ENVIRONMENTAL PRODUCT DECLARATION

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

Owner of the Declaration	vonRoll hydro (deutschland) gmbh & co. kg
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-VRL-20230045-IBC1-EN
Issue date	31.10.2023
Valid to	30.10.2028

Ductile iron pipes

vonRoll production (deutschland) Gmbh & Co. KG

Institut Bauen und Umwelt e.V.

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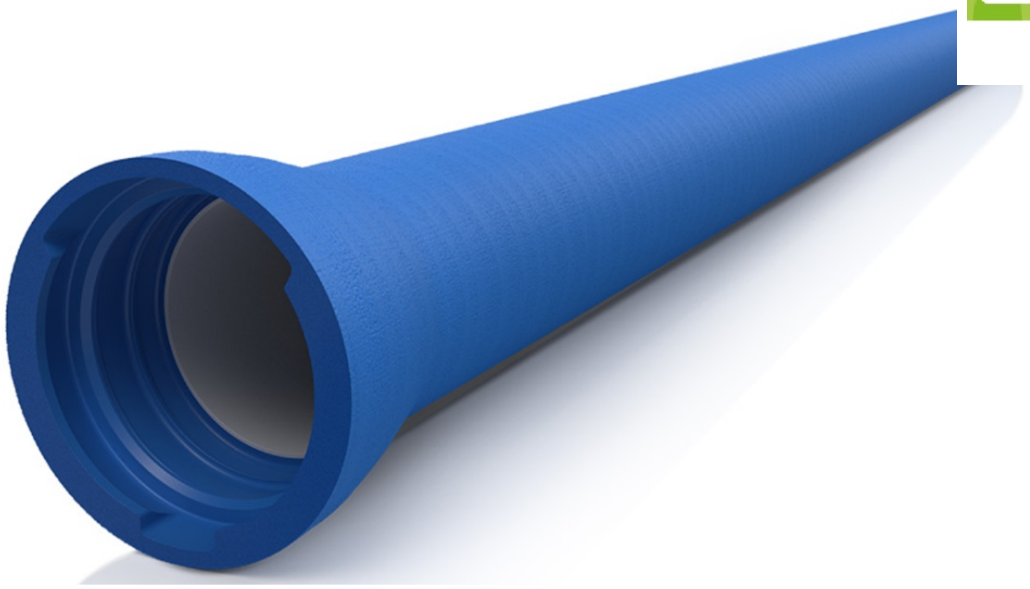

1. General Information

vonRoll production (deutschland) Gmbh & Co. KG

Ductile iron pipes

Programme holder

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

Owner of the declaration

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Germany

Declaration number

EPD-VRL-20230045-IBC1-EN

Declared product / declared unit

1 t Ductile cast iron pipes

This declaration is based on the product category rules:

Steel pipes for pressure applications, 06.10.2022
(PCR checked and approved by the SVR)

Scope:

This document refers to an average EPD of 1 ton of ductile iron cast pipes manufactured at the production site of vonRoll production (deutschland) GmbH & Co KG in Wetzlar (Germany). The declared unit is 1 ton of cast iron pipe of an average product. The data collection was plant-specific with current annual data from 2020/2021. The declaration holder is responsible for the underlying data and its verification.
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*.

Issue date

31.10.2023

Valid to

30.10.2028

Verification

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

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

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

Christina Bocher,
(Independent verifier)

2. Product

2.1 Product description/Product definition

Ductile cast iron is a tough iron-carbon material whose carbon content is predominantly present in free form as graphite. It differs from gray cast iron mainly in the shape of the graphite particles. In ductile cast iron, the stress lines flow around the graphite precipitated in spherical form almost undisturbed. For this reason ductile cast iron can be deformed under load. Ductile cast iron pipes and fittings are statically considered as flexible pipes.

The VONROLL Group produces ductile cast iron pipes in dimensions DN 80 to DN 1000 according to DIN standards *EN 545* (drinking water) and *EN 598* (waste water).

The ductile iron pipes and fittings with restrained BLS push-in joints are available in nominal joints in nominal sizes DN 80 to DN 400 also have an FM approval.
This means that these pipes and fittings can be used for be used for fire extinguishing systems with this requirement profile.

The fittings are coated on the inside and outside with an epoxy resin cover coating in accordance with *EN 14 901*. This coating also meets the stringent requirements of the "Gütegemeinschaft Schwerer Korrosionsschutz" (GSK). This means that our fittings can be installed in soil of any corrosiveness in accordance with *EN 545*.

