Report on Scopes 1, 2 and 3

Management of GHG emissions and decarbonization strategy

Photograph Valdirene Resende

Index

Photograph: Ricardo Teles

1

Introduction

Iron ore wagons
Parauapebas, Pará (PA), Brazil, 30-Nov-2020 - Serra Norte, Carajás. Aeriel view of wagons loaded with iron ore. Photo: Ricardo Teles

Vale is one of the leaders in the supply of essential products for the development of the world's production chains, being guided by the understanding that new ways of doing business will be necessary to construct the Vale of the future: a company aiming to promote more sustainable mining, with a low carbon approach and a focus on the disciplined allocation of capital.

A recurring topic in the World Economic Forum's Global Reports, climate change is recognized as being one of the leading global risks to society and production chains. This reality is reflected in the concern felt by the interested parties over Vale's corporate risks and materiality. The challenge is to facilitate low carbon mining as a cross-sectional agenda for the entire value chain, an approach that aims to make the business resilient to the effects of climate change.

The company's Global Climate Change Policy outlines the commitments and strategic directives for its reduction of greenhouse gas (GHG) emissions. In order to accelerate the decarbonization agenda, and with support provided by its global policy, Vale can count upon strong internal governance in pursuit of this goal. Since 2019, the Low Carbon Forum, made up of members of the Executive Committee and the senior management, has been monitoring the implementation and delivery of the commitments assumed, as well as the variable remuneration targets tied to the reduction of emissions.

In 2019, Vale established public commitments regarding the reduction of its Scope 1 and 2 emissions, namely:

- **To reduce the absolute Scope 1 and 2 emissions by 33% by 2030** in line with the Paris Agreement to limit global warming to less than 2°C (WB2D – Well Below 2 Degrees), using 2017 as the base year;
- **To reduce the net Scope 1 and 2 emissions to zero (net zero) by 2050.**

Besides the operational boundaries, the Scope 3 emissions account for 98% of Vale's total GHG emissions. Whilst in 2022 the company emitted approximately 8.9 million tons of CO_2e[1] in Scopes 1 and 2, the Scope 3 emissions were in the order of 477.8 million tons of CO_2e per year in 2022.

In 2020, Vale was the first company in the sector to assume a quantitative target with regard to Scope 3, aiming to **reduce its net emissions by 15% by 2035**, in relation to its 2018 levels, such being defined according to science-based methodology[2] and aligned with the scenario of a temperature increase of 2°C.

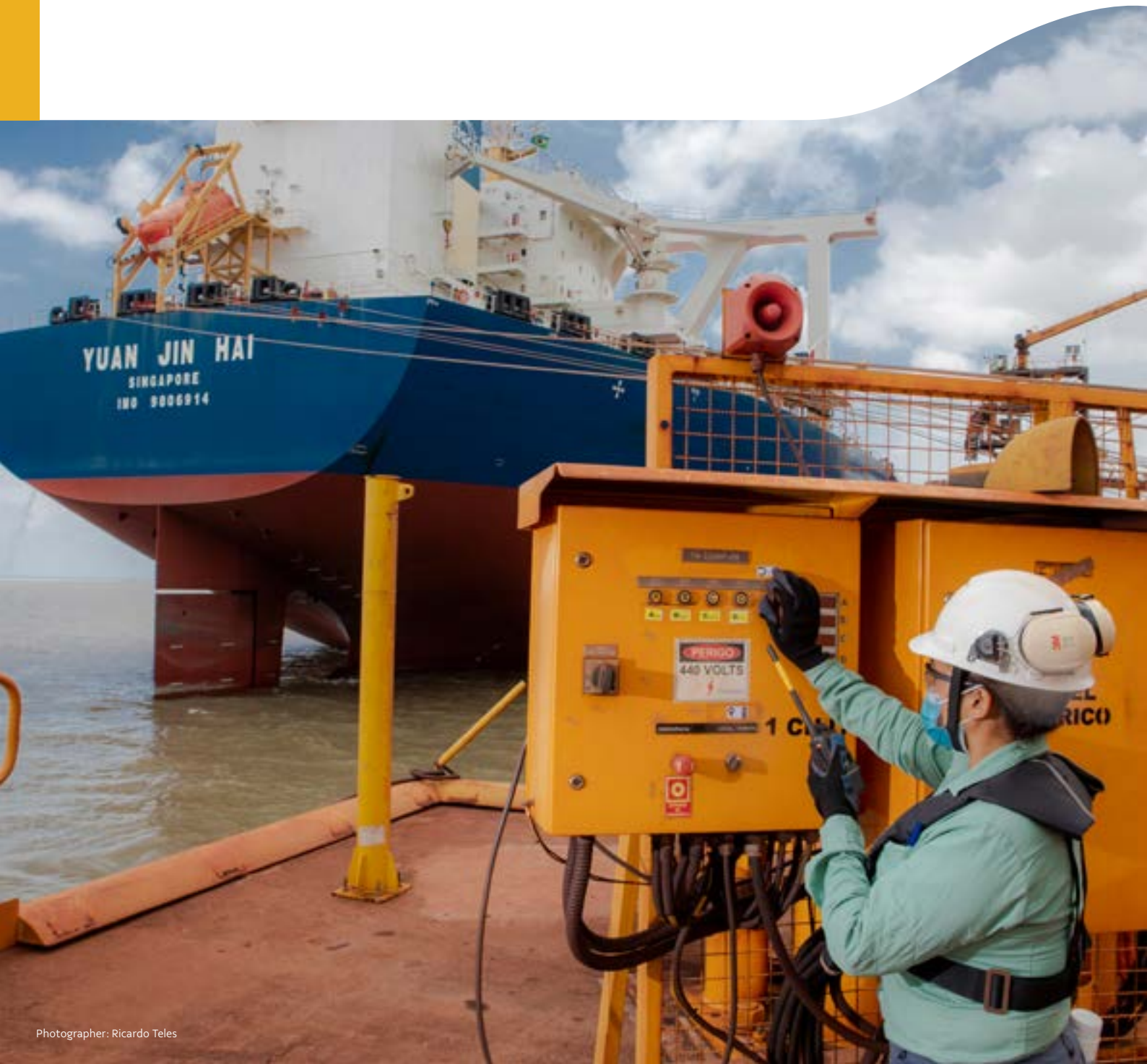
Photographer: Valdirene Resende

Vale's climate commitments are reflected in the strategic pillar of promoting low carbon solutions, with a focus on top-quality products and resources, solutions for the steel industry, metals for the energy transition, and circular mining.

