NUPI INDUSTRIE ITALIANE S.p.A.

ENVIRONMENTAL PRODUCT DECLARATION

Product names:

POLYETHYLENE PIPE FOR WATER, GAS AND INDUSTRIAL APPLICATIONS TYPE "POLIETILENETUBI"

Site Plants:

Castel Guelfo (BO)

in compliance with ISO 14025 and EN 15804+A2:2019

Program Operator	EPDItaly
Publisher	EPDItaly

Declaration Number	2023PC12T
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General information

EPD OWNER:	Nupi Industrie Italiane S.p.A., Piazza San Marco, n. 1 – 20121 Milano (MI) - Italy
PLANT INVOLVED in the declaration:	Castel Guelfo: Via dell'Artigianato n. 13 - 40023 Castel Guelfo di Bologna (BO) – Italy
SCOPE OF APPLICATION:	This Environmental Product Declaration (EPD) is valid for POLIETILENETUBI (NADIR, NADIR PLUS, NADIR GAS, NUPIGAS, NADIR PLUS GAS) pipes. The production facilities is in Castel Guelfo (BO). The type of declaration is related to a representative pipe produced in Castel Guelfo. The life cycle assessment is representative for the product introduced in the declaration for the given system boundaries.
PROGRAM OPERATOR:	EPDITALY, via Gaetano De Castillia 10, 20124 Milano, Italia.
INDIPENDENT CHECK:	This declaration has been developed referring to EPDItaly, following the General Program Instruction; further information and the document itself are available at: www.epditaly.it. EPD document valid within the following geographical area: Italy and other countries according to sales market conditions. CEN standard EN 15804 served as the core PCR (PCR ICMQ-001/15 rev.3). PCR review was conducted by Daniele Pace. Contact via info@epditaly.it Independent verification of the declaration and data, according to EN ISO 14025:2010. Third party verifier: ICMQ SpA, via De Castillia, 10 20124 Milano (www.icmq.it) ☐EPD process certification (Internal)☑ EPD verification (External) ***Accredited by: Accredia***
CPC CODE:	3632 - Tubes, pipes and hoses, and fittings therefor, of plastics
CORPORATE CONTACT:	info@nupinet.com
TECHNICAL SUPPORT:	Sphera https://www.sphera.com
COMPARABILITY:	Environmental statements published within the same product category, but from different programs, may not be comparable. In particular, EPDs of construction products may not be comparable if they do not comply with EN 15804+A2.

ACCOUNTABILITY:	Nupi Industrie Italiane S.p.A relieves EPDItaly from any non-compliance with environmental legislation. The holder of the declaration will be responsible for the information and supporting evidence; EPDItaly declines all responsibility for the manufacturer's information, data and results of the life cycle assessment.
REFERENCE DOCUMENT:	This declaration has been developed following the General Programme Instruction document of EPDItaly, available at www.epditaly.it.
PRODUCT CATEGORY RULES (PCR):	PCR ICMQ-001/15 rev.3 EN 15804+A2:2019 is the framework reference for PCRs.

Company

In October 2015, Nupi Industrie Italiane S.p.A. took over Nupigeco S.p.A.
The name change brings with it the experience of an "all-Italian" company that exports its products worldwide.
Nupigeco S.p.A. was founded on October 1st 2008 by the merger of two of our companies, NUPI S.p.A. and Geco System S.p.A. - both founded more than 45 years ago. Combining their many years of experience and constant growth, the two firms decided to create a new flexible and advanced company, ready to play its role to satisfy the demands of the market whilst being environmentally astute.

MISSION

The primary goal of Nupi Industrie Italiane S.p.A. corporate strategy is not only the production of systems that meet performance requirements and comply with the use for which they are intended, but above all general customer satisfaction. Producing better and faster are goals that technology makes more and more compatible.

Nupi Industrie Italiane S.p.A. combines high productivity with high and consistent quality standards while preventing pollution and minimizing the environmental impacts of its operations, making the most efficient use of natural resources and energy. To reduce raw materials wastes, Nupi Industrie italiane S.p.A. re-introduces in its production cycle its own reprocessed material.

Company Certifications

Nupi Industrie Italiane S.p.A. submits its management and production systems to external audits performed by third party certification bodies. The external audit consists of inspections carried out at given intervals.
Audit frequency depends on the procedure established by the specific standard and by each certification body. Nupi Industrie Italiane S.p.A. is certified in compliance with the standards for quality (EN ISO 9001), environment (EN ISO 14001) and Health and Safety of workers (ISO 45001).