The existing DVGW approval guarantees a high quality standard of the fittings.
For the use and application of the product the respective national provisions at the place of use apply, in Germany for example the building codes of the federal states and the corresponding national specifications. The verification of the mechanical material properties
is carried out with the test methods o*f DIN EN 545:2011*, sections 6.3 and 6.4.

2.2 Application

Ductile iron pipe systems are used for drinking water and wastewater transport in the municipal sector, as well as in applications such as technical snowmaking, small hydropower plant pipelines and fire extinguishing pipelines.

2.3 Technical Data

The following table shows the properties relevant for the product. The data correspond to *EN 545* or *EN 598*.

Construction data

Name	Value	Unit
Compressive strength	700	MPa
E-Module	170	MPa
Bursting strength	300	MPa
Apex pressure resistance	550	MPa
Longitudinal bending stiffness	420	MPa
Swing width	135	MPa
Average coefficient of thermal expansion	10x10^-6	W/cmK
Thermal conductivity	0,42	W/cmK
Specific heat	0,55	J/gK

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).
The verification of the mechanical
material properties is carried out using the test methods of *EN 545*, sections 6.3 and 6.4.

2.4 Delivery status

The pipes are delivered from DN 80 to DN 350 in bundles or from DN 400 loose on specific wooden beams.

2.5 Base materials/Ancillary materials

Raw materials	Value	Unit	%
Iron scrap (external purchase)	59,829,075.00	kg	80.78
iron scrap (intern. production quarry)	3,717,408.00	kg	5.02
SIC-form 35	5,104,680.00	kg	6.89
Lime	4,752,500.00	kg	6.42
Pure magnesium	117,000.00	kg	0.16
Ferro-Mangan Carbure for ZSA	31,160.00	kg	0.04
FESI 75%	362,200.00	kg	0.49
CU-waste material	16,633.00	kg	0.02
Cocilla powder	133,000.00	kg	0.18
	74,063,656.00	kg	100.00

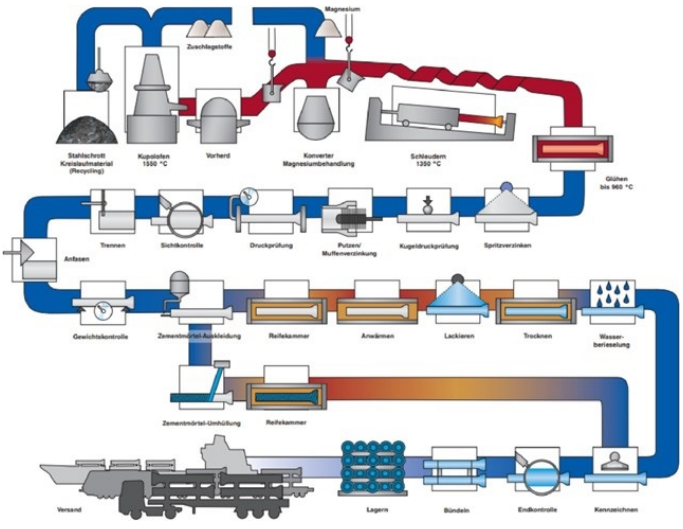
1) This product/article/at least one partial article contains substances listed in the candidate list (date: 14.06.2023) exceeding 0.1 percentage by mass: no

2) This product/article/at least one partial article contains other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: no

3) Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): no

2.6 Manufacture

The following figure shows the production steps for the manufacture of the cast iron pipes.



After the provision of all basic materials, including ferrous scrap, which is procured pre-sorted from the region, the transport of all required basic materials and additives to the

plant site for intermediate storage and processing takes place.

The metal scrap mixture (100% secondary raw materials, divided into own and external scrap) including the additives (coke, magnesium, lime, etc.) is transported in silos by elevator to the cupola furnace and gas cleaning takes place at the top of the furnace ring. The combustion gases are recycled in the recuperator plant as a heating wind for the combustion of coke (in the furnace). The liquid iron flows into a pressure siphon to separate the slag from the cast iron; as a result, the slag flows off and the liquid iron enters the pressure siphon (inductive storage vessel). Magnesium is added to the iron in the converter (magnesium treatment).Treatment of the molten iron with magnesium causes the carbon to crystallize in a largely spherical form during solidification. This results in a considerable increase in strength and ductility compared with gray iron. These so-called spherulites have only an insignificant effect on the properties of the basic metallic structure.