[1]Result of the GHG inventory based upon the Market-based methodology of the GHG Protocol. Value based upon the Location-based methodology equal to 9.2 million tons of CO_2e
[2]Methodology: SBTi – TWG-INF-002 | Version 4.2 April 2021.

2

Results of
Scopes 1, 2 and 3



Photographer: Ricardo Teles

In 2022, Vale's GHG emissions, including Scopes 1, 2 and 3, totaled 486.7 million tons of CO_2 equivalent, with 8.9 million relating to Scopes 1 and 2 and the rest, 477.8 million tons of tCO_2e, or around 98%, corresponding to Scope 3 emissions. Vale uses the methodology established by the *GHG Protocol*[1] to calculate its emissions, which are verified annually by a third party, based upon the limited assurance methodology.

Vale's Scope 1 direct emissions are principally the result of the transportation activities and the industrial processes undertaken within the operational areas, whilst the Scope 2 indirect emissions arise from the purchase and consumption of electricity. Vale has established a 'PPA' ('*Power Purchase Agreement*') with its renewable energy suppliers, which allows for the calculation of its Scope 2 market-based emissions. In 2022, the Scope 1 and 2 market-based emissions totaled 8.9 million tons of CO_2e, a reduction of 27% against the base year of 2017. This reduction is directly related to the fall in the volume of production in relation to the base year.

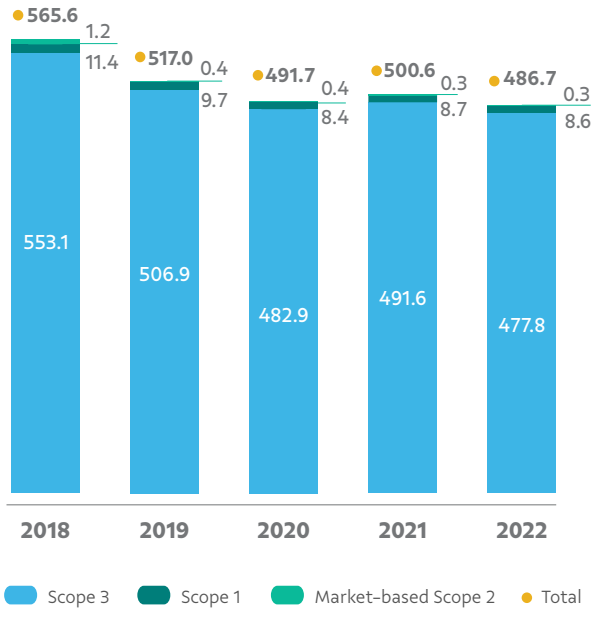
The Scope 3 indirect emissions take place outside the company's operating limits and are associated with the value chain, including suppliers and clients. In 2022, the Scope 3 emissions dropped by 14% against the base year of 2018, due principally to the reduction in the volume of sales of products, especially pellets, which dropped by 41%, and iron ore, which fell by 12%, in relation to 2018. However, according to Vale's production and sales report, production is expected to increase in the short-term, which could lead to an increase in emissions.

The results of the analysis of the GHG Inventory are presented in the Integrated Report, produced annually in accordance with the GRI (*Global Reporting Initiative*) standards, allowing the company to monitor the efforts and progress made to reduce emissions, with the aim of achieving the reduction targets established by Vale, and clearly and transparently communicating the company's evolution in this area to the interested parties.

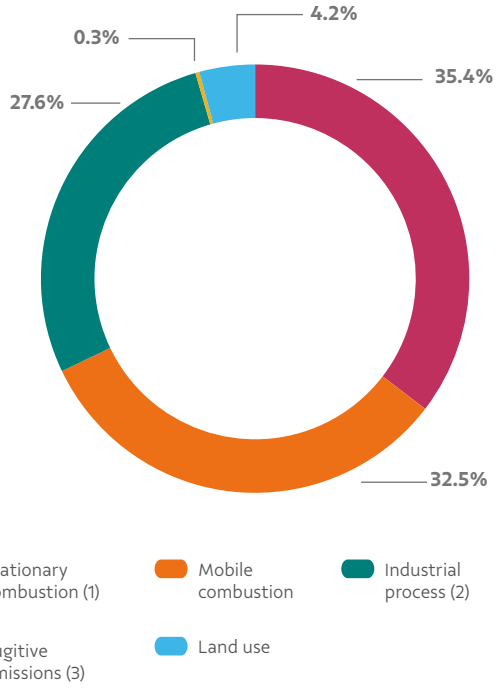
The limits of the Scope 1 and 2 emissions inventory are defined by Operational Control. Vale's operational and administrative units[2] are located in seven countries: Brazil, Canada, Indonesia, Japan, Malaysia, Oman and the United Kingdom. The company's principal operational and administrative activities are located in Brazil, resulting in a 61.3% share of Scope 1 and 2 market-based emissions, 5.45 $MtCO_2e$ of the total emissions.

Vale's total GHG emissions

Millions of [tons of] tCO_2e



Representation of the Scope 1 emissions sources in 2022



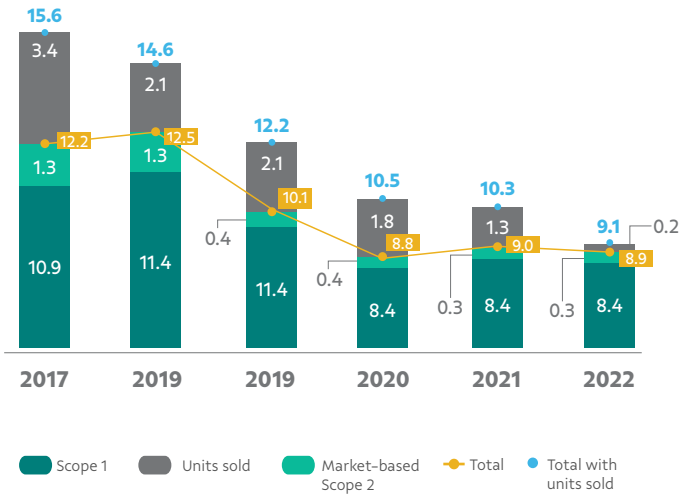
(1) Stationary Combustion: fuel consumption and use of explosives.
(2) Industrial Process: pelletizing and production of nickel and coproducts.
(3) Fugitive emissions: HFC and SF6 cooling gases.
(4) Emissions due to changes in land use.

[1] *Corporate Standard and Corporate Value Chain (Scope 3) Standard*

[2] Considering the 2022 disinvestments in the mining of Moatize coal, in Mozambique, and the iron ore, manganese, logistics and mining assets in the Central Western region of Brazil, and the Vale Nickel (Dalian) Co. In these situations the *Greenhouse Gas (GHG) Protocol* recommends that, in the year in which the sale is realized, the emissions should not be considered in the inventory, both in relation to the year under analysis and the previous years.

