NUPI INDUSTRIE ITALIANE S.p.A.

ENVIRONMENTAL PRODUCT DECLARATION

Product names:

PLASTIC PIPING SYSTEMS FOR HOT AND COLD WATER TYPE NIRON AND POLYSYSTEM

Site Plants:

Castel Guelfo (BO)

Busto Arsizio (VA)

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

Program Operator	EPDItaly
Publisher	EPDItaly

Declaration Number	2019PC031627
Registration Number	EPDITALY0061

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General information

EPD OWNER:	Nupi Industrie Italiane S.p.A., Via Stefano Ferrario n. 8, Z.I. Sud-Ovest - 21052 Busto Arsizio (VA) Italia
PLANT INVOLVED in the declaration:	Castel Guelfo: Via dell'Artigianato n. 13 - 40023 Castel Guelfo di Bologna (BO), Italy Busto Arsizio: Via Stefano Ferrario n. 8, Z.I. Sud-Ovest - 21052 Busto Arsizio (VA) Italy
SCOPE OF APPLICATION:	This Environmental Product Declaration (EPD) is valid for NIRON and POLYSYSTEM products. The production facilities are in Castel Guelfo (BO) and Busto Arsizio (VA). The type of declaration is related to an average product produced partly in Castel Guelfo (pipe) and partly in Busto Arsizio (fittings). 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 Programme 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 ISO 21003) from around the globe (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) 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 piping systems installation steps (like auxiliaries and water consumption) also 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 piping systems, 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 building integrated technical systems. No operational energy or water use are considered. A scenario of zero impact is then considered.*

*Module **C1** considers deconstruction, including dismantling or demolition of the product from the building. The energy consumption related to shredding activities is considered.*

*Module **C2** considers transportation of the discarded piping system to a recycling or disposal process.*

*Module **C3** considers waste processing for products recycling and incineration.*

*Module **C4** includes all waste disposal processes, including pre-treatment and management of the disposal site.*

*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 “cradle to grave” and it is an average EPD for the product NIRON and POLYSYSTEM produced in NUPI INDUSTRIE ITALIANE S.p.A. plants located in Castel Guelfo (BO) and Busto Arsizio (VA) and sold worldwide. All data refer to the 2020 production and sales.

According to the PCR ICMQ-001/15 rev. 3 the LCA study and the relative EPD, is “cradle to grave”. 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 1d (average product from different products and from more than one plant of a specific manufacturer) according to /REGOLAMENTO EPDITALY V.5/.

The production facilities are in Castel Guelfo - Bologna (IT) and Busto Arsizio - Varese (IT). The market range is Worldwide.

Geographical validity: Worldwide

Database: GaBi Database 2021.2

Software: EPD Process Creator, implemented through GaBi professional 10 and GaBi Envision 9.0 software. The identification code of the EPD process tool used is: NUPI EPD Process Tool – V.4.1 del 28/01/2022 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

Polypropylene Random Copolymer pipes produced by Nupi Industrie Italiane S.p.A. denominated NIRON and POLYSYSTEM meet the requirements of a wide range of applications.

NIRON and POLYSYSTEM allow the transport of hot, cold, sanitary, industrial, chemical and farming fluids under pressure.

They are suitable for different types of installations such as risers, connections to sanitaryware, piping for chilled water for fan convectors, connections between thermal generators and distribution manifolds, cooling towers.

Polypropylene systems can be used in several installations such as houses, large apartment buildings, hotels, hospitals, shopping malls, churches, schools, gyms, cruise and cargo ships.

PP-RCT represents the evolution of the PP-R. It presents better performance characteristics than its predecessor PP-R.

Polypropylene pipes reinforced with fiberglass (as Niron Clima, Niron FG…) are used in all applications where low thermal expansion is required. They are made up of several layers where the intermediate layer is composed of a specific PP-R or PP-RCT containing a given percentage of fiberglass.