Ingot molds are filled with liquid iron in a centrifugal casting process; the sand core closes the mold (so that the liquid material does not flow out during centrifuging) and forms the socket contour. Water is used to cool the ingot mold. The pipes are then annealed in a natural gas-fired furnace; the material structure becomes ductile. Corrosion protection is applied by spray galvanizing (zinc fog/zinc plasma). The cooled tube is subsequently subjected to quality control (water filling), measured and, if necessary, cut to size (resulting waste is used by a recycling company and reintroduced directly through the plant's internal circuit, closed-loop). Further, the inside of the pipe is lined with potable water and cement mortar using the rotary spinning process (cement mortar lining, ZMA as corrosion protection and prevention of incrustation and water contamination), cured in curing chambers (heat recovery from production takes place here) and finally the pipe surface is painted. The finished cast iron pipes are loaded onto pallets, packed and the transport takes place in cooperation with a logistics partner. To protect the pipes from contamination, a plastic cover is used, nail timbers are used as friction protection, a plastic band is used to bundle the pipes, and paper and wood fiber are used to protect the pipes from strapping.
vonRoll hydro cast iron pipes are produced in 12 process steps (raw material delivery, silos, cupola furnace, converter, casting, annealing, spray galvanizing, quality control, ZMA, curing, painting, packaging and in-plant handling).

The following quality management systems are applied.
ISO 9001
ISO 50001
ISO 14001

2.7 Environment and health during manufacturing

During the entire manufacturing process no occupational health and safety measures beyond those usually required by law for commercial enterprises are necessary for health protection.

Nevertheless, company paramedics (in addition to required first aiders) are deployed in the production area.

The following certifications are available as standard.
ISO 9001 (quality management) *ISO 50001* (energy management)

2.8 Product processing/Installation

Production in the respective individual steps is carried out by trained personnel, who also receive regular further training. Workplace instructions are available. The proper installation of ductile iron pipes with a with a vonRoll socket joint is described in the technical catalog of the vonRoll Group. Ductile iron pipe systems are generally always installed in previously excavated pipe trenches.

Unloading and storage of pipes and pipe bundles Pipes are delivered bundled as pipe bundles. For the and unloading of pipes and pipe bundles by crane, belts are to be used. If individual pipes are unloaded with with crane hooks, this must be done with wide and and padded hooks, which are hooked onto the head ends, as ends, otherwise there is a risk of damage to the pipe and its coating.

Opening of tube bundles
Pipe bundles are bundled with steel or plastic straps. The bands may only be opened with suitable tools, such as plate shears or a side cutter. Chisels, crowbars, picks or similar tools can damage the outer damage the outer coating of the pipe and also pose an increased risk of accidents. Before cutting the steel strips are cut, it must be ensured that: - the stack of pipes is placed on a level, non-sloping and stable surface, and load-bearing base, - the pipes are secured against rolling and sliding, - no one is standing in front of or on the stack of pipes.

Installation
The pipes and fittings must be installed in accordance with the installation instructions.

Pipe trench and pipe bedding
The pipe trench is to be constructed in accordance with the technical regulations. The following must be observed: *EN 805, EN 1610, DIN 18 300, DIN 4124, DIN 50 929 Part 3, DIN 30 675 Part 2, DVGW Worksheets W 400-2 and GW 9*, ATV DVWK Code of Practice A 139 and the Code of Practice for the backfilling of pipe trenches.

Cleaning
The areas marked with an arrow on the seal seat, groove, retaining chamber and the bolts are to be cleaned and remove any accumulations of paint.

Position of the socket windows in the pipe trench
For insertion of the bolts or screwing of the clamping ring the position of the socket windows is recommended. In the case of their position is determined by the installation situation.

Inserting the gasket
For easier insertion and installation, it is recommended to apply inserting the seal, it is advisable to apply a little lubricant to the sealing chamber before inserting the gasket. To do this, carefully and thinly coat the rastered sealing surface with the lubricant the pipe manufacturer's lubricant carefully and thinly supplied by the pipe manufacturer. Note: No lubricant may get into the retaining groove (narrow chamber)!

