ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO14025:2006 for

Steel Rails

Manufactured by

KARDEMİR KARABÜK DEMİR ÇELİK SANAYİ VE TİCARET A.Ş.

EPD of multiple products, based on average results

Programme: International EPD System, www.environdec.com
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KARDEMİR

EPD INTERNATIONAL EPD SYSTEM

EPD TÜRKİYE INTERNATIONAL EPD SYSTEM

ECO PLATFORM EPD VERIFIED

General Information

The International EPD® System: EPD International AB Box 210 60 SE-100 31 Stockholm, Sweden, support@environdec.com

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Product Category Rule (PCR): Fabricated metal products, except construction products, PCR 2023:01, version 2.0.0
UN CPC code is 412; Rolled, drawn and folded products of iron and steel.

PCR review was conducted by: The Technical Committee of the International EPD System. A full list of members is available at www.environdec.com. The review panel may be contacted via info@environdec.com.

Chair of the PCR review: Daniel Olausson (Chair) and Rui Wang (Co- chair). The review panel may be contacted via the Secretariat www.environdec.com/support.

Independent third-party verification of the declaration and data, according to ISO 14025:2006:

☐ EPD process certification ☒ EPD verification ☐ Pre-verified tool

Third party individual verifier: Dr. Rajesh Kumar Singh
Approved by: The International EPD® System

The procedure for follow-up of data during EPD validity involves third party verifier:
Yes No **X**

KARDEMİR has the sole ownership, liability, and responsibility for this EPD.

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EPDs within the same product category but registered in different EPD programmes may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison.

How to Read This EPD?

An Environmental Product Declaration (EPD) is an ISO Type III Environmental Declaration based on ISO 14025 standard. An EPD transparently reports the environmental performance of products or services from a lifecycle perspective. The preparation of an EPD includes different stages, from acquiring raw materials to the end of life of the final product/service. EPDs are based on international standards and consider the entire value chain. Additionally, EPD is a third-party verified document. This EPD includes the following sections described below.

1. General and Program Information

The first part of an EPD has information about the name of the manufacturer and product/service and other general information such as the validity and expiration dates of the document, the name of the program operator, geographical scope, etc. The second page states the standards followed and gives information about the program operator, third-party verifier, etc. The followed Product Category Rule (PCR) is indicated on the second page.

2. Company and Product/Service Information

Information about the company and the product investigated is given in this section. It summarizes the characteristics of the product provided by the manufacturer. It also includes information about the product such as product composition and packaging.

3. LCA Information

Life Cycle Analysis (LCA) information is one of the most important parts of the EPD as it describes the functional/declared unit, time representativeness of the study, database(s) and LCA software, along with system boundaries. The table presented in this part has columns for each stage in the life cycle. The stages considered are marked 'X' whereas the ones that are not considered are labeled as 'ND' (Not Declared). Not all EPDs consider the full life cycle assessment for a product's entire life stages. The 'System Boundary' page is also the place where one can find detailed information about the stages and the assumptions made.

4. LCA Results

The results of the LCA analysis are presented in table format. The first column in each table indicates the name of the impact category and their measurement units are presented in the second column. These tables show an amount at each life cycle stage to see the impact of different indicators on different stages. Each impact can be understood as what is released through the production of the declared unit of the material. The benefits of reuse/recycling of the declared product are reflected in this section.

The first impact in the table is global warming potential (GWP), which shows how much CO_2 is released at each stage. Other impacts include eutrophication potential, acidification potential, ozone layer depletion, land use related impacts, etc. The second table provides results for resource use and the third table is about the waste produced during production. The fourth and final table shows the results for the GWP-GHG indicator, which is almost equivalent to the GWP-Total indicator mentioned previously. The only difference is that this indicator excludes the biogenic carbon content by following a certain methodology.

About the Company

EPD Owner: KARDEMİR KARABÜK DEMİR ÇELİK SANAYİ VE TİCARET A.Ş.
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Established in 1937, the Karabük Demir Çelik Fabrikaları ('Karabük Iron and Steel Works') were privatized in 1995 and renamed Kardemir. It is Turkey's first integrated iron and steel plant.

Kardemir produces railway wheels, rail tracks, profiles, coils, rebar construction steel, blooms, platinas, billets, angles, mine poles, pig irons, coke and coke by-products in international quality standards and provides the basic inputs in rail systems, automotive, defense industry, machinery manufacturing, construction and the mining sectors. Since its establishment, Kardemir has realized the project, manufacturing and assembly of numerous industrial plants and is known as the "The Plant that Builds Plants" in Turkey.