1.2. Production processes description

PIPE EXTRUSION (Castel Guelfo)

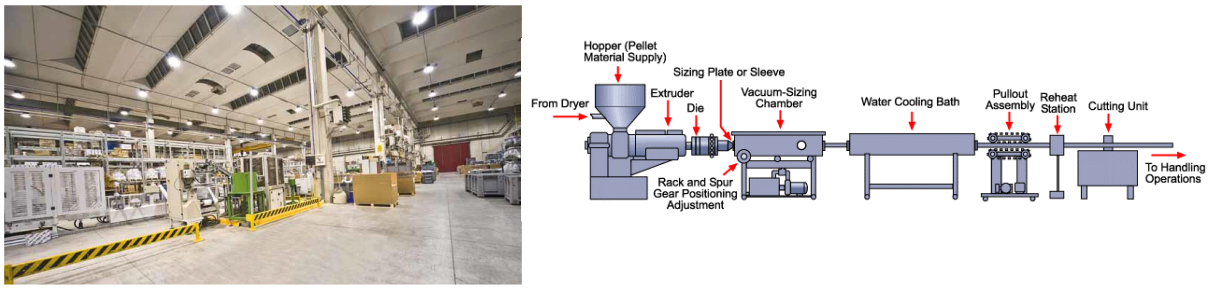


Figure 1 Pipes extrusion process

Nupi Industrie Italiane S.p.A. manufactures both solid wall (monolayer) plastic 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 plastic 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.

FITTINGS INJECTION MOULDING (Busto Arsizio)

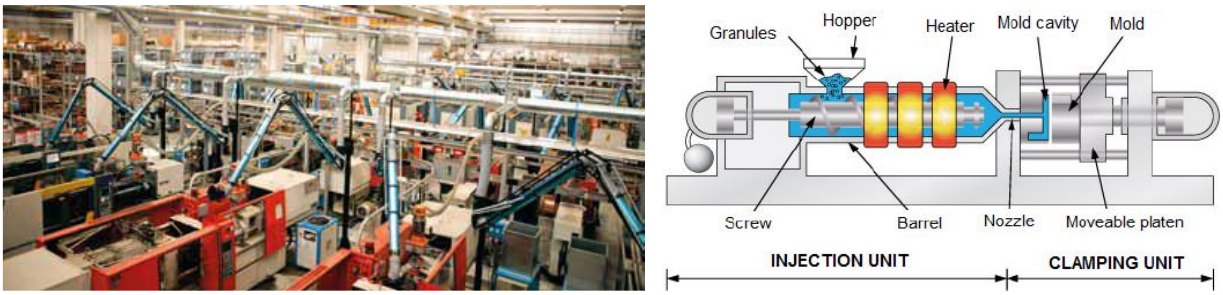


Figure 2 Fittings injection moulding process

Equipment to mould fittings consists of a mould and an injection moulding press. The mould is a split metal block that is machined to form a part shaped cavity in the block. Hollows in the part are created by core pins shaped into the part cavity. The moulded part is created by filling the cavity in the mould block through a filling port, called a gate.

The injection moulding press has two parts; a press to open and close the mould block, and an injection extruder to inject material into the mould block cavity. The injection extruder is similar to a conventional extruder except that, in addition to rotating, the extruder screw also moves lengthwise in the barrel. Injection moulding is a cyclical process. The mould block is closed and the extruder barrel is moved into contact with the mould gate. The screw is rotated and then drawn back, filling the barrel ahead of the screw with material. Screw rotation is stopped, and the screw is rammed forward, injecting molten material into the mould cavity under high pressure. The part in the mould block is cooled by water circulating through the mould block. When the part has solidified, the extruder barrel and mould core pins are retracted, the mould is opened, and the part is ejected.

NUPI Industrie Italiane S.p.A. manufactures a wide range of electrofusion fittings that incorporate a metal wire for the welding process, socket fusion, spigot and transition fittings.

1.3. Technical data

Niron&Polysystem pipes are designed to fully exploit the characteristics of the materials used to make them and offer high performance standards that allow them to be used both for plumbing and heating systems.

The table below, an excerpt from Standard EN ISO 15874, demonstrates the fields of use and the corresponding operating pressures and temperatures guaranteed for this system.