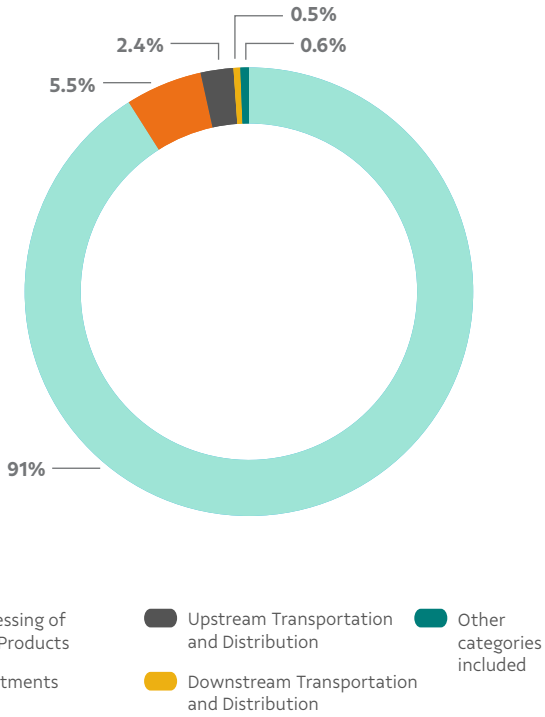
Vale's Total GHG emissions – Market-based Scope 2

Millions of tons of tCO_2e



Vale's Scope 3 GHG emissions inventory currently takes into account nine of the 15 categories established by the GHG Protocol[3]. The other unreported categories are reviewed periodically to check whether they should be included or not. In the Upstream categories, the emissions associated with the suppliers of raw-materials, products and services are calculated, as well as their transportation, with the conclusion that they accounted for 3% of the Scope 3 emissions in 2022. The Downstream categories account for around 97% of Vale's Scope 3 emissions, relating principally to the processing, use and transportation of the products traded by the company, including: (i) Iron Ore and Pellets; (ii) Nickel; (iii) Copper; (iv) Cobalt; (v) Manganese; and (vi) Ferroalloy.

Representation of the Scope 3 categories in 2022



As can be observed above, the majority of the emissions are associated with the 'Processing of Sold Products' category, which accounted for 91% of the Scope 3 inventory in 2022.

[3] *Scope 3 Calculation Guidance | GHG Protocol*

The table below presents the historical results from 2018 to 2022, by category:

Scope 3 by category

Millions of tons of tCO_2e

Category	Method	2018	2019	2020	2021	2022
Upstream						
1 – Purchased goods and services	"average-data"	1.74	1.57	1.41	1.46	1.53
2 – Capital goods	"average-data"	0.03	0.01	0.01	0.01	0.01
3 – Fuel and energy-related activities not included in Scope 1 or Scope 2	"average-data"	1.57	1.36	1.24	1.47	1.30
4 – Upstream transportation and distribution	"fuel-based" and "distance-based"	13.90	11.63	12.40	11.72	11.28
5 – Waste generated in operations	Not quantified; irrelevant	NA	NA	NA	NA	NA
6 – Business Travel	"distance-based"	0.01	0.02	0.01	0.01	0.02
7 – Employee commuting (home to work)	"fuel-based"	0.04	0.03	0.04	0.07	0.05
8 – Upstream leased assets (the organization as lessee)	NA	NA	NA	NA	NA	NA
Downstream						
9 – Downstream transportation and distribution	"fuel-based" and "distance-based"	5.05	3.32	2.36	2.40	2.35
10 – Processing of sold products	"average-data"	506.63	468.26	438.74	447.66	434.87
– Manganese	"average-data"	34.62	29.84	30.04	8.08	1.26
– Iron Ore	"average-data"	466.04	433.01	403.37	434.25	428.08
– Base Metals	"average-data"	5.97	5.41	5.34	5.33	5.53
11 – Use of sold products	NA	NA	NA	NA	NA	NA
12 – End-of-life treatment of sold products	Not quantified; irrelevant	NA	NA	NA	NA	NA
13 – Downstream eased assets (the organization as lessor)	NA	NA	NA	NA	NA	NA
14 – Franchises	NA	NA	NA	NA	NA	NA
15 – Investments	"investment-specific"	24.14	20.67	26.71	26.80	26.42
Total	–	**553.11**	**506.87**	**482.92**	**491.60**	**477.81**

3

Decarbonization strategy

Photograph: Zé Palma

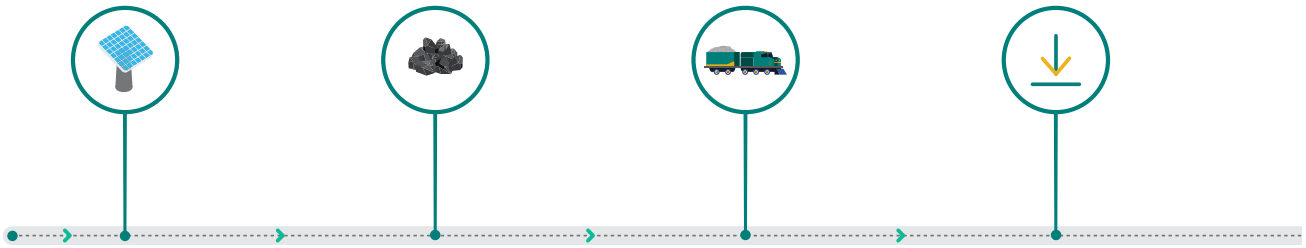
Strategy for the reduction of Scope 1 and 2 GHG emissions[1]

Vale's aim to reduce its Scope 1 and 2 emissions by 33% by 2030 is aligned with the targets of the Paris Agreement to limit global warming to less than 2°C (WB2D) and is based upon the emissions recorded in 2017, which totaled 12.2 $MtCO_2e$. The target was established using the science-based methodology[2], focused on decarbonization and total reduction of the emissions.

Vale's decarbonization journey involves renewable energy initiatives designed to use renewable sources to supply 100% of the electricity consumption, which is reflected in the company's targets to reduce its Scope 2 emissions in Brazil to zero by 2025 and in the other countries where the company has operations by 2030. With regard to this, almost 100% of its energy for electricity consumption in Brazil was generated from renewable sources by 2022, and this is an important intermediary step in relation to the company's decarbonization commitments.