All shares of Kardemir are traded on BIST and is among the top 50 Industrial Enterprises in Turkey.

After the privatization, Kardemir rapidly renewed its facilities in line with the requirements of the age, and changed its production process with its renewed steel mill, and increased its capacity, efficiency and profitability with modern technology. In the years 2000s and later on, with the commissioning of the Rail and Profile Rolling Mill, the Rod Wire Mill and the Railroad Wheel Mill, Kardemir expanded its product range and with railroad tracks and wheels, up to 550 mm width heavy profiles and up to 56 mm in diameter coil production capability, Kardemir has become the only company in Turkey and among regional countries in terms of product variety. Continuing growth with its new investments, Kardemir will be achieving 3.5 mn tons/year production capacity next year.

Focusing on Turkey's national targets in the automotive sector, the defense industry and rail systems with the products offered to the market, Kardemir has introduced many new quality steel products with R&D activities it has undertaken and offered them to the service of these sectors.

Kardemir is one of Turkey's leading industrial enterprises with a wide network of operations through its subsidiaries and affiliated companies in various sectors. Kardemir has four major subsidiaries: KARDÖKMAK Inc., which is a leader in its sector with high casting and mechanical processing capacity; KARÇEL Inc., which manufactures all types and grades of steel structures; KARDEMİR ENERGY Inc., which operates a hydroelectric power plant; and KARLİMTAŞ Inc., which handles logistics operations. Additionally, Kardemir has partnerships in other companies, including KARÇİMSA Inc. in the cement sector, ERDEMİR MINING Inc. in the mining sector, VADEMSAŞ Inc., which produces conventional and high-speed railway switches, and EPİAŞ (Energy Markets Operation Inc.) in the energy markets sector. Through these companies, Kardemir operates in steel production, energy, logistics, cement, mining, and railway sectors, maintaining a strong position both nationally and internationally.

Employing approximately 4,500 employees together with its affiliates, Kardemir continues its production as one of the leading companies in the sector with its deep-rooted industrial culture, competent human resources and corporate management experience.

About the Product

KARDEMİR is the only manufacturer of rail and heavy profile in Turkey and regional countries. Our Rail-Profile Rolling Mill which has the capacity of 450,000 tons / year, has been commissioned for this purpose in 2007. At our facility equipped with advanced technology, operators with at least level 2 user certificates are employed. In addition to the 12-75 m (46-60 kg /m) rails in international standards, R350 HT hardened rails and 59R1, 59R2, 60R1 and 60R2 corrugated rails are produced at the facility. Our company, which also has the HPQ certificate owned by only few rail manufacturers in Europe, has a modern test center consists of test units for laser where geometrical controls are performed in Ray-Profile Rolling Mill, eddy currents where surface controls are made, and ultrasonic test units for internal controls. In this facility, where the shape and size controls are made with the online laser system, we are working the production with an accuracy of one percent of the millimeter. Our company is the only producer of our country in heavy profile production. Our company, where profile production in IPE, NPI, NPU, HEA and HEB types, equal and unequal angles and mine poles are produced, manufactures up to 500 mm NPI type profiles, 400 mm NPU type profiles, 500 mm HEA and HEB type profiles, and 600 mm IPE type profiles. In addition, 25-80 mm thick and 205-520 mm wide platina are producing.

Technical Specifications

Parameters	Value	Unit
Carbon	0.38-0.82	%
Manganese	0.65-1.75	%
Silicon	0.13-0.62	%
Sulfur	≤ 0.040	%
Phosphorus	≤ 0.040	%
Chromium	0.15	%
Aluminum	0.0040	%
Vanadium	0.030	%
Nitrogen	0.010	%
Tensile Strength	≥ 680	MPa
Elongation	≥ 9	%
Hardness (HBW, Brinell Hardness Number)	200-390	-

System Boundary

A1 (Upstream) - Raw Material Supply

The A1 stage includes the extraction, processing, and production of raw materials used in the manufacturing of steel rails. The primary input is rail bloom, which is produced on-site at KARDEMİR's integrated steel plant using the blast furnace-basic oxygen furnace (BF-BOF) route. The upstream emissions associated with raw material extraction, such as iron ore, limestone, and coal, are considered. The impacts from auxiliary materials and alloying elements used during steelmaking are also included. The inventory data is based on site-specific production figures and secondary data sources from environmental databases for upstream processes.