PP-R

	APPLICATION CLASSES								P_D					
	1	2	4	5	1	2	4	5			10	8	6	4
P_D	S				SDR				S	SDR	ALLOWABLE CLASSES			
4	5	5	5	3,2	11	11	11	7,4	2,5	6	1&4	2	5	5
6	5	3,2	5	3,2	11	7,4	11	7,4	3,2	7,4	2)	1&4	2	5
8	3,2	2,5	3,2	-	7,4	6	7,4	1)	5	11	2)	2)	1&4	1&2&4
10	2,5	-	2,5	-	6	1)	6	1)						

PP-RCT

	APPLICATION CLASSES								P_D					
	1	2	4	5	1	2	4	5			10	8	6	4
P_D	S				SDR				S	SDR	ALLOWABLE CLASSES			
4	8	8	8	5	17	17	17	11	3,2	7,4	1&2&4	5	5	5
6	5	5	5	4	11	11	11	9	4	9	2)	1,2,4	5	5
8	4	4	4	3,2	9	9	9	7,4	5	11	2)	2)	1&2&4	5
10	3,2	3,2	3,2	1)	7,4	7,4	7,4	1)	8	17	2)	2)	2)	1&2&4

1) Series/SDR not available in the NIRON piping range.

2) Application class not covered by this Series/SDR.

Example: A PP-RCT, SDR7,4, Series 3,2 pipe can be used in application classes 1,2 and 4 with a design pressure of 10 bar and in class 5 with a design pressure of 8 bar.

Service Conditions - Application classes as per EN ISO 15874 and ISO 10508

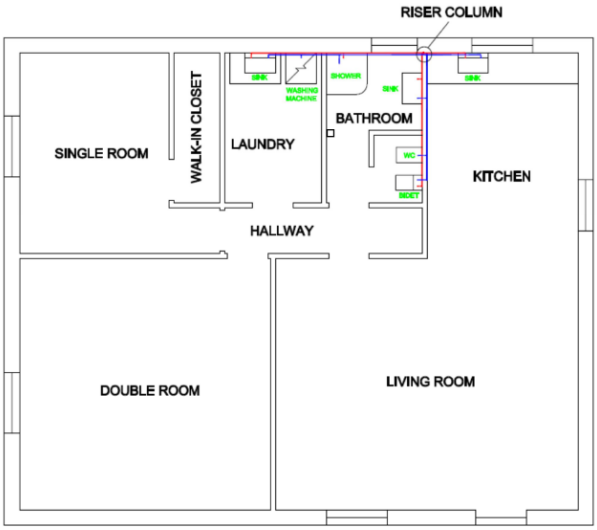
PROPERTIES	TEST METHOD	VALUES AT +23°C	UNIT OF MEASURE
Volumic mass	ISO 1183	**0,898**	g/cm^3
Yield strength	ISO 527	**23**	N/mm^2
Elongation at break	ISO 527	**> 50**	%
Modulus of elasticity	ISO 527	**850**	N/mm^2
Melt flow index MFI 190/5	ISO 1133	**0,5**	g/10 min
Heat conductivity (λ)	DIN 52612	**0,24**	W/mk
Linear thermal expansion coefficient	VDE 0304	**$1,5 \times 10^{-4}$**	K^{-1}
Melting point	DIN 53736b2	**150 - 154**	°C
Impact strength (Charpy)			
+23°C	ISO 179/1 e A	**no break**	KJ/m^2
-30°C	ISO 179/1 e A	**50**	KJ/m^2
Volumic strength	IEC 93	**$>10^{15}$**	Ω cm
Dielectric strength	IEC 243/1	**75**	KV/mm
Dielectric loss factor	DIN 53483	**$< 5 \times 10^{-4}$**	
Fire resistance	DIN 4102	**B2**	

Technical properties

1.4. Base materials/ancillary materials

Material		Piping system
Polypropylene granulate	Base	85.5 %
Glass-fibre Polypropylene	Base	5.9%
Pigments for Polypropylene	Ancillary	0.8%
Brass fittings	Fittings	7.8 %
TOTAL		100%

1.5. Description of piping system components



The environmental burdens are calculated in relation to the functional unit, which resulted for the typical PP-R/PP-RCT piping system for hot and cold water in the building in the following basic components: PP-R/PP-RCT pipes (supplied in 4 metre or longer straight lengths), PP-R/PP-RCT fittings (elbows, reducers, tees) and PP-R/PP-RCT fittings with metal (brass) insert (transition fittings).

The functional unit represents 100 m² of a typical residential single-family apartment with all the facilities clearly positioned.

