ENVIRONMENTAL PRODUCT DECLARATION

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

Owner of the Declaration	Salzgitter AG
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-SMM-20210242-IBB1-EN
Issue date	18.05.2022
Valid to	17.05.2027

Steel Oil and Gas Line Pipe

Mannesmann Line Pipe GmbH

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Institut Bauen und Umwelt e.V.

ECO PLATFORM EPD VERIFIED

1. General Information

Salzgitter AG	Steel Oil and Gas Line Pipe
Programme holder IBU – Institut Bauen und Umwelt e.V. Hegelplatz 1 10117 Berlin Germany	**Owner of the declaration** Salzgitter AG Eisenhüttenstraße 99 38239 Salzgitter Germany
Declaration number EPD-SMM-20210242-IBB1-EN	**Declared product / declared unit** 1 tonne plastic-coated steel line pipe for oil and gas
This declaration is based on the product category rules: Steel pipes for pressure applications, 11.2017 (PCR checked and approved by the SVR)	**Scope:** This Environmental Product Declaration refers to coated steel line pipe for oil and gas produced by **Mannesmann Line Pipe GmbH** in Hamm and Siegen (Germany). 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 18.05.2022	
Valid to 17.05.2027	**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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2. Product

2.1 Product description/Product definition
Steel line pipe for oil and gas involves pipes made of non-alloyed and low-alloyed structural steel and fine-grained steel which feature polyolefin coatings depending on the area of application.

Steel pipes for oil and gas pipelines are standardised in *ISO 3183* or *API 5L*, if applicable.

Polyolefin coatings are standardised in *ISO 21809-1*, for example.

Application of the products is subject to European standards, e.g.:

- *EN 12007*, Parts 1 and 3: Gas infrastructure - Pipelines for maximum operating pressure up to and including 16 bar
- *EN 1594*, Gas infrastructure – Pipelines for maximum operating pressure exceeding 16 bar
- *ISO 13623*, Petroleum and natural gas industries – Pipeline transportation systems
- or the respective national rules or regulations such as in Germany, e.g.:
- DVGW Code of Practice *G 462* Gas pipelines made of steel pipes up to 16 bar operating pressure; construction
- DVGW Code of Practice *G 463* High-pressure gas pipelines made of steel pipes for a design pressure of more than 16 bar; construction
- *TRFL*, Technical rule governing long-distance pipeline equipment

2.2 Application
Steel pipes for oil and gas pipelines are used for conveying and transporting liquid and gaseous products under internal pressure.

2.3 Technical Data
The mechanical and technological properties of steel pipes for oil and gas pipelines for gas pipelines (up to 16 bar) are indicated in Table 7 of the *API 5L (ISO 3183)* with the additional specification in accordance with Table 1 of *EN 12007-3* for gas pipelines above 16

bar and lines for conveying flammable liquids (oil), e.g. in Table A.2 of *ISO 3183*, Annex A.

Technical construction data (ISO 3183 as an example)

Name	Value	Unit
Yield strength (minimum) ASTM A370	245 - 555	N/mm²
Tensile strength (minimum) ASTM A370	415 - 625	N/mm²
Hardness ASTM E110	max. 275	HV 10
Notched-bar impact value 0°C ASTM A370	min. 40	Joule
Ductility API RP 5L3	min. 85	%

2.4 Delivery status

Materials for gas and oil lines, e.g. in accordance with *ISO 3183* and the *API 5L* in steel grades L245–L555 Where applicable, the pipes are provided with external corrosion protection and mechanical protective coating.

2.5 Base materials/Ancillary materials

The base material for manufacturing hot-rolled coils as a preliminary material for steel pipe is iron (percentage by mass >= 99.5%).

Other components are carbon, silicon and manganese. Chemical composition varies depending on the type of steel. The detailed mass fractions in per cent can be found in the product standards *ISO 3183* Annex A, Table A1 and *API 5L*, Table 5.

For corrosion protection, polyethylene (PE) or polypropylene (PP) are used as basic materials in the case of coatings, and cement, sand and water for cement mortar coatings.