Vale intends reducing the GHG emissions in its operations in the medium and long-terms, increasing the energy efficiency of its processes and developing solutions based upon the replacement of fossil energy sources with renewable alternatives. Such alternatives include the use of electricity and alternative fuels in trucks and locomotives, as well as solutions related to the substitution of mineral coal and other fossil fuels with renewable or low carbon fuels in the pelletizing and metal processing activities. As part of this strategy, in 2022, Vale continued its pilot projects focused on the use of bio-carbon[3] and bio-oil[4] for the manufacture of pellets and 72-ton electric trucks in mines, amongst other initiatives.

A solid path towards reducing our Scope 1 and 2 emissions



2017

2023

Sol do Cerrado in full operation

~7p.p of the target

- Biomass tests for the replacement of fossil fuels in the pelletizing
- and metalwork processes.
- Continuity of the electric truck pilot projects.

2025

Two pelletizing plants converted into briquetting plants

~10p.p of the target

- Scope 2 emissions reduced to zero in Brazil.
- The Voisey's Bay wind-power plant.
- Ending of the consumption of fuel oil in pelletizing and conversion of two plants into briquetting plants.

2026-2028

~ 13-27 p.p of the target

- Ramping up of trucks and locomotives powered by alternative fuels/electricity.
- Replacement of coal with low carbon fuels in the majority of the pelletizing and metallurgical processes.

2030

33% reduction of the GHG emissions

- Scope 2 emissions
- reduced to zero globally.
- Reduction of Scope 1 emissions through the use of renewable and low emission fuels.

In order to achieve our greenhouse gas emissions reduction targets, we have forecast investments in our operations of between four and six billion dollars by 2030. Since 2020, our spending related to climate change has totaled USD 810 million, with USD 543 million of this being invested during the last year. Read more about our projects on our ESG Portal.

[1] The decarbonization strategy and the Scope 1 and 2 emissions reduction forecasts take into account the contributions made by each one of the projects on the MAC curve and the associated costs.
[2] Calculation methodology: SBTi – TWG-INF-002 | Version 4.2 April 2021.
[3] Bio-carbon is a renewable product that is currently considered to be carbon neutral by the GHG Protocol, being obtained by means of the carbonization of certified biomass and tested as a replacement for coal.
[4] Bio-oil is a renewable product that is currently considered to be carbon neutral by the GHG Protocol, with a plant oil base and tested as a replacement for natural gas.

Strategy for the reduction of Scope 3 emissions

Vale's commitment to reducing its Scope 3 net emissions by 15% by 2035 means a reduction of more than 80 million tons of CO_2 equivalent. This challenge involves the shipping and steel sectors, in which it is felt that the reduction of GHG emissions is extremely difficult, principally due to the unavailability of the relevant technology and the high costs of conversion and replacement that have still not yet been priced by means of regulated carbon markets.

Photograph: Marcelo Coelho

To fulfill its commitments, Vale has established a strategy aiming to achieve the decarbonization of Scope 3 emissions that involves three main lines of activity:

Provision of a **portfolio of top-quality products and innovative technologies** to provide solutions that lead to a reduction in the emissions from its chain;

- **Partnership and engagement with the value chain;**
- **Limited use of high integrity carbon credits**, following principles such as additionality, permanence, transparency and contributions to sustainable development.

Portfolio of high-quality products and innovative technologies:

It is estimated that Vale's own initiatives will contribute to between 15% and 25%[4] of the reduction required to reach this target. In this line of operation, Vale's leading strengths are taken into consideration, with the understanding that this is a company that has its own portfolio of top-quality products that will set the stage for a reduction of steel-manufacture emissions, including innovative technologies and processes such as:

- **Direct reduction iron ore products:** direct reduction means a lower intensity of emissions compared to blast furnace production.
- **Mix of top-quality products:** by supplying top-quality iron ore to the steel industry, Vale's products intrinsically provide the most energy efficient iron ore for the manufacture of iron, since they require a lower specific consumption of fuel.
- **New solutions for the steel industry:** Vale is working with its partners Kobe, Midrex and Mitsui to establish projects capable of supplying HBI (Hot Briquetted Iron), whilst also using its own 'Tecnored' process to supply pig iron – both HBI and pig iron are necessary to being able to dilute the impurities found in metal scraps, thus allowing this material to be recycled in the form of top-quality steel. In 2021, Vale acquired a minority share in the Boston Electrometallurgical Company ("Boston Metal"), with the intention of promoting development of an innovative technology focused on the decarbonization of steel, named Molten Oxide Electrolysis (MOE), which produces steel via electrolysis directly from iron ore, using electricity instead of coal.
- **Briquette:** produced by means of the briquetting of iron ore fines and a technological solution involving binders that allows the achievement of high mechanical resistance in low temperatures, this product can replace sinter, pellets and lump ore in blast furnacing, and pellets in direct reduction furnaces. The replacement of the sintering stage allows for a potential 10% reduction in GHG emissions. This new type of briquette emits around 80% less carbon in relation to pellets during the manufacturing process, thus lowering the company's direct and indirect emissions.

[4] 2021 Climate Change Report

Partnership and engagement with the value chain:

The necessary additional reductions represent around 75 to 85% of the target – the majority arising from the engagement of suppliers and clients with the intention of helping them innovate and decarbonize.

Photograph: Vitor Nogueira

- **Suppliers:**
  We are engaged with 492 of our suppliers by means of the CDP Supply Chain, with an adherence rate of 84%, using our size and importance to influence best climate change management practices.

Photograph: Marcelo Coelho

- **Clients:**
  We are mapping different steel decarbonization technologies and their cost competitiveness, and we are open to partnerships with our clients in this area.

Partnership and engagement with the value chain:


Photograph: Nivaldo Lage

Steel


Photograph: Valdirene Resende

More than 90% of Vale's Scope 3 emissions are due to the processing of iron ore in the steel industry (blast furnaces).

The GHG emissions from the steel industry have been increasing annually, having more than doubled in the last 20 years. Today this is one of the industries that has the greatest impact on climate change, responsible for around 7% of global GHG emissions[5].

The steel industry is a 'hard-to-abate' sector, not due to the non-existence of reduction technologies, but rather due to the higher cost of reduction compared to other sectors. To unlock the potential for the reduction in emissions, a number of facilitating factors are necessary, including global carbon pricing and the availability of investments for the development of low carbon technologies - necessary conditions for achieving the ambitions of the Paris Agreement.