The EPD is declared as the average environmental performance for NUPI families of polypropylene piping systems for hot and cold water in the building, over its reference service life cycle of 50 years (being the estimated reference life time of the apartment), in accordance with EN 806, EN ISO 15874 and CEN TR 12108.

Pipes included are PP-RCT pipe DN 20 mm and 25 mm SDR 7,4 for hot water (70°C/10 bar) and DN 20 and 25 mm PP-R SDR7,4 for cold water (20°C/10 bar) served by a riser column DN 32 SDR 11 in PP-RCT for hot water (70°C/6 bar) and in PP-R for cold water (20°C/10 bar). No other components (tap connectors, brackets/clips) have been included.

1.6. Products Distribution

Pipes and fittings are supplied to customers in customised dimensions with appropriate protection and packaging. The product packaging is made of cardboard boxes, wooden pallets and crates, plastic sheaths, stretch film and bags.

Installation

Water, fast fixing cement, wall fixing metals and electricity are used during installation. No emissions are generated during installation and piping systems installations do not cause health or environmental hazards.

Functional unit

The functional unit is defined as “The pressure supply and transport of hot and cold drinking water, from the entrance of a well-defined apartment to the tap, by means of a random copolymer polypropylene (PP-R and PP-RCT) hot & cold drinking water pipe system installation supplying a 100 m² apartment, incorporating a bathroom, a separate WC including the bidet, one kitchen and a washroom (laundry).The service life time of the pipe system has been considered to be aligned with the 50 year service life time of the apartment”.

Name		Value	Unit
Reference flow		6.88	Kg/FU
Pipes		5.17	Kg/FU
Joints		1.71	Kg/FU
	Plastic fittings	1.18	Kg/FU
	Brass inserts	0.531	Kg/FU
Conversion factor to 1 kg		0.145	
Total pipes length		22.0	m

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 with the sole exception of brass components in which Lead, with a concentration below 3% w/w, is present.

The total mass involved is 6.88 kg of which 5.17 kg of plastic pipes, 1.18 kg of plastic fittings and 0.531 kg of brass inserts.

The functional unit’s packaging includes 0.086 kg of plastic, 0.022 kg of paper/cardboard and 0.200 kg of wooden pallets.

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 NIRON and POLYSYSTEM hot & cold pipe system. According to /PrEN 16904:2021/ (used as useful reference for the functional unit and end of life scenarios) a general scenario of zero impact for plastic piping systems inside the building is considered.

Reference service life

Plastic piping systems are regarded as having 50 years RSL independent of their material according to /PrEN 16904:2021/ (used as useful reference for the functional unit and end of life scenarios).

End of life

After the demolition and deconstruction phase, piping systems are recycled as likely end of life scenario from the ones suggested by the /PrEN 16904:2021/.

LCA results – Environmental impacts per functional unit

The tables below show the results of NIRON and POLYSYSTEM piping system LCA (Life Cycle Assessment).

Additional environmental impact indicators have been calculated and included in the project report but are not declared according to /EN 15804+A2:2019/ chapter 7.2.3.2.