Ancillary materials:
Various lubricants depending on the respective rolling process

The product contains substances from the *ECHA* list of candidates of Substances of Very High Concern (SVHC) (dated 17 January 2022) exceeding 0.1 percentage by mass: **no**

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

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 Ordinance on Biocide Products No. (EU) 528/2012): **no**

2.6 Manufacture

Hot-rolled strips of suitable width and sheet thickness, wound as coils, represent the preliminary material for manufacturing longitudinal seam-welded steel pipes. With Siegen and Hamm, Mannesmann Line Pipe GmbH has two production facilities with identical manufacturing processes.

Pipe production

The process is broken down into three phases: **forming** the infinitely welded strip as open-seam pipes, **welding** and **annealing** the seam for achieving the requisite structure. The heated strip edges are welded together by pressing. The pipes are rounded and aligned followed by non-destructive testing of the high-frequency inductive (HFI) seam. The pipe string is then cut to the requisite lengths.

Processing (coating)
The pipes are blasted and heated to the requisite application temperature prior to coating. Polyethylene and polypropylene are applied by means of sleeve extrusion. The coated pipe string is then cooled in a cooling line.

The cement mortar coating as a mechanical protective layer is offered as an option. For this purpose, the corrosion protection layer is provided with a mortar layer in a winding process.

For product manufacturing and quality assurance, both sites are certified according to *ISO 9001* and based on *API Q1* for products according to *API 5L*.

2.7 Environment and health during manufacturing

During the entire manufacturing process, no other health protection measures are required extending beyond the legally specified industrial protection measures for commercial enterprises.
Certification of industrial safety and health protection in accordance with ISO 45001 is in place for both sites.

Via regular analyses of the environmental impacts and permanent improvement measures and action within the framework of TQM (Total Quality Management), the environmental impacts attributable to the manufacturing process are continuously minimised.

Both Mannesmann Line Pipe GmbH production facilities are certified to *ISO 14001* and *ISO 50001* in terms of environmental and energy management.

2.8 Product processing/Installation

Processing recommendations for the production of moulded parts:

Hot- and cold-forming
Hot- and cold-forming are possible without any difficulty. Hot-forming should be carried out in a range of 750 to 1050 °C. Forming with a predominantly upsetting component, e.g. forging, can be carried out in the upper temperature range, whereas forming in which stretching occurs should be carried out in the lower temperature range. The temperature can decrease to 700 °C for degrees of deformation of less than 5% in the final stage. This must be followed by cooling down in stationary air. After hot-forming, normalising is necessary if temperatures arose outside the temperature range of 980 to 850°C during the previous forming process. After stronger cold-forming processes requiring heat treatment in accordance with the respective guidelines (see AD data sheets), stress-relief heat treatment is often sufficient unless other acceptance test procedures or other specifications expressly demand normalising.

Welding
The steels can be welded manually or automatically after each of these procedures. At external

temperatures below approx. +5 °C and wall thicknesses exceeding 50 mm (for S 355 and higher exceeding 30 mm), preheating a sufficiently wide zone to 80 to 200 °C is recommended. In any case, the surface should be free of condensation. Stress-relief heat treatment (see heat treatment) is not generally necessary and it should only be carried out if demanded by a building regulation or when welded constructions and/or operating conditions commend depletion of the internal welding stresses. Verifiably suitable welding additives must be used for arc welding while alkaline welding additives are preferable for S 355 and higher. If necessary, corrosion protection should be supplemented in the pipe connecting area.

Industrial safety and health protection measures
When processing/installing the steel line pipes for oil and gas, no health protection measures beyond the usual occupational health and safety measures (such as protective gloves) are to be taken.

Environmental protection measures
No noteworthy environmental pollution is triggered by processing/assembling the products in question. No special measures need to be taken to protect the environment.

Residual material incurred
Residual material and packaging incurred on the building site must be collected separately. The specifications of local waste authorities must be maintained during processing.

2.9 Packaging
Steel pipe for oil and gas pipelines is bundled using steel bands and/or shipped on wooden beams, secured with wooden wedges (waste code numbers: 150103 packaging made of wood, 150104 packaging made of metal). All packaging can be re-used.