The analysis of different scenarios helps Vale to understand the paths open to the steel and mining industries to be able to achieve the targets established by the Paris Agreement and limit global warming to "well below 2°C". Vale has set out four main paths for the reduction of emissions:

- **Energy efficiency:** Heat recovery, iron ore quality and improvement in the manufacturing process.
- **Circular economy:** *Electric Arc Furnace* and *Basic Oxygen Furnace*.
- **Low carbon fuels:** Use of fuels with lower or zero emissions of CO_2 compared to the metallurgical coke used in blast furnaces, such as natural gas, green hydrogen, biomass and other byproducts of the Tecnored process.
- **CCUS:** Capture, use and storage of carbon.

[5]Source: World Steel Association
[6]https://www.tecnored.com.br/nossa-tecnologia/

Partnership and engagement with the value chain:

Photograph: Anderson Bibico

Shipping


Photograph: Vitor Nogueira

In the area of shipping, included in Scope 3, Vale is committed to the targets established by the International Maritime Organization (IMO) to work to reduce the intensity of emissions by at least 40% by 2030, reach peak emissions as soon as possible, and achieve net zero emissions by or around 2050, taking the 2008 emissions as a benchmark[7].

The company has created the Ecoshipping program, involving the collaboration of different industry players, aiming to promote projects that reduce emissions in the marine transportation of our products. The pilots of the program include innovative technologies designed to reduce the intensity of emissions, including rotating sails, air lubrication and multi-fuel tanks.

A number of new test technologies deserve special mention:


Photograph: Anderson Bibico

Rotating sails: This technology uses wind to generate thrust and move the ship, resulting in fuel economy. The use of this technology in Very Large Ore Carriers (VLOC) means a fuel economy of between 5% and 8% and an annual reduction of as much as 3,500 tons of CO_2 equivalent per ship.

[7]Revised GHG reduction strategy for global shipping adopted (imo.org)

Credit: Video produced by the Look production company

Air lubrication: This technology injects balls of air under the vessel to reduce the resistance to friction and save fuel. It is estimated that by using this technology on a Guaibamax vessel energy efficiency is increased by between 4% and 8% in relation to the normal speed, with an annual reduction of up to 5,600 tons of CO_2 equivalent per ship.

Morten Løvstad (Business Director, DNV), Cristina Saenz de Santa Maria (Regional Manager, DNV Maritime), Rodrigo Bermelho (Shipping Technical Manager, VALE), Remi Eriksen (President and CEO, DNV Group), Guilherme Brega (Global Head of Shipping & Distribution, VALE) and Lukasz Luwanski (Regional Business Development Manager, DNV)

Photograph: DNV site

Multifuel tanks: this joint-industry project for the pioneering development of Type B tanks and container systems for a range of fuels such as LNG, methanol and ammonia, is being developed by Vale SA together with DNV.

The fleet of vessels contracted by Vale currently adheres to the highest market energy efficiency standards, due to the high volume transported and economy of scale. Valemax ships have been in operation since 2018, and Guaibamax ships since 2019. Both are second generation VLOCs, with 400,000 and 325,000 capacities respectively. Both emit up to 41% less CO_2 equivalent than a 180,000 ton Capesize, constructed in 2011, used as a base for the first generation Valemaxes launched that year.

The second generation Valemaxes and Guaibamaxes were also designed to use liquid natural gas (LNG) in the future, which could allow for a further 23% reduction[8] per ship once the system has been installed.

Vale is also developing a solution for new alternative fuels, such as methanol and ammonia.

A preliminary evaluation has indicated that the reduction in emissions can vary between 40% and 80%. The plan is to have multi-fuel ships ready to be adapted to the more acceptable fuels as soon as the current technological and regulatory uncertainties have been better defined.

Finally, in 2023, Vale submitted a request for proposal to the market for the construction of the next generation of Guaibamax vessels. These ships are set to represent the cutting edge in decarbonization and will be equipped with a set of technologies that will facilitate a reduction in the intensity of emissions, including rotating sails, advanced hull coating, and shaft generators, amongst others. Biofuels will also be employed with the possibility of using fuel oil or methanol, with the future option of being adapted to use liquid natural gas and/or ammonia.

[8]Amount calculated using a study based on the Guaibamax

Limited use of high integrity carbon credits:


Photograph: Alexandre Rezende

Offsetting


Photograph: Vantoen Pereira Jr.

Vale's Scope 3 involves 'hard-to-abate' sectors, such as shipping and steel manufacture. As such, in order to achieve the Scope 3 target, the flexibility of use is limited to 20%[9], meaning around 17 $MtCO_2e$ of high-integrity carbon credits, following principles such as additionality, permanence, transparency and contributions to sustainable development.

Vale is committed to transparency and will use its expertise and knowhow to find solid, nature-based solutions, whilst also entering qualified carbon markets that have high standards of credibility, always in line with the best international practices. Vale actively contributes in the form of public hearings and working groups in institutions that define the requirements and criteria for the definition and use of high-integrity carbon credits, such as the *Integrity Council for the Voluntary Carbon Market* and the *Voluntary Carbon Market Initiative*. Furthermore, Vale was one of the companies that participated in the pilot version of the *GHG Protocol Land Sector and Removals Guidance*, with one of the main objectives being the definition of the calculation of biogenic and technological reductions and removals at the limits of corporate GHG inventories.

[9]In order to forecast the use of carbon credits to fulfill the commitment, SBTi has formally established that it will not approve our Scope 3 target and neither will it approve the target for Scopes 1 and 2 separately.

4

Methodology for calculation of the GHG emissions

Photograph: Marcelo Coelho

4.1. Calculation standard

For the calculation of the Scope 1, 2 and 3 GHG emissions, Vale follows the guidelines and methodologies contained in the Greenhouse Gas (GHG) Protocol: *Corporate Standard and Greenhouse Gas (GHG) Protocol*: Corporate Value Chain (Scope 3) Standard, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).

Vale follows the directives of the GHG Protocol in its selection of the emissions factors adopted in the calculation of the inventory, whilst the *Global Warming Potential* (GWP) values considered were taken from the Fifth Assessment Report (AR5) published by the Intergovernmental Panel on Climate Change (IPCC).

This GHG Protocol directive establishes fifteen (15) categories of Scope 3 emissions sources, divided into 'Upstream' and 'Downstream' emissions. The Upstream emissions are classified as indirect GHG emissions related to goods and services purchased or acquired for use by Vale, being divided into eight categories. The Downstream emissions, meanwhile, are related to goods and services that are provided by the reporting organization (Vale), being divided into seven categories.

The following chart provides a detailed description of all the Scope 3 categories of the GHG Protocol.