Installing the insertion end in the pipe socket
Apply a thin coat of lubricant to the cleaned insertion end - especially at the chamfers - with a thin layer of lubricant and then pull or push it in as far as the bottom of the socket (stop). The pipes must not be bent when pulling in or inserting the locks.

Locking
Push the pipe out of the socket until the bolts or the clamping ring are in the chamber or press it out of the socket, e.g. with an assembly device.

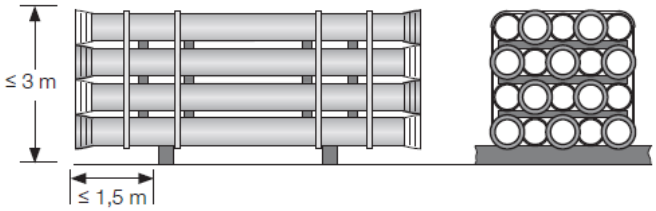
Backfilling the pipe trench
The pipes must be bedded in accordance with *EN 805 or DVGW Code of Practice W 400-2*. A sand coating or with foreign material is only necessary in special cases. In the area of traffic areas, the code of practice for backfilling of pipeline

trenches (Forschungsgesellschaft für das Straßen- und Verkehrswesen e. V., Cologne) must be observed.

Pressure test before commissioning
For the performance of pressure tests of pressure lines *EN 805 and DVGW Worksheet W 400-2* are applicable. During the pressure test, all work on the pipes must be stopped. Particularly in the case of pressure lines, sufficient safety distance must be maintained.

2.9 Packaging

Pipes up to DN 350 are delivered bundled between bundling timbers as pipe bundles, above that as individual pipes.The finished cast pipes are loaded onto pallets, packed and the transport effort takes place in cooperation with a logistics partner. To protect the pipes from contamination, a plastic cover, nail timbers as friction protection, a plastic band to bundle the pipes and paper and wood fiber to protect the pipes from strapping are used.



The pipe bundles are bundled with steel or plastic straps.

2.10 Condition of use

The material composition of the ductile iron pipes of the VONROLL Group does not change during the service life.The very good corrosion coatings and very high wall thicknesses in conjunction with the corrosion-inhibiting internal cementing allow very long service lives.

2.11 Environment and health during use

No health or environmental hazards are caused by processing/installation of the products mentioned.
The products are certified according to
EN 545
W 270
W 347.

The long service life of up to at least 50 years allows long-term use of the above-mentioned products. After their service life, they can be returned to the service cycle and cast as new pipes.
The products of VONROLL HYDRO (deutschland) gmbh & co kg for drinking water supply are certified by DVGW. The basis for this certification is the Technical Test Specification of the DVGW according to *GW337*. All materials used by us for the production, which come in later contact with drinking water, such as the lubricant, the seal and the cement mortar lining, have been tested in accordance with the corresponding DVGW guidelines or have KTW approval.

This means that any negative impact on drinking water quality by our products can be ruled out. Both the manufacturing and the factory production control of our products are subject to regular external inspections.

2.12 Reference service life

The reference useful life could not be determined according to *ISO 15686.*
The service life according to the BBSR table is over 50 years.

However, a metallic material, such as ductile cast iron, retains its mechanical properties throughout its service life, which is at least 50 years if installed correctly and under the right soil conditions.Ductile iron pipes are therefore resilient and safe even after decades of use.

2.13 Extraordinary effects

Fire

Pipes from DN 80 to DN 350 have FM Approval and are thus used specifically in fire-fighting pipelines in railroad, subway and highway tunnels, as well as in industrial applications. This certification is recognized by the world's leading regulatory authorities.

Fire protection

Name	Value
Building material class	A

Water

No ingredients hazardous to water are washed out.
Ductile iron pipelines with the BLS restrained socket system remain stable even under high forces and thus sometimes guarantee the drinking water supply for residents.

Mechanical destruction

In the case of mechanical destruction, all substances remain in a bound state. There are no relevant environmental impacts associated with mechanical destruction.

2.14 Re-use phase

After the re-use phase, the ductile iron pipes can be recycled and sent for remelting.

2.15 Disposal

The waste codes are according to the Waste Catalogue Ordinance (Abfall Verzeichnis Verordnung *AVV*) and European Waste Catalogue *(EWC*):

- 17 04 05 - Iron and steel

2.16 Further information

Further information and downloads are available on www.vonroll-hydro.world

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is 1 t of average ductile cast iron pipe.
The average proportion of cement mortar or sand core in the declared unit is about 16.7% (inner shell) and 0.6% (outer shell). The remaining share of 82.5% is attributable to the cast iron shell used.