2.10 Condition of use
Contents in condition of use
The material composition during the use phase is the same as at the time of production. Steel pipes for gas and oil pipelines are made of unalloyed or low-alloy structural steels according to *ISO 3183* or *API 5L*. The ingredients can be found in Annex A Table A1 of *ISO 3183* and Table 5 of *API 5L*, depending on the area of application.

Corrosion protection
Information on corrosion protection can be found in the technical delivery conditions (see section 2.1). Application-related information is provided, for example, in *DIN 30675-1*.

2.11 Environment and health during use
There are no health risks for users of steel pipe for oil and gas pipelines or for persons manufacturing or processing steel pipe for oil and gas pipelines. From an environmental perspective, there are no restrictions governing the use of steel pipe for oil and gas pipelines.

2.12 Reference service life
The life cycle of steel pipe for oil and gas pipelines is dependent on the respective structural design, use and maintenance. The use phase for steel pipe for oil and gas pipelines is not depicted as they involve maintenance-free and generally durable products.

2.13 Extraordinary effects

Fire
Steel pipe for oil and gas pipelines complies with the requirements of construction product class A1 “non-flammable” in accordance with *DIN 4102-1* and *EN 13501-1.* No smoke gas develops.

Fire protection

Name	Value
Building material class	A1

Water
The effects of flooding on steel pipe for oil and gas pipelines do not lead to any changes in the product or any other negative environmental impact.

Mechanical destruction
In the event of extraordinary mechanical impact, steel components display very good characteristics thanks to the high degree of ductility (malleability) of the material. As a general rule, no chips, breaking edges or similar are incurred.

2.14 Re-use phase
Steel pipe for oil and gas pipelines is 100% recyclable. Steel pipe for oil and gas pipelines can be directed to electro-steel plants as scrap at the EoL.

2.15 Disposal
As steel is 100% recyclable, this material does not require disposal. Waste code in accordance with the European List of Wastes (EWC), as per the European List of Wastes Ordinance *AVV*: 17 04 05 Iron and steel.

Plastic waste incurred, e.g. in accordance with AVV no. 150102, is generally thermally utilised while cement mortar waste, e.g. in accordance with AVV no. 170101, can be returned to the cement industry as a secondary raw material.

2.16 Further information
For more information on steel pipes for oil and gas pipelines, see *Mannesmann Line Pipe*.

3. LCA: Calculation rules

3.1 Declared Unit
1 tonne plastic-coated steel pipeline for oil and gas serves as the declared unit.

The average proportion of plastic (polyethylene and polypropylene) in the declared product is around 4.5%. The remaining 95.5% can be allocated to the steel pipe used.

Details on declared unit

Name	Value	Unit
Declared unit	1000	kg
Thickness (max. wall thickness of	25,4	mm

steel pipe)		
Conversion factor to 1 kg	0.001	-

3.2 System boundary
Type of EPD: cradle to gate with Modules C1–C4 and Module D.

The EPD comprises the following life cycle phases:

- Product stage (Modules A1–A3)
- End-of-Life stage (Modules C1–C4)
- Benefits and loads beyond the system boundary (Module D)

Modules A1–A3 cover both the upstream chain of production and provision of raw materials, auxiliary materials and energy sources, the production of hot strip on the basis of iron ore, as well as its transport to the plants of Mannesmann Line Pipe GmbH, and the energy and material costs there. Waste water treatment is also considered.

As steel pipelines for oil and gas involves composite pipes, the individual materials are separated in Module C3 and then directed to their designated purposes in Modules C4 and/or Module D.

The material and energy expenses required for Module C3 and the ensuing emissions are not considered.

In accordance with the selected scenario, thermal utilisation of the plastic coating takes place in Module C4, whereby emissions generated are allocated to this module while the generated thermal and electric energy is credited to Module D.

The recycling potential is also considered in Module D. Recycling credits are allocated in line with the “theoretically 100% primary furnace route” approach, in accordance with *Worldsteel 2017*.