UNI EN ISO 9001
UNI EN ISO 14001
ISO 45001

Product Certifications

NUPI products are of high quality, complying with regulations and conforming to the most stringent standards and certifications schemes (according to EN 12201, EN 1555, EN ISO 4427, EN ISO 4437, EN ISO 15494, DIN 8074, DIN 8075, PAS 1075, ASTM D 2513, ASTM D 3035, ASTM F 1055, ASTM F 714, FM 1613, NSF 61, etc…) from around the world (the full updated list is available on the website: www.nupiindustrieitaliane.com).

Goal and scope of EPD

The entire life cycle of the product is considered (Type of EPD: cradle to grave an module D) and the modules described below are declared in this EPD:

*Modules **A1-A3** include those processes that provide energy and material input for the system (A1), transport up to the factory gate of the plant (A2), manufacturing processes as well as waste processing and emissions to air (A3).*

*Module **A4** includes the transport from the production site to the customer or to the point of installation of the products.*

*Module **A5** considers all pipe installation steps to build the construction site (like auxiliaries and mechanical energy consumption) including packaging waste processing (recycling, incineration, disposal). Credits from energy substitution are declared in module D. During this phase a pipe leftover of 2% has been considered.*

*Module **B1** considers the use of the installed product. During the use of plastic pipes, a scenario of zero impact is considered.*

*Module **B2** includes the maintenance of the product. A scenario of zero impact is considered.*

*Modules **B3-B4-B5** are related to the repair, replacement and refurbishment of the products. If the products are properly installed no repair, replacement or refurbishment processes are necessary. A scenario of zero impact is then considered.*

*Modules **B6-B7** consider energy use and operational water to operate the pipe. No operational energy or water use are considered. A scenario of zero impact is then considered.*

*Modules **C1-C4** consider the end of life of the product. The most representative end of life stage of buried HDPE pipes is the "left in ground", therefore zero impacts are considered.*

*Module **D** includes benefits from all net flows in the end-of-life stage that leave the product boundary system after having passed the end-of-waste stage. Benefits from packaging incineration (electricity and thermal energy) are declared within module D.*

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	X	X	X	X	X	X	X	X	X	X	X	X

X = modules included in the study

The type of EPD is a “cradle to grave and Module D” EPD for the product “POLIETILENETUBI” Polyethylene pipe. It is produced in NUPI INDUSTRIE ITALIANE S.p.A. plant in Castel Guelfo (BO) and sold worldwide, but mostly in Europe. All data refer to the 2021 production and sales.

According to the PCR ICMQ-001/15 rev. 3, this EPD, is “cradle to grave and Module D”. Modules included are A1, A2, A3, A4, A5, B, C and D. All manufacturing activities and packaging/auxiliary’s production are in module A3, while energy production and input materials are in A1. Transport to clients (A4) and installation (A5) are included together with end-of-life scenarios (benefits and loads included according to D module).

The declaration is a Type 3 EPD (Product EPD based on a qualified LCA-Tool) according to /REGOLAMENTO EPDITALY V.5.2/.

The Polietilenetubi pipe production is in Castel Guelfo - Bologna (IT). The market range is Italian for the 88%, and 96% European.

Geographical validity: EU+GLO

Database: GaBi Database 2022.2

Software: EPD Process Creator, implemented through GaBi professional 9 and GaBi Envision 9.0 software. The identification code of the EPD process tool used is: NUPI EPD Process Tool – V.4.2 del 10/07/2023 developed by Sphera.

EPD realized by means of a validated algorithm:
In 2019 NUPI Industrie Italiane S.p.A. implemented and certified a Process for EPD generation by using an algorithm that has been validated and certified by ICMQ S.p.A., in agreement with EPDItaly’s requirements. The process is based on an automatic data collection from different manufacturing plants that have been integrated, verified and validated in compliance with internal procedures. The validated algorithm allows the automatic calculation of the indicators reported into the current EPD coming from an LCA model implemented into the EPD process tool.

Product description

1.1. Detailed product description

Nupi Industrie Italiane S.p.A. produces Polyethylene High density HDPE pipes and fittings systems for the distribution of water, gas and industrial fluids under pressure.