CORE ENVIRONMENTAL IMPACT INDICATORS										
	A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**D**
GWP - total [kg CO_2 eq.]	1.79E01	1.11E00	2.85E00	9.02E-01	1.13E00	0	8.90E-02	1.24E00	3.13E00	-1.01E01
GWP- fossil [kg CO_2 eq.]	1.79E01	1.10E00	3.16E00	8.93E-01	5.90E-01	0	8.90E-02	1.22E00	3.12E00	-1.01E01
GWP - biogenic [kg CO_2 eq.]	2.37E-02	4.98E-03	-3.06E-01	2.36E-03	5.38E-01	0	4.99E-05	3.68E-03	1.07E-02	-4.94E-02
GWP - LULUC [kg CO_2 eq.]	5.74E-03	8.06E-03	4.77E-04	5.78E-03	3.70E-04	0	1.52E-05	1.00E-02	6.86E-04	-2.38E-03
ODP [kg CFC-11 eq.]	6.07E-13	2.03E-16	4.14E-13	1.59E-16	1.50E-15	0	1.00E-15	2.43E-16	1.02E-14	-3.11E-14
AP [mol of H+ eq.]	3.97E-02	4.43E-03	1.68E-03	8.03E-03	1.10E-03	0	1.44E-04	1.24E-03	3.79E-03	-2.05E-02
EP - freshwater [kg P eq.]	1.89E-05	2.95E-06	2.15E-05	2.14E-06	5.23E-06	0	3.58E-08	3.65E-06	4.62E-05	-1.08E-05
EP - marine [kg N eq.]	8.99E-03	1.32E-03	6.44E-04	2.10E-03	2.87E-04	0	3.80E-05	3.75E-04	9.65E-04	-5.06E-03
EP - terrestrial [mol of N eq.]	9.64E-02	1.47E-02	7.06E-03	2.33E-02	2.93E-03	0	4.07E-04	4.56E-03	1.01E-02	-5.41E-02
POCP [kg NMVOC eq.]	3.78E-02	3.66E-03	3.76E-03	5.86E-03	1.10E-03	0	1.08E-04	1.05E-03	2.64E-03	-2.24E-02
ADPe [kg Sb eq.]*	2.18E-04	8.98E-08	6.84E-07	6.83E-08	7.65E-07	0	1.10E-08	1.09E-07	6.88E-07	-1.21E-06
ADPf [MJ]*	6.40E02	1.41E01	8.35E00	1.17E01	1.34E01	0	1.84E00	1.64E01	4.45E01	-3.77E02
WDP [m^3 world equiv.]*	2.99E00	9.27E-03	6.52E-01	6.84E-03	7.98E-02	0	7.12E-03	1.14E-02	4.53E-01	-1.83E00

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 impacts 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:

	A1	A2	A3	A4	A5	B1-B7	C1	C2	C3	D
Global Warming Air, excl. biogenic carbon [kg CO_2 eq.]	1.71E01	1.09E00	3.15E00	8.81E-01	7.15E-01	0	8.68E-02	1.21E00	3.05E00	-9.66E00
Global Warming Air, incl. biogenic carbon [kg CO_2 eq.]	1.70E01	1.09E00	2.83E00	8.82E-01	1.03E00	0	8.68E-02	1.21E00	3.06E00	-9.67E00
Acidification [kg SO_2 eq.]	3.47E-02	3.82E-03	1.53E-03	6.85E-03	9.98E-04	0	1.28E-04	1.06E-03	3.60E-03	-1.81E-02
Eutrophication [kg N eq.]	2.06E-03	2.27E-04	2.54E-04	2.96E-04	1.21E-04	0	1.12E-05	1.38E-04	6.97E-04	-1.14E-03
Human Health Particulate Air [kg PM2.5 eq.]	1.78E-03	2.88E-04	1.95E-04	6.13E-04	5.97E-05	0	8.29E-06	4.35E-05	2.31E-04	-8.50E-04
Ozone Depletion Air [kg CFC 11 eq.]	8.10E-13	2.71E-16	5.52E-13	2.12E-16	2.00E-15	0	1.33E-15	3.23E-16	1.35E-14	-4.15E-14
Resources, Fossil fuels [MJ surplus energy]	8.86E01	2.02E00	1.07E00	1.67E00	1.71E00	0	9.45E-02	2.34E00	3.78E00	-5.27E01
Smog Air [kg O3 eq.]	5.80E-01	7.88E-02	4.50E-02	1.31E-01	1.72E-02	0	2.35E-03	1.88E-02	5.58E-02	-3.32E-01
Ecotoxicity [CTUe]	2.80E00	9.53E-02	6.78E-02	7.62E-02	7.00E-02	0	1.64E-03	1.12E-01	1.80E-01	-1.51E00
Human toxicity, cancer [CTUh]	2.08E-08	6.84E-10	4.81E-09	5.01E-10	8.54E-10	0	2.44E-11	7.24E-10	2.50E-09	-1.25E-08
Human toxicity, non-canc. [CTUh]	2.11E-06	8.97E-08	5.29E-07	6.97E-08	6.05E-08	0	2.27E-09	1.08E-07	1.68E-07	-1.12E-06