3.3 Estimates and assumptions
The base material for manufacturing the “steel pipelines for oil and gas” is low-alloyed hot-rolled coils via the furnace route with production facilities in Germany.

Estimates and assumptions were documented in detail and are based on real production data from hot strip and steel pipe production.

3.4 Cut-off criteria
The end-of-life scenario involves product losses of 3.1%. Landfilling is not considered. Likewise, the manufacture and utilisation of packaging material (steel bands, wooden beams) are not considered. Nor is the use of lubricants taken into consideration.

In their entirety, these unconsidered flows significantly comply with the cut-off criterion of max. 5% of energy and mass expenditure while also adhering to the criterion of 1% in relation to individual processes, *PCR, Part A + A2*.

3.5 Background data
The LCA results of the declared product are based on modelling in the *GaBi ts* software environment. Modelling is based on primary production data for the production of hot strip and the energy and media consumption values for an entire year.

This has been supplemented by secondary data from the GaBi database. The respective documentation can be viewed online.

3.6 Data quality
All primary data on steel and/or strip production and steel (line) pipe production refers to the financial year 2018. The annual volumes have been examined for representativity in relation to previous financial years.

The current GaBi database (GaBi version 10.5.1.124, database 2021.2) was used as background data sets.

The assessment model of the “Product Environmental Footprint (PEF)” approach of the EC Joint Research Centre 2012 was used to assess the quality of the primary and secondary data in this EPD. Accordingly, the overall data quality can be rated as “very good”.

3.7 Period under review
The period under review is fiscal 2018. The volumes of steel pipeline for oil and gas produced in 2018 serve as averages for the Declaration.

3.8 Allocation
The methodology used for the co-products in the "coking plant" and "power plant" processes of primary steel production was physical allocation based on calorific value. For the other co-products, a partitioning approach based on the product energy content was used according to the recommendation of *Worldsteel 2014*.

The use of steel scrap for the production of hot strip in Module A1 is considered unencumbered. However, a large percentage of scrap requirements is already covered by the cutting losses incurred during steel pipeline production.

The remaining residual quantity is fed into Module A1 before the End-of-Life scenario is considered and deducted from the “scrap for recycling” material flow. The difference is the net scrap quantity that is transferred to the recycling process; please refer to *Helmus*. Recycling credits are allocated in line with the “theoretically 100% primary furnace route” approach, in accordance with *Worldsteel 2014*.

Caloric waste during the end-of-life stage (PE and PP plastic) is directed to thermal utilisation (Module C3), whereby the waste incineration processes applied are based on partial-flow analyses of the respective materials (PE and PP) with an energy efficiency factor of less than 0.6. Accordingly, all ensuing emissions and waste are allocated to Module C4 while the credits for thermal and electric energy generated are considered in Module D.

Credits are allocated via the current German power mix and the steam generation based on natural gas.

3.9 Comparability
Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account.

The background database used involves the GaBi data base, version 2021.2 (GaBi ts).

4. LCA: Scenarios and additional technical information

Characteristic product properties
Information on biogenic Carbon

End of Life (C3–C4)

Name	Value	Unit
Collection Rate	96,9	%
Loss	3,1	%
Recycling	926	kg
Energy recovery	43.4	kg
Landfilling	0	kg

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

Name	Value	Unit
Recycling	100	%

5. LCA: Results

Important:
EP freshwater: This indicator was calculated as “kg P equiv.” in accordance with the characterisation model (EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe; http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml).