“POLIETILENETUBI” pipes *(NADIR, NADIR PLUS, NADIR GAS, NUPIGAS, NADIR PLUS GAS)* are suitable for potable water, water for general purposes, gas and industrial applications. “POLIETILENETUBI” pipes are made of PE100, PE100 RC and PE80 grades, single and multi-layer.

They are manufactured using advanced technologies and according to the most stringent international standards.

1.2. Production processes description

PIPE EXTRUSION (Castel Guelfo)

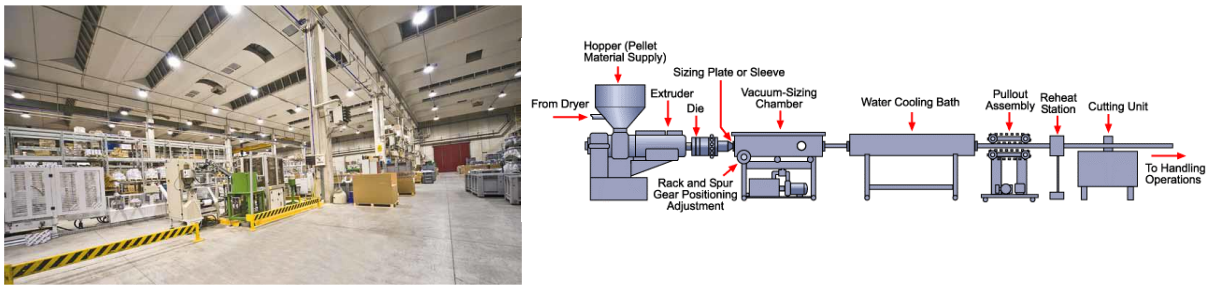

Figure 1 Pipes extrusion process

Nupi Industrie Italiane S.p.A. manufactures both solid wall (monolayer) polyethylene pipes, in diameter sizes ranging from 16 mm to 1000 mm, and coextruded multilayer (from two to five layers) pipes.

The raw materials used to manufacture polyethylene pipes are supplied in pellets (provided in bulk transporter, octabins or bags), both as natural resin or finished compound. Resin is pneumatically conveyed from the bulk transporters to silos at the plant site. The resin is then transferred from the silos to the pipe extruder by a vacuum transfer system.

The pipe extrusion line consists of the extruder, die, cooling systems, puller, printer, saw and take-off equipment. The function of the extruder is to heat, melt, mix, and convey the material to the die, where it is shaped into a pipe. The extruder is used to heat the raw material and then force the resulting melted polymer

through the pipe extrusion die. The pipe extrusion die supports and distributes the homogeneous polymer melt around a solid mandrel, which forms it into an annular shape for solid wall pipe.

The dimensions and tolerances of the pipe are determined and set during the sizing and cooling operation. The sizing operation holds the pipe in its proper dimensions during the cooling of the molten material. During vacuum sizing, the molten material is drawn through a sizing tube or rings while its surface is cooled enough to maintain proper dimensions and a circular form. The outside surface of the pipe is held against the sizing sleeve

by vacuum. After the pipe exits the vacuum sizing tank, it is moved through a second vacuum tank or a series of spray or immersion cooling tanks.

The puller must provide the necessary force to pull the pipe through the entire cooling operation. Pipes are marked at specific intervals through ink jet or hot marking with tape machines.

Finished pipes can be coiled (depending to their sizes and physical/mechanical characteristics) or cut in customised straight lengths for handling and shipping convenience. Coiled pipes and straight lengths are then arranged with the proper packaging, ready for the storage, handling and transport phases.

1.3. Technical data

For design purposes of polyethylene pipes under pressure, it is essential to know the internal pressure capability by defining the nominal pressure (PN) typical for water applications and the maximum allowable pressure (MOP) typical for gas and/or industrial applications.
The most important properties for the design of a PE pipe is the MRS (Minimum Required Strength) of the PE grade selected. For a PE100 grade, the MRS is 10 MPa and takes into account the creep properties and applies to operating temperatures up to 20°C. MOP (Maximum Operating Pressure) is related to the MRS of the material used; the pipe geometry is also essential (SDR; standard dimension ratio) as well as the service conditions.
For HDPE pipe, continuously operating in pressure at 20°C for 50 years with water, the design coefficient (C) is 1,25; for natural gas not ruled by national regulations and industrial applications, C is minimum 2.