LCA results – Resource use per functional unit

RESOURCE USE										
	A1	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**D**
PERE [MJ]	2.84E01	7.59E-01	-7.76E-01	5.49E-01	1.08E00	0	1.90E-01	9.42E-01	6.06E00	-9.97E00
PERM [MJ]	0	0	3.65E00	0	-4.61E-01	0	0	0	0	0
PERT [MJ]	2.84E01	7.59E-01	2.88E00	5.49E-01	6.16E-01	0	1.90E-01	9.42E-01	6.06E00	-9.97E00
PENRE [MJ]	2.65E02	1.42E01	4.14E00	1.17E01	1.45E01	0	1.84E00	1.64E01	4.45E01	-3.77E02
PENRM [MJ]	3.75E02	0	4.22E00	0	-1.03E00	0	0	0	0	0
PENRT [MJ]	6.41E02	1.42E01	8.36E00	1.17E01	1.34E01	0	1.84E00	1.64E01	4.45E01	-3.77E02
SM [kg]	5.09E-01	0	7.26E-02	0	5.25E-03	0	0	0	0	0
RSF [MJ]	0	0	0	0	0	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0	0	0	0	0	0
FW [m³]	8.02E-02	8.71E-04	1.65E-02	6.33E-04	2.37E-03	0	4.15E-04	1.08E-03	1.36E-02	-4.91E-02

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**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**D**
HWD [kg]	1.46E-07	7.02E-10	1.63E-08	5.15E-10	2.79E-09	0	2.22E-10	8.66E-10	3.74E-09	-7.02E-08
NHWD [kg]	2.32E-01	2.17E-03	1.47E00	1.71E-03	1.77E-01	0	3.46E-04	2.58E-03	8.51E-01	-6.80E-02
RWD [kg]	6.08E-03	2.50E-05	1.12E-04	1.97E-05	2.16E-04	0	2.98E-04	2.98E-05	2.96E-03	-3.33E-03
EEE [MJ]	0	0	0	0	3.00E-01	0	0	0	0	0
EET [MJ]	0	0	0	0	3.95E-01	0	0	0	0	0
CRU [kg]	0	0	0	0	0	0	0	0	0	0
MER [kg]	0	0	0	0	0	0	0	0	0	0
MFR [kg]	0	0	0	0	1.83E-01	0	0	0	7.21E00	0

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Caption: 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

LCA results – Biogenic carbon content of product and packaging per functional unit

Biogenic carbon content of product and packaging

	A1	A2	A3	A4	A5	B1-B7	C1	C2	C3	D
Biogenic carbon content in product [kg]	0	0	0	0	0	0	0	0	0	0
Biogenic carbon content in packaging [kg]	0	0	0.08	0	0	0	0	0	0	0

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

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. For brass recycling the steel billet recycling process has been used as conservative choice (melting temperature for recycling brass is higher than for steel)
2. Lead batteries have been taken into account as a conservative choice
3. Where potential benefits from energy recovery in A5 and C modules are considered, for rest of world countries (other than Europe) these are calculated based on the European grid mix
4. An average packaging (considering also other type of products different from the one under study) is considered as also average from the 3 plants involved
5. Wastes deriving from extraordinary maintenance activities have not been considered
6. For mixed packaging waste the production impact is taken into account, but as it is mainly made of polyethylene, the polyethylene production is considered
7. Auxiliaries used in installation are sent to landfill at the end of life of the product
8. The functional unit is defined as mass of pipes and fittings (pipe system) without packaging
9. Some components produced by third party companies come to NUPI with their own packaging. This packaging is not accounted for in this study
10. In case of transports on truck where the payload was neither available nor conceivable, a utilization factor of 0.53 has been considered (empty way back.
11. Internal transports between production sites have not been considered
12. For gaskets made of alloys and/or paper, a recycling scenario has not been considered, but only incineration and landfill scenarios
13. A European scenario has been considered for end of life scenarios.

Cut off rules

EN 15804+A2:2019 requires that if 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 nylon strips for some fitting packaging and 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 2020.