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; ND = 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	ND	ND	ND	ND	MNR	MNR	MNR	ND	ND	ND	ND	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 tonne plastic-coated steel pipeline for oil and gas

Core Indicator	Unit	A1-A3	C3	C4	D
Global warming potential - total	[kg CO_2-Eq.]	2.49E+3	0.00E+0	1.36E+2	-1.52E+3
Global warming potential - fossil fuels	[kg CO_2-Eq.]	2.48E+3	0.00E+0	1.36E+2	-1.52E+3
Global warming potential - biogenic	[kg CO_2-Eq.]	4.49E+0	0.00E+0	8.00E-3	2.00E+0
GWP from land use and land use change	[kg CO_2-Eq.]	1.38E+0	0.00E+0	1.47E-3	-1.96E-1
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	3.57E-8	0.00E+0	1.80E-14	-2.62E-8
Acidification potential, accumulated exceedance	[mol H^+-Eq.]	6.81E+0	0.00E+0	2.10E-2	-4.37E+0
Eutrophication, fraction of nutrients reaching freshwater end compartment	[kg P-Eq.]	2.64E-3	0.00E+0	2.49E-6	-3.73E-4
Eutrophication, fraction of nutrients reaching marine end compartment	[kg N-Eq.]	1.50E+0	0.00E+0	3.36E-3	-8.37E-1
Eutrophication, accumulated exceedance	[mol N-Eq.]	1.62E+1	0.00E+0	9.77E-2	-9.11E+0
Formation potential of tropospheric ozone photochemical oxidants	[kg NMVOC-Eq.]	4.36E+0	0.00E+0	9.11E-3	-2.22E+0
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	4.84E-4	0.00E+0	2.61E-7	-2.43E-4
Abiotic depletion potential for fossil resources	[MJ]	2.62E+4	0.00E+0	2.15E+1	-1.28E+4
Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	[m^3 world-Eq deprived]	8.75E+0	0.00E+0	1.25E+1	-3.37E-1

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 tonne plastic-coated steel pipeline for oil and gas

Indicator	Unit	A1-A3	C3	C4	D
Renewable primary energy as energy carrier	[MJ]	1.71E+3	0.00E+0	4.39E+0	1.36E+3
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	1.71E+3	0.00E+0	4.39E+0	1.36E+3
Non-renewable primary energy as energy carrier	[MJ]	2.63E+4	0.00E+0	2.15E+1	-1.33E+4
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	2.63E+4	0.00E+0	2.15E+1	-1.33E+4
Use of secondary material	[kg]	1.80E+2	0.00E+0	0.00E+0	9.23E+2
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m^3]	8.75E+0	0.00E+0	1.25E+1	-3.37E-1

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 tonne plastic-coated steel pipeline for oil and gas

Indicator	Unit	A1-A3	C3	C4	D
Hazardous waste disposed	[kg]	2.23E+0	0.00E+0	4.40E-9	-9.59E-4
Non-hazardous waste disposed	[kg]	2.84E+1	0.00E+0	5.51E-1	-2.33E+1
Radioactive waste disposed	[kg]	2.21E-1	0.00E+0	5.39E-4	1.60E-1
Components for re-use	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	[kg]	1.84E+2	9.26E+2	0.00E+0	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	4.34E+1	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	2.48E+2	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	5.70E+2	0.00E+0

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 tonne plastic-coated steel pipeline for oil and gas

Indicator	Unit	A1-A3	C3	C4	D
Potential incidence of disease due to PM emissions	[Disease Incidence]	ND	ND	ND	ND
Potential Human exposure efficiency relative to U235	[kBq U235-Eq.]	ND	ND	ND	ND
Potential comparative toxic unit for ecosystems	[CTUe]	ND	ND	ND	ND
Potential comparative toxic unit for humans - cancerogenic	[CTUh]	ND	ND	ND	ND
Potential comparative toxic unit for humans - not cancerogenic	[CTUh]	ND	ND	ND	ND
Potential soil quality index	[-]	ND	ND	ND	ND

Limitation note 1 – applies to the indicator “Potential impact of exposure to people to U235”: This impact category mainly addresses the potential impact of low-dose ionising radiation on human health in the nuclear fuel cycle. This does not consider impacts attributable to possible nuclear accidents and occupational exposure, nor to the disposal of radioactive waste in underground facilities. Potential ionising radiation from soil, radon and some building materials is not measured by this indicator either.