Declared unit

Name	Value	Unit
Declared unit	1	t
Conversion factor	0,02	t/m
Raw density	7,1	t/m³

3.2 System boundary

The LCA considers the system boundaries "cradle to factory gate - with options" and follows the modular structure according to *EN 15804*. The LCA considers the following modules:The

LCA takes into account the following modules:

- A1: Raw material supply: extraction of raw material, production of precursors, processing of secondary material (100% metal scrap mix).
- A2: Transport: transport of raw materials to manufacturing plant in Wetzlar, Germany
- A3: Manufacturing: Production of cast iron pipes in the manufacturing plant
- C1: Deconstruction/demolition
- C2: Transportation towards disposal
- C3: Waste processing: Waste management for reuse, recovery and/or recycling
- C4: Disposal of all non-metallic product components such as cement mortar coating and sand core to landfills
- D: Reuse, recovery or recycling potential as net flows and credits or debits.

3.3 Estimates and assumptions

Plant-specific and data regarding the production process was provided by vonRoll hydro. Missing data was supplemented by estimates based on comparable substitutes or data used from the secondary literature. Missing data set were modeled by the auditor.

3.4 Cut-off criteria

All relevant data, i.e. all applied materials according to the recipe and the energy used originate from the production data acquisition and have been considered within the inventory analysis. The actual transport distances were used for the inputs and outputs taken into account. Material- and energyflows with a proportion of less than 1 % were collected. It can be assumed, that the sum of the neglected processes does not exceed 5 % of the impact categories. Provision of the infrastructure (machines, buildings, etc.) of the entire foreground system were not taken into account. The packaging of the primary products and the final product are not included.

3.5 Background data

The starting point for the LCA is a plant-specific data collection including all energy sources and operating resources for one year (observation period July 2020 to July 2021). Background data for the modeling as well as missing inventories of intermediate products are based on the LCIA database *ecoinvent 3.8*. The modeling and impact assessment is carried out using the software *SimaPro* (version 9.4.0.1). Background datasets used throughout are for the year ending 2021.

3.6 Data quality

The foreground data refers to the fiscal year July 2020 to July 2021. The data collected were based on representativeness in relation to previous years.
Data sets for background data are based on the database *ecoinvent 3.8*. Missing specific data of intermediate products (such as iron scrap (intern. production breakage, closed-loop DE)) were calculated based on generic datasets from *ecoinvent 3.8* under consideration of country-specific conditions.

3.7 Period under review

The amount of raw materials, input energy and the volume of waste relate to the year 2020/21. It corresponds to the best currently available technology and thus is representative for the considered time period.

3.8 Geographic Representativeness

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

3.9 Allocation

All energy consumption and material flows for the product could be allocated on the basis of measured production data or on a mass basis. Within production, natural gas-fired CHP units are used to produce electricity for own use and district heating for export. For the share of natural gas for captive power production, an energetic co-product allocation was performed based on the efficiency of the CHP and the exergy and the final values were considered in the model.

Due to the use of 100% secondary metals (scrap) in production, the cut-off approach was used in the end-of-life calculations, whereby no credits can be given for avoided loads in other product systems (system space expansion) at the end of life for the proportion of secondary materials introduced in production (inputs). Together with a recycling rate of 95%, this results in a negative net flow for steel scrap in the end-of-life; due to this, additional loads result in module D for the compensation of lost secondary material in the previous product system.

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. Es wurde die Hintergrunddatenbank *ecoinvent 3.8* verwendet.

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The product contains less than 5% biogenic carbon as a proportion of the total mass of the product, which is why it is not stated in this EPD.

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment.

The reference life span according to *ISO 15686* could not be determined. The information on service life is taken from Table *BBSR* 2017, Service life of components for - Life cycle analyses according to the Sustainable Building Assessment System (Bewertungssystem Nachhaltiges Bauen BNB).