$$PN = \frac{20 \times MRS}{C \times (SDR - 1)}$$

Relationship between MRS, PN, MOP (gas) and SDR (some SDR)

SDR	PN (C = 1,25)		MOP (gas), European (C = 2)	MOP (gas), Italy (C ≥ 3,25)	MOP (gas), European (C = 2)	MOP (gas), Italy (C ≥ 3,25)
	PE100	PE80	PE100	PE100	PE80	PE80
7.4	25	16	NA*	NA*	NA*	NA*
11	16	12.5	10	5	8	5
17	10	8	6.3	3.9	5	3
26	6	5	NA*	NA*	NA*	NA*

*NA: not applicable. SDR 7.4 and 26 not included in EN 1555 for gas applications.

Some physical and mechanical characteristics of “POLIETILENETUBI” pipes are summarized in the following tables:

Raw Material Physical Characteristics

Material property	Unit of measure	Requirements	Test method
Density	Kg/m^3	>950	ISO 1183
Thermal Stability (T=200 °C)	min	>20	ISO 11357-6
MFI (190°C/5 kg) (PE80 and PE100)	g/10 min	0.2-1.4 (max. diff. +/- 20%)	ISO 1133
Volatile content	mg/kg	<350	ISO 760
Water content	mg/kg	<350	ISO 760
Carbon Black content	%	2-2.5	ISO 6964
Carbon black dispersion	-	Grade <=3 A1, A2, A3, B	ISO 18553

Mechanical Characteristics

Raw Material grade	Unit of measure	Requirements	Test parameters	Test method
PE100	h	>100	σ=12.0 MPa T=20 °C	EN ISO 1167
	h	>165	σ =5.4 MPa T=80 °C	EN ISO 1167
	h	>1000	σ =5.0 MPa T=80 °C	EN ISO 1167
PE80	h	>100	σ =10.0 MPa T=20 °C	EN ISO 1167
	h	>165	σ =4.5 MPa T=80 °C	EN ISO 1167
	h	>1000	σ =4.0 MPa T=80 °C	EN ISO 1167

Property	Unit of measure	Requirements	Test method
Elongation at Break	%	>350	EN ISO 6259
Tensile Strength at Yield	MPa	> 19 per PE80 > 21 per PE100	EN ISO 6259
MFI	g/10'	0.2<MFI<1.2 variation <20% after production	ISO 1133
Thermal Stability (OIT) @200°C	min	>20	ISO11357-6
Longitudinal Reversion @ 110°C	%	≤ 3	EN ISO 2505
Resistance to Rapid Crack Propagation	Bar	Pc≥ 1.5MOP	EN ISO 13477
Resistance to Slow Crack Propagation - pipe size DN 110	h	80°C, 500h	EN ISO 13479

1.4. Base materials/ancillary materials

Material	
Polyethylene compound	100%
TOTAL	100%

1.5. Description of reference product (pipe)

The environmental burdens are calculated in relation to the functional unit defined as 100 m buried polyethylene pipe for the conveyance of fluids under pressure.

The reference pipe considered in the study is made of black or coloured polyethylene PE100 or PE80 (monolayer or double layer) and has a diameter of 110 mm that is the most common pipe used (as representative for the average pipe diameter from the exit of the supplying plant to the fluid meter of the building\users).

Standard dimension ratio considered is SDR 17 with wall thickness of 6,6 mm.
The service lifetime of 100 years is considered according to relevant international publication on this item (Ulrich Schulte and Joachim Hessel, 2006).

NUPI Polyethylene pipes are conforming to the principal standards as EN 12201, EN 805, EN ISO 4437 for water and EN 1555, EN 12007-2, EN ISO 4427 for natural gas and EN ISO 15494 for industrial application. CEN TS 1046, EN 12007-1 and EN 1610, can be used as installation guidelines.

The product covered by this EPD is a polyethylene pipe that, in relation to the specific application is called: ***NADIR, NADIR PLUS, NADIR GAS, NUPIGAS, NADIR PLUS GAS.***

It can be produced in a nominal diameter of 20 mm to 1000 mm and different wall thicknesses (SDR 7.4, SDR 11, SDR 17 and 26). The raw material used can be PE 100 or PE 80.

The selected reference product is representative for all the above-mentioned products and therefore the LCA results, in A1-A4 and C+D stages, considered by kilograms, do not change. The only stage that is dependent on the product pipe size (external diameter) is the installation phase (A5 module), that is a scenario.