Limitation note 2 – applies for the indicators: "Potential for Abiotic Resource Depletion - Non-Fossil Resources", "Potential for Abiotic Resource Depletion - Fossil Fuels", "Water Depletion Potential (User)", "Potential Ecosystem Toxicity Comparison Unit", "Potential Human Toxicity Comparison Unit - Carcinogenic Effect", "Potential Human Toxicity Comparison Unit - Non-Carcinogenic Effect", "Potential Soil Quality Index". The results of this environmental impact indicator must be used with caution, as the uncertainties in these results are high or there is limited experience with the indicator.

6. LCA: Interpretation

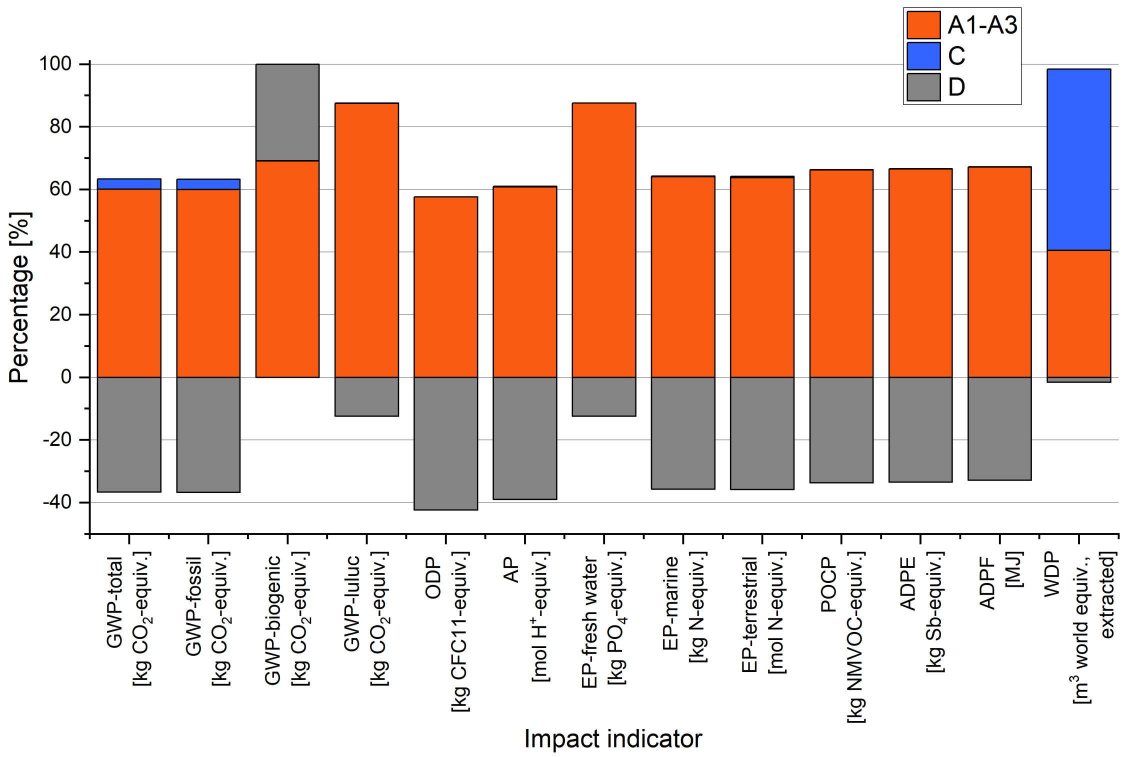

Fig.: Environmental impacts on the declared modules

Steel – as a material with inherent properties – is infinitely recyclable. Therefore, the aim when analysing steel products and products containing a high percentage of steel is to consider End-of-Life scenarios in particular and analyse them comprehensively across all life cycle phases. This advantage is obvious with the examination of the diagram: almost all impact categories receive credit in Module D due to the recyclability of steel and the established recycling system with maximum collection rates.

The results of the impact assessment show that almost the “entire greenhouse gas emissions (**GWP total**)” of Modules A1–A3 come from fossil sources (cf. indicator **GWP fossil**). As expected, a more detailed analysis shows that hot strip production (Module A1) has the greatest influence on GWP total or GWP fossil, accounting for almost 92%. Here, the fossil carbon input in the blast furnace process is particularly noteworthy, leading to direct, process-related CO2 emissions and to further indirect emissions in the power plant process. Within Module A1, approx. 70% of greenhouse gas emissions come from the direct plant emissions and about 30% from the emissions of the preliminary processes for the production of the raw materials such as the coal, iron ore carriers and lime.

