse gas emissions that are stored in the packaging materials made from renewable raw materials in the form of carbon in the biomass (negative value in A1-A3) and are released back into the environment when the product is installed in the course of packaging disposal (positive value in A5). The very low biogenic greenhouse gas emissions of the energy supply processes are neglected in the present case. The product itself contains no renewable raw materials and therefore does not cause any biogenic greenhouse gas emissions.

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 t AustroPEX

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
GWP-total	kg CO_2 eq	3.27E+03	1.91E+02	1.3E+03	1.15E+03	4.62E+01	2.38E+03	0	-4.94E+02
GWP-fossil	kg CO_2 eq	3.39E+03	1.9E+02	1.17E+03	1.15E+03	4.62E+01	2.38E+03	0	-4.94E+02
GWP-biogenic	kg CO_2 eq	-1.29E+02	0	1.29E+02	0	0	0	0	0
GWP-luluc	kg CO_2 eq	2.92E+00	9.4E-02	1.32E-01	1.3E-01	2.28E-02	1.8E-02	0	-3.16E-01
ODP	kg CFC11 eq	4E-05	4.14E-06	1.84E-05	1.84E-05	1.01E-06	2.44E-06	0	-1.98E-05
AP	mol H^+ eq	1.39E+01	4.16E-01	1.07E+01	1.07E+01	1.01E-01	5.42E-01	0	-9.33E-01
EP-freshwater	kg P eq	1.06E-01	1.55E-03	4.2E-03	4.17E-03	3.75E-04	6.67E-04	0	-3.02E-02
EP-marine	kg N eq	2.37E+00	1.02E-01	4.95E+00	4.95E+00	2.49E-02	2.57E-01	0	-2.06E-01
EP-terrestrial	mol N eq	2.65E+01	1.07E+00	5.39E+01	5.39E+01	2.59E-01	2.64E+00	0	-2.43E+00
POCP	kg NMVOC eq	1.32E+01	6.46E-01	1.6E+01	1.6E+01	1.57E-01	6.64E-01	0	-1.07E+00
ADPE	kg Sb eq	2.09E-02	6.22E-04	4.15E-04	4.03E-04	1.51E-04	1.14E-04	0	-7.67E-04
ADPF	MJ	9.63E+04	2.7E+03	1.52E+04	1.51E+04	6.56E+02	4.39E+02	0	-7.47E+03
WDP	m^3 world eq deprived	1.62E+03	1.11E+01	3.28E+01	3.26E+01	2.7E+00	1.08E+02	0	-6.39E+01

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 t AustroPEX

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	6.32E+03	4.25E+01	1.16E+03	8.6E+01	1.03E+01	1.8E+01	0	-2.98E+03
PERM	MJ	1.07E+03	0	-1.07E+03	0	0	0	0	0
PERT	MJ	7.39E+03	4.25E+01	8.68E+01	8.6E+01	1.03E+01	1.8E+01	0	-2.98E+03
PENRE	MJ	5.32E+04	2.7E+03	1.53E+04	1.51E+04	6.56E+02	4.34E+04	0	-7.47E+03
PENRM	MJ	4.31E+04	0	-1.32E+02	0	0	-4.3E+04	0	0
PENRT	MJ	9.63E+04	2.7E+03	1.52E+04	1.51E+04	6.56E+02	4.39E+02	0	-7.47E+03
SM	kg	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0
FW	m^3	1.56E+03	1.11E+01	3.3E+01	3.28E+01	2.69E+00	1.07E+02	0	-6.36E+01

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 t AustroPEX

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D

HWD	kg	7.21E-02	1.72E-02	1.02E-01	1.02E-01	4.17E-03	2.65E-03	0	-2.27E-02
NHWD	kg	3.63E+02	1.34E+02	2.43E+01	2.17E+01	3.26E+01	6.45E+01	0	-3.36E+01
RWD	kg	2.19E-01	1.62E-03	3E-03	2.97E-03	3.93E-04	4E-04	0	-3.03E-02
CRU	kg	0	0	0	0	0	0	0	0
MFR	kg	0	0	2.12E+01	0	0	0	0	0
MER	kg	0	0	0	0	0	0	0	0
EEE	MJ	0	0	1.67E+01	0	0	3.92E+03	0	0
EET	MJ	0	0	3.21E+01	0	0	7.66E+03	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 t AustroPEX

Parameter	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
PM	Disease incidence	1.29E-04	1.41E-05	2.98E-04	2.98E-04	3.43E-06	2.69E-06	0	-4.03E-06
IR	kBq U235 eq	1.51E+02	1.37E+00	3.12E+00	3.09E+00	3.32E-01	3.34E-01	0	-1.78E+01
ETP-fw	CTUe	8.9E+03	1.34E+03	7.25E+03	7.22E+03	3.24E+02	4.7E+03	0	-9.12E+02
HTP-c	CTUh	1.22E-06	8.68E-08	3.55E-07	3.53E-07	2.11E-08	2.07E-07	0	-1.18E-07
HTP-nc	CTUh	3.1E-05	1.92E-06	2.51E-06	2.46E-06	4.66E-07	7.32E-06	0	-2.23E-06
SQP	SQP	1.85E+04	1.64E+03	1.05E+03	1.02E+03	3.97E+02	1.31E+02	0	-1.3E+03