1.6. Products Distribution and functional unit

Pipes are supplied in customised dimensions (straight lengths or coils) with appropriate packaging made of PET or PP stripes and polyethylene end caps (for gas application).

Installation

Ancillary materials (bedding and backfilling material) and electricity are used during installation. No emissions are generated during installation and piping systems installations do not cause health or environmental hazards.

The installation method considered in the study was the open trench (U-shaped) method.

The left over related to installation is 2%.

Functional unit

The functional unit is defined as 100 m buried polyethylene pipe for the conveyance of fluids under pressure.

The reference pipe considered in the study is made of black or coloured polyethylene PE100 or PE80, monolayer (solid wall) or double-layered and has a diameter of 110 mm that is the most common pipe used (as representative for the average pipe diameter from the exit of the supplying plant to the fluid meter of the building\users).

Standard dimension ratio considered is SDR 17 with wall thickness of 6,6 mm.
The service lifetime of 100 years is considered according to relevant international publication on this item (Ulrich Schulte and Joachim Hessel, 2006).

Name	Value	Unit
Reference flow	**218**	Kg/FU
Total pipe length	**100**	m
Pipe	**218**	**Kg/FU**
Conversion factor to 1 kg	**0,00459**	
Conversion factor to 1 m	**0,01**	

Dangerous materials
The product does not contain any substances included in the “Candidate List of Substances of Very High Concern for Authorization" compliant with REACH and with EC 1272/2008

Condition of use:

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 "POLIETILENETUBI" pipe (the cleaning process has not been included). According to /prEN 16903/a general scenario of zero impact for buried polyethylene pipes is considered.

Reference service life

Polyethylene pipes are regarded as having 100 years RSL independent of their material according to /prEN 16903/ and (Ulrich Schulte and Joachim Hessel, 2006).

End of life

The most representative end of life stage (C modules) of buried HDPE pipes is the "left in ground" and was considered at 100% percentage as indicated in the /prEN 16903:2021.

LCA results – Environmental impact per functional unit

The tables below show the results of the **"POLIETILENETUBI" LCA** (Life Cycle Assessment), expressed per functional unit of 100 m of a 110 mm SDR 17 pipe (Total mass 218 kg).

Additional environmental impact indicators have been calculated but are not declared according to EN 15804+A2:2019 chapter 7.2.3.2.

CORE ENVIRONMENTAL IMPACT INDICATORS												
	A1	**A2**	**A3**	**A1-A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
GWP - total [kg CO_2 eq.]	3,73E+02	3,37E+01	4,90E+01	4,56E+02	1,59E+01	1,98E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,50E+00
GWP- fossil [kg CO_2 eq.]	3,72E+02	3,35E+01	4,88E+01	4,54E+02	1,58E+01	2,03E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,47E+00
GWP - biogenic [kg CO_2 eq.]	1,16E+00	6,90E-02	1,47E-01	1,38E+00	4,83E-02	-6,70E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-2,71E-02
GWP - LULUC [kg CO_2 eq.]	2,40E-02	8,97E-02	8,67E-04	1,15E-01	9,63E-02	1,10E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-3,28E-04
ODP [kg CFC-11 eq.]	1,14E-09	2,47E-12	1,10E-10	1,25E-09	1,49E-12	2,75E-11	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-7,45E-12
AP [mol of H+ eq.]	6,90E-01	7,60E-01	1,75E-02	1,47E+00	7,56E-02	1,86E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-1,08E-02
EP - freshwater [kg P eq.]	3,82E-04	5,19E-05	7,96E-05	5,14E-04	5,14E-05	6,48E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,96E-06
EP - marine [kg N eq.]	1,89E-01	2,02E-01	7,33E-03	3,98E-01	2,05E-02	7,68E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-2,90E-03
EP - terrestrial [mol of N eq.]	2,02E+00	2,22E+00	7,98E-02	4,32E+00	2,29E-01	8,46E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-3,11E-02
POCP [kg NMVOC eq.]	8,90E-01	5,64E-01	2,22E-02	1,48E+00	5,65E-02	2,15E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-1,42E-02
ADPe [kg Sb eq.]*	5,51E-05	2,08E-06	4,50E-06	6,17E-05	1,50E-06	1,78E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-7,64E-07
ADPf [MJ]*	1,45E+04	4,19E+02	2,79E+01	1,49E+04	2,06E+02	2,80E+03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-2,22E+02
WDP [m^3 world equiv.]*	6,75E+01	1,85E-01	1,10E+01	7,87E+01	1,63E-01	3,40E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-1,09E+00

Caption: GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestrial = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator according to EN 15804+A2:2019 chapter 7.2.3.2.