In Module A3, the majority of greenhouse gas emissions are accounted for by upstream emissions in the production of electricity (3.4%) and PE/PP plastic (4.4%).

In contrast, the absolute shares of the "greenhouse potentials from biogenic sources (**GWP biogenic**)" and from "landscape use and landscape use change (**GWP luluc**)" have only a negligible share of the total greenhouse potential. As expected, the contributions in Modules A1 and A3 come exclusively from the upstream processes, and here primarily from the electricity mix used or the raw material supplies.

For the "Water Removal Potential (User) (WDP)", the upstream chains of plastic production (64.3%) and electricity generation to cover electricity demand (19.8%) in Module A3 are decisive in the production stage. Across all declared modules, the production stage accounts for about 40%. The remaining 60% is accounted for by the energy recovery of plastics in Module C4 (waste disposal).

The other core indicators of environmental impacts are predominantly determined by steel and hot strip production in Module A1. The "Potential for stratospheric ozone depletion (**ODP**)" should be emphasised. The ODP is almost exclusively caused by the use of methanol in wastewater treatment in Module A1, as halogenated hydrocarbons are emitted during the production of methanol.

For the remaining impact indicators, the provision of raw materials for steel production (Module A1) also has the greatest influence on the absolute size of the environmental indicators. As expected, the largest contributions are made by the provision of iron ore carriers, coal and lime, i.e. those input materials that are used in the largest quantities. In addition, the impact indicators describing the acidification potential (**AP**), the eutrophication potential (**EP freshwater**, **EP marine**, **EP terrestrial**) and the ozone creation potential (**POCP**) are increased by the direct NO_x and SO_2 emissions of the sintering plant and the power plant.

The overall small shares of the pipe manufacturing process (Module A3) in the impact categories of this class are mainly attributable to power generation and its upstream chains.

In contrast to fossil-based primary steel production recycling by means of the electric arc process is mainly based on electricity. This is largely provided by renewable sources. For this reason, "Module D leads to an increase rather than a decrease in the use of renewable energy, while at the same time reducing the use of fossil energy, as can be seen from the indicators **PERE** (Renewable Primary Energy as Energy Source) and **PENRE** (Non-renewable Primary Energy as Energy Source). For this reason, recycling in Module D also increases the **GWP biogenic** impact indicator.

In summary, greenhouse gas emissions are determined by the use of fossil fuels during the steel production process in Module A1. For Mannesmann Line Pipe, material efficiency is therefore the biggest lever in this and most categories.

7. Requisite evidence

This EPD concerns steel pipe for oil and gas pipelines made of unalloyed and low-alloyed structural steel. Further processing depends on the respective application. Evidence of tests in line with the technical conditions governing delivery is provided by inspection certificates.

Verification for mechanical pipe properties
Apart from the structural technical data provided in section 2.3, evidence and results of additional mechanical tests must be provided depending on customer requirements. These include:

- Guided Bend Test in accordance with *ASTM A 370*
- Bend Test in accordance with *ASTM A 370*
- Flattening Test in accordance with *ASTM A 370*

8. References

Standards

DIN 30675
DIN 30675-1:2019-05, External corrosion protection of buried pipes – Part 1: Corrosion protection systems and application for steel pipes

DIN 4102-1
DIN 4102-1:1998-05, Fire behaviour of building materials and building components – Part 1: Building materials, terms, requirements and tests

EN 12007
DIN EN 12007-3:2015-07, Gas infrastructure – Pipelines for maximum operating pressure up to and including 16 bar – Part 3: General functional requirements

EN 13501
EN 13501-1:2019-05, Classification of construction products and methods by reaction to fire – Part 1: Classification with the results of tests on reaction to fire of construction products

EN 15804
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EN 1594
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