Reference service life

Name	Value	Unit
Reference service life (according to ISO 15686-1, -2, -7 and -8)	-	a
Life Span (according to BBSR)	> 50	a

End-of-Life (C1-C4)

Name	Value	Unit
Collected separately waste type Secondary metals (C1)	835.81	kg
Recycling 95 %	790.21	kg
Landfilling as recycling loss 5 %	41.59	kg

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

Name	Value	Unit
Net amount of metal scrap	41,59	kg

5. LCA: Results

The table displayed below summarizes the results of the Life Cycle Assessment (LCA). The results of the impact assessment do not provide any information on endpoints of the impact categories, exceedances of thresholds, safety margins or risks. The results refer to the declared unit of 1 t Ductile cast iron pipes. Long-term emissions >100 years are not considered in the impact assessment. The impact assessment is based on *EN 15804, SimaPro.*

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	MND	MND	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 Ductile iron pipes

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Global Warming Potential total (GWP-total)	kg CO_2 eq	1.39E+03	1.42E+01	5.42E+02	2.15E-02	9.19E-01	1.38E-01
Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq	1.37E+03	1.42E+01	5.41E+02	2.15E-02	9.17E-01	1.39E-01
Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq	1.93E+01	7.41E-03	5.51E-01	2.33E-05	9.96E-04	-6.9E-04
Global Warming Potential luluc (GWP-luluc)	kg CO_2 eq	1.25E+00	1.77E-03	1.95E-01	2.03E-05	8.66E-04	2.12E-04
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	9.6E-05	3.02E-06	1.29E-04	8.69E-09	3.71E-07	2.19E-08
Acidification potential of land and water (AP)	mol H^+ eq	7.81E+00	1.44E-01	2.26E+00	2.02E-04	8.63E-03	1.42E-03
Eutrophication potential aquatic freshwater (EP-freshwater)	kg P eq	6.93E-01	6.83E-04	3.37E-02	1.97E-06	8.4E-05	6.74E-05
Eutrophication potential aquatic marine (EP-marine)	kg N eq	9.8E-01	6.31E-02	6.89E-01	7.02E-05	3E-03	3.53E-04
Eutrophication potential terrestrial (EP-terrestrial)	mol N eq	9.72E+00	6.91E-01	7.53E+00	7.69E-04	3.28E-02	3.93E-03
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg NMVOC eq	5.66E+00	1.9E-01	2.42E+00	2.24E-04	9.55E-03	1.09E-03
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb eq	1.5E-02	1.02E-05	1.24E-03	4.9E-08	2.09E-06	1.21E-05
Abiotic depletion potential for fossil resources (ADPF)	MJ	1.66E+04	1.94E+02	8.43E+03	6E-01	2.56E+01	1.97E+00
Water use (WDP)	m^3 world eq deprived	1.32E+02	4.09E-01	2.9E+01	2.7E-02	1.15E+00	2.05E-02

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 t Ductile iron pipes

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Renewable primary energy as energy carrier (PERE)	MJ	1.48E+03	0	0	1.61E+00	1.07E+02	5.12E-03
Renewable primary energy resources as material utilization (PERM)	MJ	0	0	0	0	0	0
Total use of renewable primary energy resources (PERT)	MJ	1.48E+03	0	0	1.61E+00	1.07E+02	5.12E-03
Non renewable primary energy as energy carrier (PENRE)	MJ	1.91E+04	0	0	2.06E+02	8.96E+03	6.38E-01
Non renewable primary energy as material utilization (PENRM)	MJ	0	0	0	0	0	0
Total use of non renewable primary energy resources (PENRT)	MJ	1.91E+04	0	0	2.06E+02	8.96E+03	6.38E-01
Use of secondary material (SM)	kg	7.2E-01	0	0	0	0	6.9E-01
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0	0	0
Use of non renewable secondary fuels (NRSF)	MJ	0	0	0	0	0	0
Use of net fresh water (FW)	m^3	7.54E+00	1.38E-02	1E+00	6.43E-04	2.75E-02	8.28E-04

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 t Ductile iron pipes

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	7.21E-02	5.34E-04	2.04E-02	9.07E-07	3.87E-05	5.46E-06
Non hazardous waste disposed (NHWD)	kg	0	0	0	0	0	0
Radioactive waste disposed (RWD)	kg	7.39E-02	1.29E-03	5.71E-02	3.93E-06	1.68E-04	1.21E-05
Components for re-use (CRU)	kg	0	0	0	0	0	0
Materials for recycling (MFR)	kg	0	0	0	8.36E+03	0	0
Materials for energy recovery (MER)	kg	0	0	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0	0	0
Exported thermal energy (EET)	MJ	0	0	0	0	0	0