A2 (Upstream) - Raw Material Transport

The A2 stage covers the transportation of raw and auxiliary materials from suppliers to KARDEMİR's production site in Karabük, Türkiye. Transportation modes primarily include rail and road, depending on the source location of materials such as iron ore, coke, and fluxes. Specific transport distances and load capacities are taken into account. Emissions associated with fuel consumption and vehicle operation are modelled using appropriate transport datasets.

Road	Rail
Vehicle: Lorry Size Class: 16-32 metric ton Emission Standard: EURO5 Fuel Type: Diesel Capacity utilisation: 50 %	Vehicle: Train Fuel Type: Diesel & Electric Mass: 1000 Gt Capacity utilisation: 50 %

A3 (Core) - Manufacturing

The A3 stage encompasses the entire steel rail manufacturing process at KARDEMİR's facility, including crude steel production, secondary metallurgy, continuous casting, and rolling. The process is powered by various energy sources including electricity, blast furnace gas, and natural gas. This stage includes in-house material handling, reheating, hot rolling, finishing operations, quality control, and packaging. All emissions and resource consumption (e.g. electricity, water, fuel) occurring within the factory boundary are accounted for based on site-specific operational data. The manufacturing stage includes the following processes as shown in the below production flow diagram.

C1 (Downstream) - Demolition

The C1 stage covers the mechanical dismantling of steel rails at the end of their service life. This includes the use of equipment such as rail cutters and lifting machinery. Emissions from fuel use and equipment operation are considered minimal and included accordingly.

C2 (Downstream) - Waste Transport

This stage accounts for the transport of deconstructed steel rails to recycling or waste treatment facilities. Transport is assumed to be by road over average distances, modelled using typical payload and fuel consumption data.

Transport Mode	Type
Vehicle Type	Vehicle: Lorry Size Class: 16-32 metric ton Emission Standard: EURO5 Fuel Type: Diesel
Distance	100 km