Photograph: Zé Palma

Description of the Scope 3 categories

Category	Description
Upstream	
1 – Purchased Goods and Services	Upstream emissions (cradle to gate) arising from the extraction, production and transportation of goods and services acquired by the reporting company in the reporting year, when not included otherwise in categories 2 to 8.
2 – Capital Goods	Emissions arising from the extraction, production and transportation of purchased or acquired capital goods (plant, properties, equipment – 'PP&E').
3 – Fuel and energy-related activities not included in Scopes 1 or 2	Emissions related to the extraction, production and transportation of fuels and energy purchased and consumed by the company. The energy acquired for the processes (Scope 2) present transmission and distribution losses in the system, such which are also calculated in this category.
4 – Upstream transportation and distribution	Emissions related to the transportation and distribution of Vale's inputs, products and waste, when executed by a directly contracted third party company (inbound – transportation from the suppliers to Vale; and outbound – transportation from Vale to the consumer or final disposal). Also includes the emissions caused by transportation of materials and between units.
5 – Waste generated in operations	Emissions resulting from the disposal and treatment of waste generated in the reporting company's operations in the reporting year, occurring in third parties' installations (installations not owned or controlled by the reporting company).
6 – Business travel	Emissions arising from business trips, including both domestic and international flights undertaken by employees, as well as other services related to business trips, such as accommodation in hotels and vehicle hire.
7 – Employee commuting (home-work)	Emissions arising from the transportation of employees between their homes and their worksites during the reporting year (in vehicles that do not belong to or are not operated by the reporting company).
8 – Upstream leased assets (the organization as lessee)	Emissions arising from the operation of assets that are leased by the reporting company (lessee) during the reporting year, that have not already been included in the reporting company's Scope 1 or Scope 2 inventories.

Source: Definition of the Scope 3 categories. Technical Note from the Brazilian GHG Protocol Program.

Category	Description
Downstream	
9 – Downstream transportation and distribution	Emissions arising from the transportation and distribution of products sold by the reporting company in the reporting year between the company's operations and the end consumer (if not paid for by the company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company).
10 – Processing of sold products	Emissions arising from the industrial processing of products subsequent to sale by the reporting company. This category includes emissions generated through to the end of the chain (end consumer).
11 – Use of sold products	Emissions arising from the end use of goods and services sold by the reporting company.
12 – End-of-life treatment of sold products	Emissions arising from the disposal and treatment of waste from products marketed by the reporting company, during the reporting year, when these products reach the end of their useful life.
13 – Downstream leased assets (the organization as lessor)	Emissions arising from the operation of assets that are the property of the reporting company (lessor), that were leased to other entities during the reporting year, and have not already been included in the reporting company's Scope 1 or Scope 2 inventories.
14 – Franchises	Emissions arising from the operation of franchises in the reporting year, not already included in the franchisor's Scope 1 or Scope 2 inventories.
15 – Investments	Emissions associated with the operation of the reporting company's investments, including investments in shares, debts and project financing during the reporting year; and emissions not already incorporated in Scope 1 and/or Scope 2.

Source: Definition of the Scope 3 categories. Technical Note from the Brazilian GHG Protocol Program.

4.2. Calculation methodologies

Calculation of the Scope 1 and 2 emissions in Vale's inventory is disaggregated, with a combination of the 'top-down' and 'bottom-up' approaches (by business units and type of equipment when available), using mass balance and emissions factors for each type of input and activity, and for each of the countries where Vale operates.

Vale collects and consolidates the data from all the units and emissions sources in the inventory. The majority of the data is collected and analyzed on a monthly basis, including use of fuels, electricity, explosives and data on industrial processes activities, which are also used for calculation of Scope 3 categories 1 and 3. The polygon of Vale's properties and suppressed areas of nature, the purchase of capital goods, amount of products sold, cooling gases, and transportation performed by third parties, amongst others, are collected annually.

The following table shows the tier levels[4] that are applied to each type of source in Vale's inventory:

Type of emissions source	Calculation method used	Tier level
Scope 1 Burning of fuels	CO_2: Mass balance, with specific carbon content by type of fuel and country CH_4 and N_2O: IPCC or domestic benchmark emissions factors by type of equipment and fuel	*Tier 2* for CO_2 *Tier 1* for CH_4 and N_2O
Scope 1 Pellet production	CO_2: Mass balance	*Tier 2* for CO_2
Scope 1 Nickel and Ferronickel production	CO_2: Mass Balance	*Tier 2* for CO_2
Scope 1 Use of explosives	CO_2: Emission Factor CH_4: Emission Factor	*Tier 2* for CO_2 *Tier 1* for CH_2
Scope 1 Changes in land of use	CO_2: Emission Factor	*Tier 2* for CO_2
Scope 1 Fugitive emissions of cooling gases	HFCs and SF_6: Emission Factor	*Tier 1* for HFCs and SF_6
Scope 2 Electricity consumption.	CO_2, CH_4 and N_2O: Emission factors for the generation of electricity in the Electrical System of each country or province (Canada – Manitoba, Ontario and NFL)	*Tier 2* for CO_2
Scope 3 All categories	CO_2-eq or CO_2, CH_4 and N_2O: Emissions factors in relation to the IPCC, GHG Protocol, EPA, DEFRA and Ecoinvent For category 15, there was no need to collect the emissions factors since the emissions of Joint Venture companies and those not controlled by Vale were consulted in the inventory reports and other public sources	*Tier 2* for CO_2 *Tier 1* for CH_4 and N_2O

[4]The tiers represent the level of complexity of the approach to collecting the data and calculation methodology. Three types of tier are usually established. Tier 1 is the basic and aggregate method, Tier 2 is intermediary, and Tier 3 is the most demanding method. Tiers 2 and 3 are called higher tiers and are considered to be more accurate.

No new Scope 1 or 2 emissions sources were included in the 2022 inventory. Alterations were however made to the quantification method, such as, for example, a review of the emissions factors and the properties of inputs.

The direct and indirect emissions relating to the processes of treating waste and effluents (sanitary landfills, biological treatment, composting, incineration), the direct emissions from acetylene fuel in the welding process, as well as the fugitive emissions of gases from fire extinguishers, are not calculated in the inventory, due to their insignificance in Vale's global results.

Along these lines, the following emissions sources were not included in the 2022 inventory:

- **Scope 1 –** Combustion: use of acetylene in the welding processes;
- **Scope 1 –** Fugitive emissions: use of fire extinguisher gases;
- **Scopes 1 and 3 –** Solid Waste and Liquid Effluents: direct and indirect emissions (category 5) arising from the treatment and/or final disposal of solid waste and liquid effluents;
- **Scope 3 –** Indirect emissions relating to leased assets (categories 8 and 13), use of sold goods and services (category 11), end-of-life treatment of sold products (category 12) and franchises (category 14) due to the fact that they do not apply to Vale.