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 t Ductile iron pipes

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Incidence of disease due to PM emissions (PM)	Disease incidence	1.38E-04	3.83E-06	6.36E-05	4.07E-09	1.74E-07	2.02E-08

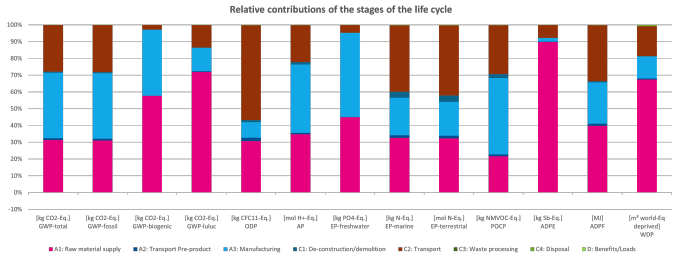
Human exposure efficiency relative to U235 (IR)	kBq U235 eq	1.91E+02	8.88E-01	4.27E+01	2.67E-03	1.14E-01	1.75E-02
Comparative toxic unit for ecosystems (ETP-fw)	CTUe	3.46E+04	1.25E+02	6.59E+03	3.79E-01	1.62E+01	5.66E+00
Comparative toxic unit for humans (carcinogenic) (HTP-c)	CTUh	4.8E-06	7.19E-09	1.82E-07	9.62E-12	4.11E-10	1.93E-10
Comparative toxic unit for humans (noncarcinogenic) (HTP-nc)	CTUh	4.56E-05	9.2E-08	7.21E-06	2.49E-10	1.06E-08	8.11E-09
Soil quality index (SQP)	SQP	4.4E+03	2.59E+01	9.65E+03	1.26E+00	5.38E+01	3.08E+00

Disclaimer 1 – for the indicator “Potential Human exposure efficiency relative to U235”. This impact category deals mainly with the eventual impact of low-dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure or radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, radon and from some construction materials is also not measured by this indicator.

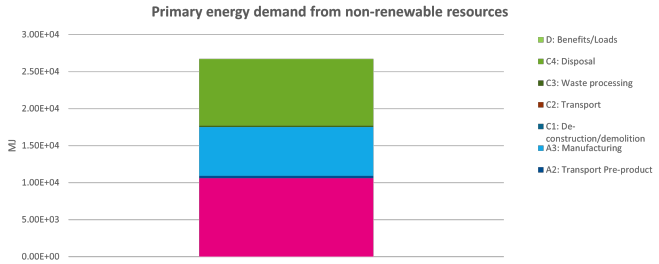
Disclaimer 2 – for the indicators “abiotic depletion potential for non-fossil resources”, “abiotic depletion potential for fossil resources”, “water (user) deprivation potential, deprivation-weighted water consumption”, “potential comparative toxic unit for ecosystems”, “potential comparative toxic unit for humans – cancerogenic”, “Potential comparative toxic unit for humans - not cancerogenic”, “potential soil quality index”. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

6. LCA: Interpretation

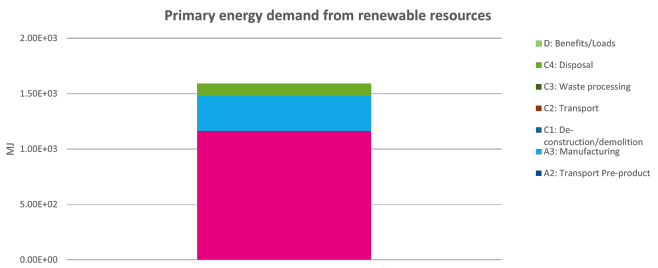
The following figure shows the relative contributions of different Life Cycle processes and the primary energy demand in the form of a dominance analysis.