System Boundary

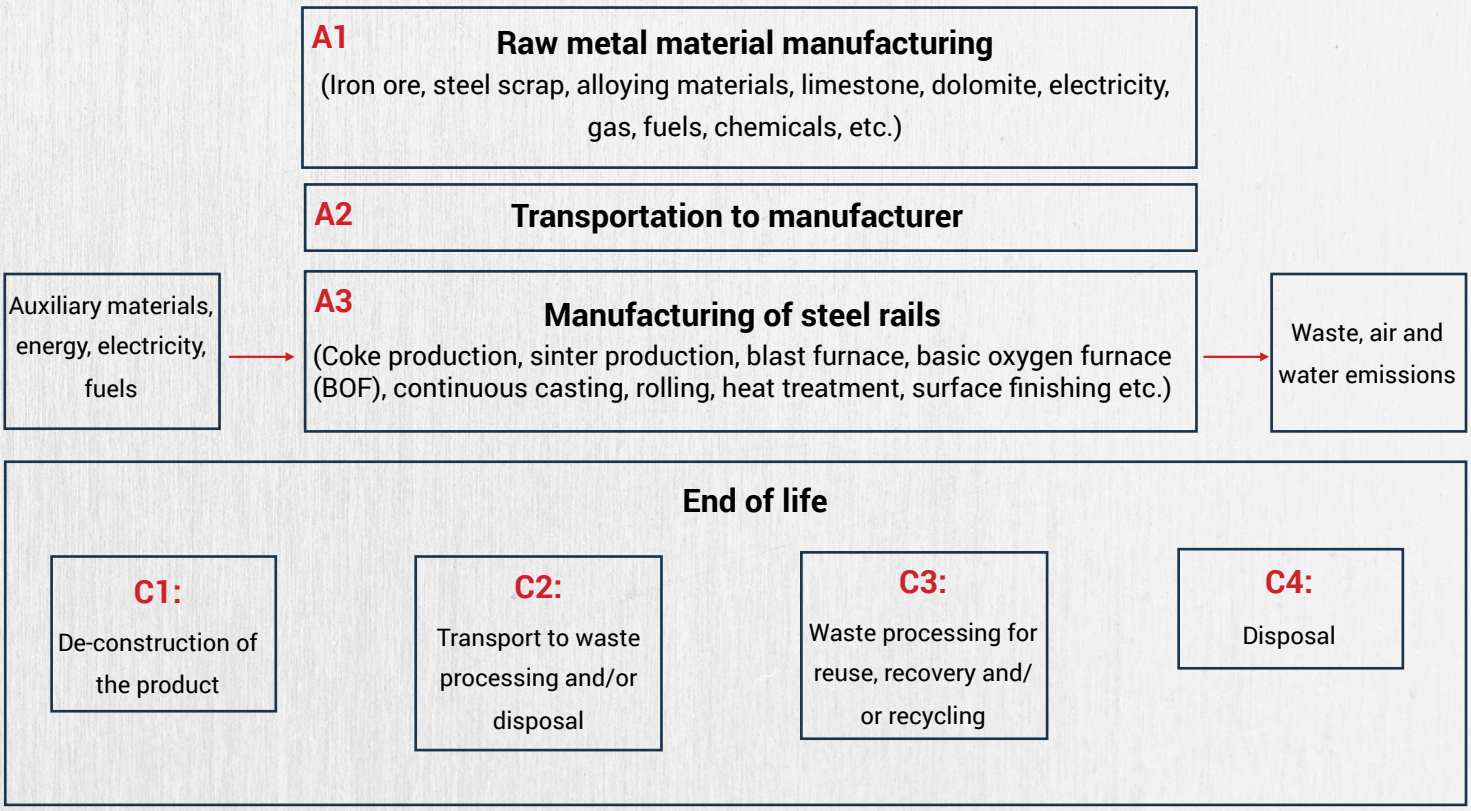
C3 (Downstream) - Waste Processing

The C3 stage represents the waste processing of dismantled steel profiles prior to recycling. This includes operations such as loading and unloading at the sorting facility, mechanical sorting, and steel fragmentation (shredding). In the absence of primary data, the assumptions outlined in the applicable PCR have been applied. Accordingly, diesel consumption is assumed to be 1.8 kWh per tonne for loading/unloading activities and 7.4 kWh per tonne for steel fragging. Additionally, mechanical sorting is assumed to consume 2.2 kWh of electricity per tonne. Emissions from these processes are modelled based on these assumptions.