In creating the inventory, we use different factors that allow the consumptions (in mass and volume, for example) to be converted into GHG emissions. Vale has a database that includes information on the physical/chemical properties of the manufacturing processes and fuels used; GHG emissions factors for each type of emissions source included in the inventory; composition of the electrical grid and percentage of losses in the transmission and distribution systems of the countries in which Vale operates; and compounds of renewable fuels and fossil fuels in the locations of the operations.

This database is revised each year to ensure that the GHG emissions for that year are as precise as possible. The revision of the database is performed in line with existing good practices, preferably using national technical benchmarks such as the Brazilian GHG Protocol, or internationally accepted benchmarks, such as the GHG Protocol, IPCC, EPA and DEFRA.

Photograph: Maurício Moreira

Vale's Scope 3 calculation methodology by category

Category	Limit	Exclusions	Information source[1]	Calculation methodology[2 3]	References
Upstream					
1 – Purchased goods and services	1) Acquisitions related to production: includes the emissions arising from the extraction, manufacture and transportation of inputs purchased and used in Vale's manufacturing processes (e.g.: bentonite, lime, limestone, dolomite, soda ash, metallurgical coke, electrodes, explosives, caustic soda, lubricating oil and grease). 2) Acquisitions not related to production: includes the emissions arising from the extraction, manufacture and transportation of consumer goods for mining and railroad infrastructures (e.g.: ball mills, conveyor belts, tires and wheels).	This category does not include inputs for civil construction (works projects), just inputs for use in the operations.	Secondary data on consumption or purchases: a) information on the amount of inputs consumed is provided by the operational units; b) information on the amount of inputs sold is provided by Vale's Corporate Procurement Department.	Based on the "average-data" method. Data on goods and services acquired by Vale, by type. Where necessary, the data has been adjusted using conversion factors. The industry's average emission factors (cradle to gate) corresponding to each commodity or service acquired have been applied afterwards.	– DEFRA – Ecoinvent
2 – Capital goods	Includes the emissions arising from the manufacture of capital goods used in railroad infrastructure (sleepers and track).	It does not include emissions arising from the assembly of equipment or manufacture of replacement parts.	Secondary data on sales: Amount of inputs sold, provided by Vale's Corporate Procurement Department.	Based on the "average-data" method. Data on capital goods acquired by Vale, by type. Where necessary, the data has been adjusted using conversion factors. The industry's average emissions factors (cradle to gate) corresponding to each item of capital goods acquired have been applied afterwards.	– Ecoinvent
3 – Fuel and energy-related activities not included in Scopes 1 or 2	Includes the emissions arising from the extraction, production and transportation of energy inputs (fuel) consumed by Vale, as well as the losses arising from the transmission and distribution (electrical grid).	--	Secondary data supplied by the Vale operational units: a) fuel consumption; b) electricity consumption and losses (%) in the distribution transmission system.	Based on the "average-data" method. Fuel and electricity consumption data are reported by the Vale units. The corresponding emission factors are applied to each type of fuel (cradle to gate). The loss of electricity by the distribution lines is estimated by means of percentage of loss, with the same emission factor for energy purchased from the GRID being applied (Scope 2).	– DEFRA – Ecoinvent – National grid emission factors – IEA (International Energy Agency)

Category	Limit	Exclusions	Information source[1]	Calculation methodology[2 3]	References
Upstream					
4 – Upstream Transportation and Distribution	This covers the emissions arising from the transportation of inputs and waste, and from the transport and distribution of products, when the contract is under Vale's responsibility.	--	Estimated secondary data: (i) fuel consumption; (ii) distance traveled (total) and vehicle performance (km/L); (iii) operation time and vehicle performance (L/h); or, (iv) cargo and distance traveled (one way).	Using the "fuel-based" and "distance-based" methods. Data provided by the supplier, considering three calculation methods: (i) fuel consumption applied to the emission factor; (ii) estimate of fuel consumption, based upon the distance traveled or time of the operation, considering the efficiency of the vehicle. Following the estimate, the emission factor is applied;and (iii) the amount of material transported and the distance traveled, considering only the one way journey, with the corresponding emission factor being applied afterwards.	- DEFRA
5 – Waste generated in operations	Not quantified; irrelevant.	Not quantified; irrelevant.	Not quantified; irrelevant.	Not quantified; irrelevant. Justification: An analysis of these emissions was performed in relation to the other Scope 3 categories, demonstrating that the emissions relating to the treatment and disposal of the waste and effluents resulting from the process are not relevant to Vale.	NA
6 – Business Travel	Includes the emissions generated by travel performed by people in the form of flights for business trips.	Land travel and accommodation, due to the minimal importance (size) and risk.	Secondary data provided by Vale's operational units, considering the distance per leg of the trip (origin-destination airport) and number of flights per leg.	Using the "distance-based" method. Emissions estimate considering the distance per leg (and the number of trips per leg, separated into three groups: (i) short trips; (ii) average distance trips; and (iii) long trips. The relative emission factor is applied to each travel group. The distance per leg of the trip is obtained from the following website: www.world-airport-codes.com	- DEFRA - PBGHG Protocol Tool - www.world-airport-codes.com

Category	Limit	Exclusions	Information source[1]	Calculation methodology[2 3]	References
Upstream					
7 – Employee commuting (home–work)	Covers the emissions arising from the journeys undertaken by employees from their homes to the workplace, based upon Vale's service provision agreements.	Journeys performed where the employees themselves are responsible, due to the influence criteria.	Estimated secondary data: (i) fuel consumption; (ii) distance traveled (total) and vehicle performance (km/L); (iii) operation time and vehicle performance (L/h).	Using the "fuel–based" method Emission estimate using two forms of calculation: (i) Fuel consumption applied to the corresponding emission factor; (ii) estimate of fuel consumption, based upon the distance traveled or time of the operation, considering the efficiency of the vehicle; the emission factor is applied following the consumption estimate.	– DEFRA – PBGHG Tool
8 – Upstream leased assets (the organization as lessee)	N.A.	N.A.	N.A.	N.A. Justification: Vale has operational leases, the emissions of which are accounted for in Scopes 1 and 2.	––
Downstream					
9 – Downstream transportation and distribution	Covers the emissions arising from the transportation of inputs and waste, and from the transportation and distribution of products, when the contract is the responsibility of the suppliers and the clients.	–	Estimated secondary data: (i) fuel consumption; (ii) distance traveled (total) and vehicle performance (km/L); (iii) operation time and vehicle performance (L/h); or, (iv) cargo and distance traveled (one way).	Using the "fuel–based" and "distance–based" methods. Data provided by the supplier, considering three calculation methods: (i) fuel consumption applied to the emission factor; (ii) estimate of fuel consumption, based upon the distance traveled or time of the operation, considering the efficiency of the vehicle. Following the estimate, the emission factor is applied; (iii) the amount of material transported and the distance traveled, considering only the one way journey, with the corresponding emission factor being applied afterwards.	– DEFRA – PBGHG Tool