A large part of the emissions within the individual impact categories occurs during the manufacturing phase (A1-A3) (exception for ODP). The main drivers here are, in particular, the supply of raw materials and the production of the cast iron pipes. In terms of GWP-total, emissions from the manufacturing phase contribute around 71% to the total emissions of the entire value chain. In addition, emissions from transport to waste treatment (C2) make a relevant contribution to the total environmental impact across all impact categories.
Compared to raw material supply (A1) and manufacturing (A3), the contributions to environmental impacts in GWP from the transport of precursors (A2) within the manufacturing phase are significantly lower and its significance in terms of effectiveness to GWP is negligible.
Due to the negative net scrap balance in the EoL, additional burdens result in Module D for the compensation of lost secondary material in the previous product system.
Global warming potential (GWP) In terms of greenhouse gas potential (GWP-total), within the manufacturing phase (A1-A3), manufacturing itself accounts for the largest share of total emissions, at just under 55%, followed by raw material supply (A1) at 44%.
Depletion potential of the stratospheric ozone layer (ODP) In terms of ozone depletion potential (ODP), raw material supply (A1) has the area with the clearly highest share of total emissions, at just under 73%. Manufacturing (A3) (22%) and transportation (A2) (5%) play a minor role within the manufacturing phase. **Acidification potential of land and water (AP)** For the acidification potential (AP), a similar picture emerges as for the greenhouse gas potential; with approx. 53 %, production (A3) has the highest contribution to the total emissions during the production phase, just ahead of raw material supply (A1) (46 %); transports (A2) have no relevant factor on the environmental impacts.
Eutrophication potential (EP) The eutrophication potential (EP) , whether EP-freshwater, EP-saltwater, or EP-terrestrial, is likewise dominated by the influence of raw material supply (A1) and manufacturing (A3) on the total environmental impacts within the manufacturing phase; across categories, the contribution of these two modules to the total environmental impacts of the manufacturing phase is at least 97% for EP. In the case of EP-freshwater, the largest share of emissions is attributable to production (A3) (53 %); in the case of EP-saltwater and EP-terrestrial, it is raw material supply (A1), with just under 58 % and 60 %, respectively.
Potential of tropospheric ozone photochemical oxidants (POCP) The photochemical oxidant potential (POCP) within the manufacturing phase (A1-A3) is dominated by the emissions from manufacturing (A3) (67%); the environmental impacts from raw material supply (A1) (32%) account for the majority of the remainder.
In the case of **abiotic depletion potential für non-fossil resources (ADP elem.)** and **abiotic depletion potential for fossil resources** (ADP fossil), the environmental impacts from the production phase (A1-A3) largely arise during raw material supply (A1) (61 %); emissions from production (A1) also make a relevant contribution, accounting for 38 % of total emissions.
In the case of the water withdrawal potential (WDP), the main source of total emissions during the manufacturing phase (A1-A3) is raw material supply (A1) (83%). The share of emissions from manufacturing (A3) is 16 %.
Within the cradle-to-gate system boundary (A1-A3), the **primary energy demand** from non-renewable energy sources is approximately 92 % and that from renewable energy sources is correspondingly 8 %.
Within the manufacturing phase (A1-A3), the highest contribution to the non-renewable primary energy demand (PENRT) results from raw material supply (A1) (61 %); with just under 38 %, manufacturing (A3) contributes to the total PENRT (see following figure).



When considering the total renewable primary energy demand (PERT), about 78% is generated during raw material supply (A1); and about 21% of the total PERT is generated during manufacturing (A3) (see the following figure).



7. Requisite evidence

Not relevant.

7.1 Verification for drinking water installations

The products of vonRoll production (deutschland) gmbh & co kg for drinking water supply are certified by the *DVGW*. The basis for this certification is the Technical Test Specification of the DVGW according to *GW337*. All of the materials used in their manufacture that come into contact with drinking water during use, such as the lubricant, the seal and the cement mortar lining, have been tested in accordance with the corresponding DVGW guidelines have been tested or have a KTW approval. This means that any negative impact on drinking water quality by our products can be ruled out. Both the manufacturing and the factory production control of our products are subject to regular external monitoring.

8. References

Standards

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General EPD program guidance of IBU Institut Bauen und Umwelt e.V. (ed.): The preparation of environmental product declarations (EPD), version 2.1., 2022.

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Product category rules for building-related products and services: EPD requirements for steel pipes for pressure applications, version 3, Berlin: Institut Bauen und Umwelt e.V. (ed.), 2023.

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DIN 4124
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ISO 14044
DIN EN ISO 14044:2021-02 Environmental management - Life cycle assessment - Requirements and guidance.

ISO 15686
ISO 15686-1:2011-05, Building construction and structures - Design for life - Part 1: General principles and framework.

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Further literature

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CPR
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GW 337
DVGW GW 337:2010-09, Ductile iron pipes, fittings and accessories for gas and water supply - Requirements and tests.

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German accreditation body.

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