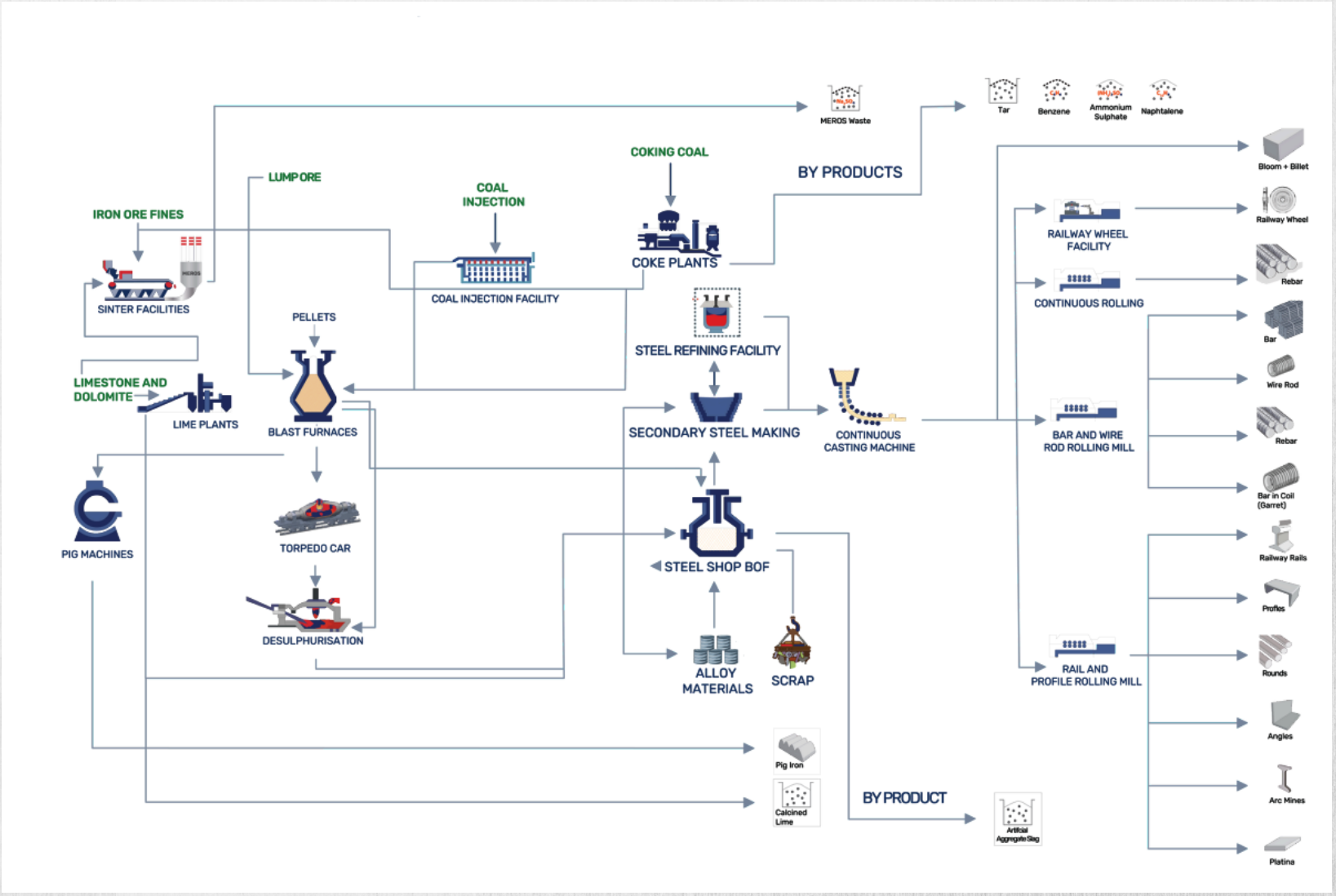
C4 (Downstream)- Disposal

The C4 stage addresses the final disposal of the portion of steel rails that are not recycled. As steel is predominantly recycled at end-of-life, only 5% of the total product mass is assumed to be sent to landfill. This fraction undergoes compacting as inert construction waste for landfilling or backfilling purposes. In the absence of primary data, the applicable PCR assumption has been applied, with diesel consumption estimated at 1.6 kWh per tonne of waste. Emissions are modelled accordingly for this minor share of the product.

Process Flow Diagram



Process Flow Diagram



LCA Information

Declared Unit:

1 tonne of steel rail.

Time Representativeness:

Full year of 2024 (2024.01.01 – 2024.12.31).

Database(s) and LCA Software:

Ecoinvent 3.11 and SimaPro 10.

System Boundaries:

Cradle to grave with options, covering stages A1-A3 and C1 to C4.

Source of Electricity

Approximately 60% of the electricity used on site is generated internally through Kardemir's on-site coal and gas fired power plant (CPP). The remaining 40% is sourced from the national electricity grid. The internal generation ensures partial energy independence and contributes to the stability of supply for energy-intensive steel production processes.

Allocation

Allocation has been applied where relevant in accordance with ISO14025:2006 and ISO 14044. In the coke oven process, environmental impacts were allocated based on energy content among coke, coke oven gas and related co-products. In the blast furnace (BF) process, economic allocation was applied to distribute impacts between hot metal, granulated blast furnace slag and blast furnace gas. In the basic oxygen furnace (BOF) process, allocation was carried out based on energy content. Internal production scrap is considered a closed-loop flow and fully recycled within the system without allocation, while externally purchased scrap is modelled as an input material according to its respective background data.

Cut-Off Criteria

The criteria for exclusion were set so that individual input flows less than 1% of the total, with a cumulative limit of less than 5%, could be omitted. This was contingent upon confirming that these excluded flows did not significantly alter the reported data, with "significant" defined as affecting the total by less than 5%.

REACH Regulation

No substances included in the Candidate List of Substances of Very High Concern for authorization under the REACH regulations are present in this product either above the threshold for registration with the European Chemicals Agency or above 0.1% (wt/wt).

Packaging Composition

Steel rails are sent to customers without packaging. Thus, there is no need for packaging material.

Background Data

For all LCA modelling and calculation, Ecoinvent database (v3.11) and SimaPro (v10.0.2) LCA software were used. Characterization factors of EN 15804 reference package based on EF 3.1 are utilized. Impact of infrastructure and capital goods are excluded from the analysis.

Content Declaration

The content declaration is provided as intervals due to confidentiality reasons.

Product Component	Weight, %	Post-consumer material, weight-%	Biogenic material, weight-% of product	Biogenic material, kg C/declared unit
Steel Rails*	100	11.2	0	0
Total	**100**	**11.2**	**0**	**0**

*Steel rails are made through steel rail blooms.