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

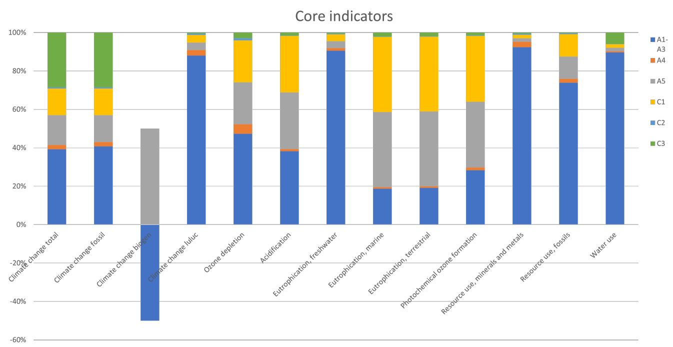
Limitation note 1 – applies for the indicator 'Potential impact of human exposure to U235'. This impact category deals mainly with the possible impact of low-dose ionising radiation on human health in the nuclear fuel cycle. It does not take into account effects attributable to possible nuclear accidents 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 experienced with the indicator.
This EPD was created using a software tool.

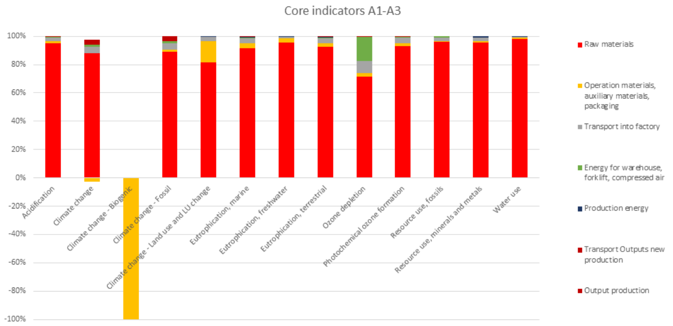
6. LCA: Interpretation

The following interpretation provides a summary of the LCA results (excluding module D) based on a declared unit of one tonne of AustroPEX pipe.

The A1–A3 manufacturing phase is the dominant factor in the environmental profile. It is classified in 5 (GWP-lulu, EP-freshwater, ADP-minerals & metals, ADP-fossil resources, WDP) out of 13 indicators responsible for at least 70% of the environmental impacts.
In the indicators AP, EP-marine, EP-terrestrial and POCP, product installation (A5) and dismantling (C1) are jointly responsible for 55% of the environmental impacts. This is due to the fuel consumption of the excavator used.
The production phase and thermal recycling of the product in C3 mainly contribute to the global warming potential (Climate change - total). During thermal utilisation of the product, the sequestered fossil carbon is released into the atmosphere in the form of CO2 emissions, thus contributing to global warming.
The biogenic greenhouse gas emissions are due to the carbon content of the product packaging made of cardboard and pallets. This carbon was taken from the atmosphere during tree growth and sequestered in the biomass (hence negative CO2 emissions in A1-A3). In module A5, the cardboard boxes and pallets leave the product system (hence positive CO2 emissions in A5) and are recycled or reused.
Over the entire life cycle of the product, this results in a balanced CO2 balance for the biogenic carbon sequestered in the product packaging.
In terms of volume, the two indicators Climate change - biogenic and Climate change – land use account for only minor shares of the Climate change – total indicator, which is why it hardly differs from the Climate change – fossil indicator.



The analysis of the manufacturing phase of AustroPEX identifies the supply of raw materials (including ancillary materials and packaging) as a key driver with a share of at least 74% in all environmental indicators. Among the individual raw materials, PN pipes are responsible for an average of 59% of the environmental impact in all environmental indicators, followed by HDPE casing with 25%, (X)PE foam with 14% and PE 100 pipe with 2%.



The evaluation of the individual raw materials shows that the PE-Xa medium pipes have the greatest environmental impact in 3 indicators alone and the HDPE cladding pipe has the smallest environmental impact. The composition of the individual pipe variants means that AustroPEX-CW pipe 90A25 causes the lowest proportion of PE-Xa and the largest proportion of HDPE and thus the lowest overall environmental impact. The 200a125 single pipe has the highest proportion of PE-Xa and the lowest proportion of HDPE, thus causing the highest environmental impact in the three main indicators.

Fluctuation

The following table shows the range of results for the different AustroPEX pipe dimensions (off-the-shelf goods) for the three indicators GWP-fossil, acidification (AP) and total non-renewable primary energy demand per tonne of AustroPEX. Only A1–A3 is considered, as the fluctuations are mainly reflected in the composition of the raw materials, and this has no influence on the remaining modules.

Parameter	Pipe dimension	Unit	A1-A3	Deviation from the average
MAX GWP-fossil	200a125	kg CO_2 equiv.	3.88E+03	+14.18%
MIN GWP-fossil	90A25	kg CO_2 equiv.	2.75E+03	-18.99%
Fluctuation range		kg CO_2 equiv.	1.13E+03	
MAX AP	200a125	Mol H+ equiv.	1.67E+01	+19.69%
MIN AP	90A25	Mol H+ equiv.	1.04E+01	-25.46%
Fluctuation range		Mol H+ equiv.	6.29+00	
MAX PENRT	200a125	MJ	1.05E+05	+8.71%
MIN PENRT	90A25	MJ	8.40E+04	-12.83%
Fluctuation		MJ	2.07E+04	

7. Requisite evidence

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