Allocation – upstream data

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

- 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, plastic injection moulding for fittings production) and processes not directly carried out by NUPI Industrie Italiane S.p.A such as the brass inserts production but included in the study as requested in the functional unit. (secondary data have been used in this case).
- Module A4 takes into account the transport to the final customer/distributor. In 2020, NIRON and POLYSYSTEM piping system was sold to Europe (64.71%), to USA (15.56%) and to the rest of the world (19.73%). 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	791.10
Ship	Average ship, 27500 dwt payload capacity/ ocean going	1'907.74

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

Parameter	Parameter unit expressed per functional unit	Source
Water for the commissioning test	3 liters	/TEPPFA EPD /
Fast fixing cement	0.04 kg (ratio water/cement 0,3) of which 0.028 kg cement and 0.012 kg water	/TEPPFA EPD /
Wall fixing metals	0.03 kg (galvanized steel)	/TEPPFA EPD /
Electrical energy	0.01 kWh for the installation (screw driver)	/TEPPFA EPD /
Leftover	We took an average value of 2%[<1% from (Teppfa, 2018) and 3% from (VITO, 2013)].	sphera assumption

Moreover, following leftover end of life scenarios have been included:

	Mechanical recycling	Source
Leftover	100 %	/TEPPFA EPD /
Distance to treatment	600 km	/TEPPFA EPD /

- Module B (maintenance and operational use): Operational use and Maintenance are not relevant for the piping system. According to /PrEN 16904:2021/ (used as useful reference for the functional unit and end of life scenarios) a general scenario of zero impact for plastic piping systems inside the building is considered for all B modules (B1-B2-B3-B4-B5-B6-B7).
- Module C1 (Deconstruction / demolition) has been included and deconstruction impacts have been considered.
- Module C2, C3 (recycling and incineration with energy recovery) and C4 (landfilling) consider the end of life scenarios of the product, considering all components of the piping system. The percentages to the given scenarios have been suggested by the /TEPPFA EPD / and /PrEN 16904:2021/ (used as useful reference for the functional unit and end of life scenarios) as shown below:

Material	EoL treatment - /FprEN 16904/	Distances to treatment [C2] / TEPPFA EPD /
Piping systems	100 % recycling	600 km to recycling
Brass inserts	100% recycling	600 km to recycling

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

Other additional environmental information

Emissions to indoor air:

No direct emissions at the building site. Nupi Industrie Italiane S.p.A confirms that the MULTINUPI piping system does not contain any substances mentioned on the REACH-list, with the sole exception of brass components in which Lead, with a concentration below 3% w/w, is present.

Emissions to soil and water:

No direct emissions at the building site. Nupi Industrie Italiane S.p.A confirms that MULTINUPI piping system does not contain any substances mentioned on the REACH-list, with the sole exception of brass components in which Lead, with a concentration below 3% w/w, is present.

References

ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework

ISO 14044:2006 Environmental Management – Life Cycle Assessment – Requirements and Guidelines.

ISO 14025:2011-10, 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. Retrieved from Sphera: http://www.gabi-software.com/international/databases/gabi-databases/

PCR ICMQ-001/15 – Prodotti da costruzione e servizi per costruzioni, Rev.3 del 02.12.2019. GABI 10 2021

REGOLAMENTO EPDITALY V.5 Regolamento del Programma EPDItaly. Data di emissione: 01/07/2020

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/

PrEN 16904:2021 – Plastics piping systems - Environmental product declarations - Product Category rules complementary to EN 15804, for plastic piping systems inside buildings

REACH Registration, Evaluation, Authorization and Restriction of Chemicals

CEN/TR 12108- Plastics piping systems - Guidance for the installation inside buildings of pressure piping systems for hot and cold water intended for human consumption, 2012

EN 806-1, Specifications for installations inside buildings conveying water for human consumption. Part 1: General, 2000

EN 806-2, Specification for installations inside buildings conveying water for human consumption. Part 2: Design, 2005

EN 806-3, Specifications for installations inside buildings conveying water for human consumption. Part 3: Pipe sizing. Simplified method, 2006

EN ISO 15874-1, Plastics piping systems for hot and cold water installations. Polypropylene (PP). Part 1: General, 2013

EN ISO 15874-2, Plastics piping systems for hot and cold water installations. Polypropylene (PP). Part 2: Pipes, 2013

EN ISO 15874-3, Plastics piping systems for hot and cold water installations. Polypropylene (PP). Part 3: Fittings In compliance with European Construction Products Directive (89/106/EEC), 2013

TEPPFA EPD Polypropylene random copolymer (PP-R) pipe system for hot and cold water in the building, 2018

ASTM F 2389 - Standard Specifications For Pressure-Rated Polypropylene (PP) Piping Systems, 2017

DIN 8078 - Polypropylene (PP) pipes - PP-H, PP-B, PP-R, PP-RCT - General quality requirements and testing, 2008