LCA Information

LCA RESULTS for 1 ton of Steel Rail

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

CORE ENVIRONMENTAL IMPACTS PER DECLARED UNIT

Mandatory indicators	Unit	Upstream	Core	Downstream	Total
GWP-total	kg CO_2 eq.	8.66E+02	1.57E+03	3.00E+01	2.47E+03
GWP-fossil	kg CO_2 eq.	8.64E+02	1.57E+03	3.00E+01	2.46E+03
GWP- biogenic	kg CO_2 eq.	2.06E-01	5.48E-01	3.62E-02	7.90E-01
GWP-luluc	kg CO_2 eq.	9.05E-01	1.81E-01	2.92E-03	1.09E+00
ODP	kg CFC 11 eq.	5.57E-06	6.54E-07	5.87E-07	6.81E-06
AP	mol H+ eq.	6.50E+00	2.58E+00	1.07E-01	9.20E+00
EP-freshwater	kg P eq.	8.45E-01	1.54E-01	8.43E-04	1.00E+00
EP- marine	kg N eq.	1.54E+00	6.07E-01	4.37E-02	2.19E+00
EP-terrestrial	mol N eq.	1.65E+01	6.39E+00	4.77E-01	2.34E+01
POCP	kg NMVOC eq.	4.56E+00	2.80E+00	1.73E-01	7.53E+00
ADP - minerals & metals*	kg Sb eq.	1.03E-03	1.15E-05	1.05E-06	1.05E-03
ADP-fossil*	MJ	1.90E+04	2.86E+03	4.03E+02	2.23E+04
WDP*	m^3	2.73E+02	6.35E+02	9.53E-01	9.08E+02
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption				
***Disclaimer 1**	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.				
****Disclaimer 2**	This impact category deals mainly with the eventual impact of low dose ionising radiation on human health of the nuclear fuel cycle, It does not consider effects due to possible nuclear accidents, occupational exposure, or due to radioactive waste disposal in underground facilitie. This indicator also does not measure potential ionising radiation from the soil, from radon and from some construction materials is also not measured by this indicator.				

LCA Information

Additional Mandatory and Voluntary Impact Category Indicators

Parameter	Unit	Upstream	Core	Downstream	Total
***GHG-GWP	kg CO_2 eq.	8.66E+02	1.57E+03	3.00E+01	2.47E+03
*** Disclaimer 3	GWP-GHG = Global Warming Potential total excl. biogenic carbon following IPCC AR5 methodology. The indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. The GWP-GHG indicator is identical to GWP-total except that the characterisation factor (CF) for biogenic CO_2 is set to zero.				

Resource use

Parameter	Unit	Upstream	Core	Downstream	Total
PERE	MJ	9.14E+02	1.10E+02	5.19E+00	1.03E+03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	9.14E+02	1.10E+02	5.19E+00	1.03E+03
PENRE	MJ	1.90E+04	2.86E+03	4.03E+02	2.23E+04
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.90E+04	2.86E+03	4.03E+02	2.23E+04
SM	kg	2.55E+02	2.03E-02	3.21E-04	2.55E+02
RSF	MJ	6.71E-02	2.20E-03	3.60E-05	6.93E-02
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	6.87E+00	1.48E+01	2.40E-02	2.17E+01
Legend	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 re-sources; SM: Use of secondary material; RSF: Use of renewable secondary fuels; NRSF: Use of non-renewable secondary fuels; FW: Use of net fresh water				

Waste & Output Indicators

Parameter	Unit	Upstream	Core	Downstream	Total
HWD	kg	2.95E+02	7.16E+01	5.69E-02	3.67E+02
NHWD	kg	4.25E+03	1.89E+03	4.60E+00	6.15E+03
RWD	kg	3.74E-03	1.92E-04	1.54E-04	4.09E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	8.50E+02	8.50E+02
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE (Electrical)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE (Thermal)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	HWD: Hazardous waste disposed, NHWD: Non-hazardous waste disposed, RWD: Radioactive waste disposed, CRU: Components for reuse, MFR: Material for recycling, MER: Materials for energy recovery, EE (Electrical): Exported energy electrical, EE (Thermal): Exported energy, thermal.				

References

PCR 2023:01 (ver. 2.0.1) FABRICATED METAL PRODUCTS, EXCEPT CONSTRUCTION PRODUCTS

ISO 14040:2021 “Environmental management - Life cycle assessment - Principles and framework”.

ISO 14044:2018 “Environmental management - Life cycle assessment - Requirements and guidelines”.

ISO 14025:2006 “Environmental labels and declarations - Type III environmental declarations - Principles and procedures”.

General Program Instructions of International EPD System, (Ver. 5.0.1) 2025-02-27 “General Programme Instructions for International EPD System”.

Ecoinvent database (v3.11) - www.ecoinvent.org

Kardemir www.kardemir.com

Metsims www.metsims.com

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