LCA results – Environmental impact per functional unit - TRACI

According to UL, USA program operator, (Product Category Rules for Building-Related Products and Services- Adapted for UL Environment from the range of Environmental Product Declarations of Institute Construction in order to achieve the mutual recognition, TRACI indicators (version 2.1), from EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci, are listed below:

TRACI INDICATORS												
	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Global Warming Air, excl. biogenic carbon [kg CO2 eq.]	1,45E+01	9,68E-01	3,02E+00	1,85E+01	8,83E-01	6,48E-01	0,00E+00	7,98E-02	1,19E+00	2,83E+00	0,00E+00	-9,47E+00
Global Warming Air, incl. biogenic carbon [kg CO2 eq.]	1,44E+01	9,70E-01	2,68E+00	1,81E+01	8,83E-01	8,81E-01	0,00E+00	7,98E-02	1,19E+00	2,84E+00	0,00E+00	-9,48E+00
Acidification [kg SO2 eq.]	2,77E-02	3,68E-03	1,20E-03	3,26E-02	6,87E-03	8,39E-04	0,00E+00	1,07E-04	1,07E-03	3,08E-03	0,00E+00	-1,64E-02
Eutrophication [kg N eq.]	1,74E-03	2,23E-04	1,41E-04	2,10E-03	3,07E-04	1,12E-04	0,00E+00	9,95E-06	1,55E-04	6,57E-04	0,00E+00	-1,12E-03
Human Health Particulate Air [kg PM2.5 eq.]	1,38E-03	2,84E-04	2,03E-04	1,87E-03	6,14E-04	5,08E-05	0,00E+00	6,87E-06	4,46E-05	1,97E-04	0,00E+00	-7,33E-04
Ozone Depletion Air [kg CFC 11 eq.]	2,15E-12	1,88E-15	5,74E-13	2,73E-12	1,67E-15	1,70E-14	0,00E+00	1,63E-14	2,48E-15	1,45E-13	0,00E+00	-3,57E-13
Resources, Fossil fuels [MJ surplus energy]	7,52E+01	1,78E+00	3,95E-01	7,74E+01	1,66E+00	1,42E+00	0,00E+00	9,27E-02	2,28E+00	3,08E+00	0,00E+00	-5,22E+01
Smog Air [kg O3 eq.]	4,80E-01	7,51E-02	3,91E-02	5,94E-01	1,31E-01	1,49E-02	0,00E+00	2,01E-03	1,90E-02	4,61E-02	0,00E+00	-3,23E-01
Ecotoxicity [CTUe]	2,40E+00	8,56E-02	5,31E-02	2,54E+00	7,66E-02	6,09E-02	0,00E+00	1,45E-03	1,12E-01	1,60E-01	0,00E+00	-1,47E+00
Human toxicity, cancer [CTUh]	1,74E-08	5,86E-10	4,52E-09	2,25E-08	4,86E-10	7,77E-10	0,00E+00	2,39E-11	6,93E-10	2,41E-09	0,00E+00	-1,22E-08
Human toxicity, non-canc. [CTUh]	1,80E-06	8,44E-08	4,86E-07	2,37E-06	7,33E-08	5,36E-08	0,00E+00	2,12E-09	1,13E-07	1,56E-07	0,00E+00	-1,09E-06
Global Warming Air, excl. biogenic carbon [kg CO2 eq.]	1,45E+01	9,68E-01	3,02E+00	1,85E+01	8,83E-01	6,48E-01	0,00E+00	7,98E-02	1,19E+00	2,83E+00	0,00E+00	-9,47E+00
Global Warming Air, incl. biogenic carbon [kg CO2 eq.]	1,44E+01	9,70E-01	2,68E+00	1,81E+01	8,83E-01	8,81E-01	0,00E+00	7,98E-02	1,19E+00	2,84E+00	0,00E+00	-9,48E+00

LCA results – Resource use per functional unit

RESOURCE USE												
	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PERE [MJ]	4,91E+02	1,30E+01	7,04E+00	5,11E+02	1,31E+01	1,60E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,27E+00
PERM [MJ]	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	0,00E+00	0,00E+00	0,00E+00
PERT [MJ]	4,91E+02	1,30E+01	7,04E+00	5,11E+02	1,31E+01	1,60E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,27E+00
PENRE [MJ]	1,89E+03	4,20E+02	-3,17E+01	2,28E+03	2,07E+02	2,80E+03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-2,22E+02
PENRM [MJ]	1,27E+04	0,00E+00	5,98E+01	1,28E+04	0,00E+00	-2,08E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT [MJ]	1,46E+04	4,20E+02	2,81E+01	1,50E+04	2,07E+02	2,80E+03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-2,22E+02
SM [kg]	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	0,00E+00	0,00E+00	0,00E+00
RSF [MJ]	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	0,00E+00	0,00E+00	0,00E+00
NRSF [MJ]	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	0,00E+00	0,00E+00	0,00E+00
FW [m^3]	1,75E+00	1,54E-02	2,60E-01	2,03E+00	1,51E-02	2,12E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-2,79E-02
PERE [MJ]	4,91E+02	1,30E+01	7,04E+00	5,11E+02	1,31E+01	1,60E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,27E+00
PERM [MJ]	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	0,00E+00	0,00E+00	0,00E+00
PERT [MJ]	4,91E+02	1,30E+01	7,04E+00	5,11E+02	1,31E+01	1,60E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,27E+00

Caption: 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

LCA results – Output flows and waste categories per functional unit

WASTE CATEGORIES AND OUTPUT FLOWS												
	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
HWD [kg]	1,12E-06	1,93E-09	2,04E-06	3,16E-06	1,07E-09	2,68E-08	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-1,10E-08
NHWD [kg]	3,68E+00	5,16E-02	2,06E+00	5,79E+00	3,24E-02	2,52E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-5,66E-02
RWD [kg]	1,16E-01	6,04E-04	4,09E-03	1,21E-01	3,71E-04	7,46E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-1,47E-03
EEE [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,02E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EET [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,37E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
CRU [kg]	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	0,00E+00	0,00E+00	0,00E+00
MER [kg]	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	0,00E+00	0,00E+00	0,00E+00
MFR [kg]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,51E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

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

Biogenic carbon content of product and packaging											
	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4
Biogenic carbon content in product [kg]	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	0,00E+00	0,00E+00
Biogenic carbon content in packaging [kg]	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	0,00E+00	0,00E+00

Caption: Biog. C in packaging = Biogenic carbon content in packaging; Biog. C in product = Biogenic carbon content in product

Calculation rules

Assumptions

Where possible, a conservative approach has been adopted, overestimating burdens to prove irrelevance. In other cases, alternatives data were selected based on scientific experience, in order to improve the accuracy of the model. Where it was not possible to know the exact materials composition in the supply chain (due to commercial or industrial confidential suppliers' reasons or due to missing datasets), these have been approximated with LCIs of similar materials, estimated by the combination of available dataset or reconstructed with literature data.

1. Where potential benefits from energy recovery in A5 and C modules are considered, the grid mix of non-European countries has been considered as the European one.
2. For boilers (natural gas fed) an efficiency factor equal to 0,95 is considered.
3. Wastes coming from extraordinary maintenance activities have not been considered.
4. For mixed packaging wastes the production impact is taken into account but as it is mainly made of polyethylene, the polyethylene production is considered.
5. Auxiliaries used in installations are assumed to be sent to landfill at the end of life of the product.
6. The functional unit is defined as mass of pipes without packaging.
7. Some components produced by third party companies arrive at NUPI with their own packaging. This packaging is not accounted for in this study.

Cut off rules

EN 15804 requires that where there are data discrepancies or insufficient input data for a unit process, the cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass of this unit process. The total neglected flows from a product stage must be no more than 5% of product inputs by mass or 5% of primary energy contribution.

Only ozone emissions have been ignored as widely < 1% of the total mass.

Data quality

The data quality can be considered as good. The LCA models have been checked and most relevant flows were considered. Technological, geographical and temporal representativeness is appropriate.

Examination period

Primary data collected in the context of this study refer to 2021.

Allocation – upstream data

Information about single datasets is documented in http://database-documentation.gabi-software.com/support/gabi/.

Scenarios and additional technical information

- Module A1 refers to all raw materials impacts production with packaging included and all types of energy inputs.
- Module A2 includes the raw materials (also auxiliary's and packaging) transport to the factory gate.
- Module A3 comprises all production activities and waste treatment and process emissions (both to air and to water). Such activities refer to NUPI Industrie Italiane S.p.A. direct activities. Primary data have been used for (such as plastic extrusion for pipes production).
  No secondary raw materials (Post-consumers materials and recyclates, according to EN 14541) have been used in the POLIETILENETUBI production processes
- Module A4 takes into account the transport to the final customer/distributor. In 2021, "POLIETILENETUBI" pressure pipe was sold to Europe (96%; 88% of this, in Italy) and the remaining 4% to the rest of the world. The distribution scenario is shown below:

Means of transport	GaBi transport dataset	Weighted Average distance [km]
Truck	Truck-trailer, Euro 6, up to 28t gross weight / 12,4t payload capacity	522
Ship	Average ship, 5000-200000 dwt payload capacity/ocean going	510

- For Module A5 the following parameters (TEPPFA reference) have been taken into account:

Parameter	Parameter unit expressed per functional unit	Source
Backfilling sand	8,70 m³	/TEPPFA EPD/*
Mechanical energy	897 MJ (excavating, backfilling and vibrating)	/TEPPFA EPD/*
Soil transported away	9,66 m³	/TEPPFA EPD/*
Leftover	2%	/TEPPFA EPD/

*: The value has been recalculated taking into account a no supported trench (U-shaped) with parallel sides of 0,51m width and 1,1m (0,9+dn) deep. A 50% of suitable native soil reuse has been considered and the other 50% has been considered to be transported away.

- Module B (maintenance and operational use): Operational use and Maintenance are not relevant for the piping system. According to /prEN 16903:2021/ (used as useful reference for the functional unit and end of life scenarios) a general scenario of zero impact for buried polyethylene pipes is considered for all B modules (B1-B2-B3-B4-B5-B6-B7).
- The most representative end of life stage (C modules) of buried HDPE pipes is the "left in ground" and was considered at 100% percentage as indicated in the /prEN 16903:2021.

Module D consists of loads and benefits beyond the system boundaries.

Other additional environmental information

Emissions to indoor air:

No direct emissions at the construction site. Nupi Industrie Italiane S.p.A confirms that the “POLIETILENETUBI” pipe does not contain any substances mentioned on the REACH SVHC list.

Emissions to soil and water:

No direct emissions at the construction site. Nupi Industrie Italiane S.p.A confirms that the “POLIETILENETUBI” pipe does not contain any substances mentioned on the REACH SVHC list.

Interpretation of LCA results – Contribution Analysis

The main contribution to environmental impacts is related to the raw material production and transport to NUPI plants (61%). The second contribution is the installation phase (30%). NUPI manufacturing and distribution phase impact for the remaining 9%.

References

ISO 14040 Environmental management - Life cycle assessment - Principles and framework

ISO 14044 Environmental Management – Life Cycle Assessment – Requirements and Guidelines.

ISO 14025 Environmental labels and declarations - Type III environmental declarations - Principles and procedures.

EN 15804+A2:2019: Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products.

GaBi LCA Database Documentation: http://www.gabi-software.de/international/support/gabi/

DOCUMENTATION GaBi 10: Documentation of GaBi10-Datasets for life cycle engineering. LBP University of Stuttgart and PE INTERNATIONAL AG, 2021. http://www.gabi-software.com/international/index/

PCR ICMQ-001/15 – Prodotti da costruzione e servizi per costruzioni, Rev.3 del 02.12.2019

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prEN 16903 - Plastics piping systems - Environmental product declarations - Product Category Rules complementary to EN 15804, for buried plastics piping systems, 2021

TEPPFA EPD Polyethylene (PE) pipe system for water distribution, 2017

TEPPFA EPD Polyethylene (PE) pipe system for combustible gas distribution, 2018

EN 805, Water supply. Requirements for systems and components outside buildings

EN 1610 - Construction and testing of drains and sewers

EN 12007-1 - Gas infrastructure - Pipelines for maximum operating pressure up to and including 16 bar - Part 1: General functional requirements.

Remaining service life of plastic pipe after 41 years in service - Ulrich Schulte and Joachim Hessel, 2006.