Category	Limit	Exclusions	Information source[1]	Calculation methodology[2 3]	References
Downstream					
10 – Processing of sold products	Includes the emissions related to the processing of intermediary products produced and sold by Vale: – Copper concentrate and cathodes; – Cobalt; – Iron Ore; – Nickel; – Ferroalloy; – Manganese ore.	--	Amount of product sold, by type, by intended use and, whenever available, technology used in the client's manufacturing process. The amount of the product sold may be provided by the sales areas or may be drawn from the financial report (IFRS).	Based on the "average-data" method. Sale of Vale products, by type, with application of the emission factors of the industry for each product. In the case of iron ore, the client's manufacturing process and the participation of Vale in the final/interim product sold are also considered (by application of the corresponding conversion factor).	– Ecoinvent – IPCC – Copper Alliance – Nickel Institute – World Steel Association
11 – Use of sold products	Includes emissions relating to the final use of the products produced and sold by Vale, that is, Thermal Coal.	To avoid double counting between categories 10 and 11, the emissions from Metallurgical Coal for the production of steel are not included in the calculations.	The amount of thermal coal sold, taken from the financial report (IFRS).	Based on the "direct use-phase" method. Amount of Thermal Coal sold, applying the emission factor used for burning in boilers.	– IPCC
12 – End-of-life treatment of sold products	Not quantified; irrelevant.	Not quantified; irrelevant.	Not quantified; irrelevant.	Not quantified. Justification: Those of Vale's products that could be considered in this category include metals and minerals with minimal emissions at the end of their lifespans. Due to the countless uses of Vale's products and their recycling, it is not possible to estimate or assume the destination of the products.	--
13 – Downstream leased assets (the organization as lessor)	N.A.	N.A.	N.A.	N.A.	--
14 – Franchises	N.A.	N.A.	N.A.	N.A.	--
15 – Investments	Includes the temporary cutting of the corporate percentage, relating to December 2022, of companies in which Vale invested with the aim of generating a profit.	Companies that did not perform operations in 2022 and companies from the third sector have not been included.	Secondary data estimated using the emissions declared by the investees and equity interest.	Based upon the "investment-specific" method, it includes the emissions declared by the investees which, in the majority of cases, submit their inventories for auditing by a third party company.	EPA (Environmental Protection Agency of the United States) Quantity CEDA

Notes:
[1]Primary database solely for categories 4 and 9. All the other categories are estimated using secondary/internal sources.
[2]Considers the guidance methodology of the following documents: (i) GHG Protocol Corporate Value Chain (Scope 3); (ii) Accounting and Reporting Standard (Scope 3 Standard).
[3]The Credit360 system is used to compile the information and calculate the GHG emissions.
[4]The factors used, in each product or process, were adapted as necessary or applied in full.
Source: Vale Greenhouse Gases Inventory (2020).

4.3. Principal challenges for the measurement of Scope 3 emissions

Inter-sectoral double counting is inherent to the nature of the Scope 3 emissions, since the flow of upstream emissions of one company will, eventually, become the Scope 1 emissions of another. In the case of mining, for example, the emissions calculated for its Scope 3 downstream emissions, due to the processing of iron ore, are equivalent to the Scope 1 and 2 emissions reported by the steel industry.

On the other hand, the double counting within a company should be avoided in order to be able to add the Scope 3 emissions to the Scope 1 and 2 emissions. In the mining sector, no standard has been established to avoid double counting within Scope 3.

Despite the existence of various proposals designed to resolve this problem of double counting, there is no specific recommendation or unanimity on the choice of methodology amongst the companies, making it difficult to compare Scope 3 emissions in mining.

One example of this overlapping relates to the emissions arising from the mining and steel-manufacturing industries. These emissions occur due to the process involved in transforming the iron ore and metallurgical coke into steel, a process which consumes a large amount of energy.

A mining company that produces iron ore and thermal and/or metallurgical coal may incur double counting in Scope 3 in the following categories:

- In category 10 (Processing of sold products), the emissions are associated with the volume of iron ore sold as an input for steel.
- In category 11 ('Use of sold products'), the emissions are associated with the use of metallurgical coal as an input/reducer in the steel manufacturing process.
- In category 1 ('Purchased goods and services'), the emissions are associated with the supply of goods/services containing steel and with the use of coal in pelletizing, as well as a reduction agent in metallurgical processes (for example: the production of metallic nickel and copper).
- In category 3 ('Fuel and energy-related activities not included in Scope 1 or Scope 2'), the emissions are associated with the production of thermal coal that is to be used for energy purposes in mining and metals activities (for example: boilers and dryers).

This double counting occurs because the emissions factors that are currently available are emissions factors in the steel manufacture process that do not yet differentiate the emissions within the process by input/product.

[1] GBA Battery Passport Greenhouse Gas Rulebook – Generic Rules – Version 1.4

Another example of this overlapping involves the emissions relating to the production of batteries. These emissions occur due to the processing of base metals for the manufacturing of a product, in this case, batteries.

A mining company that has nickel, copper and cobalt in its portfolio can incur double counting in Scope 3 and in the same category. This double counting occurs because the emissions factors that are currently available are emissions factors in the battery manufacturing process but do not yet differentiate the emissions within the process by input/product.

The Global Battery Alliance[1] aims to provide guidance on how the double counting issue should be addressed for the calculation of carbon footprints, an analysis that runs in parallel with the corporate GHG initiatives and which is focused on the emissions related to the product's life cycle.

However, the two methodologies presented seek to determine emission factors and, despite there being no internationally recognized standard, they may find themselves being reproduced in order to avoid double counting in Scope 3.

Mass allocation
The division of the GHG emissions between the inputs of the manufacturing process allocating the mass contribution of each input that results in the end production of the battery.

Economic allocation
The relative economic value of each input should be calculated using stable market prices. For metals, the global price average over 10 years may be used to avoid the impact of the high volatility of prices of the global markets.

The allocation factors calculated are thus applied in the methodology for calculation of the Scope 3 emissions.

[1] GBA Battery Passport Greenhouse Gas Rulebook – Generic Rules – Version 1.4

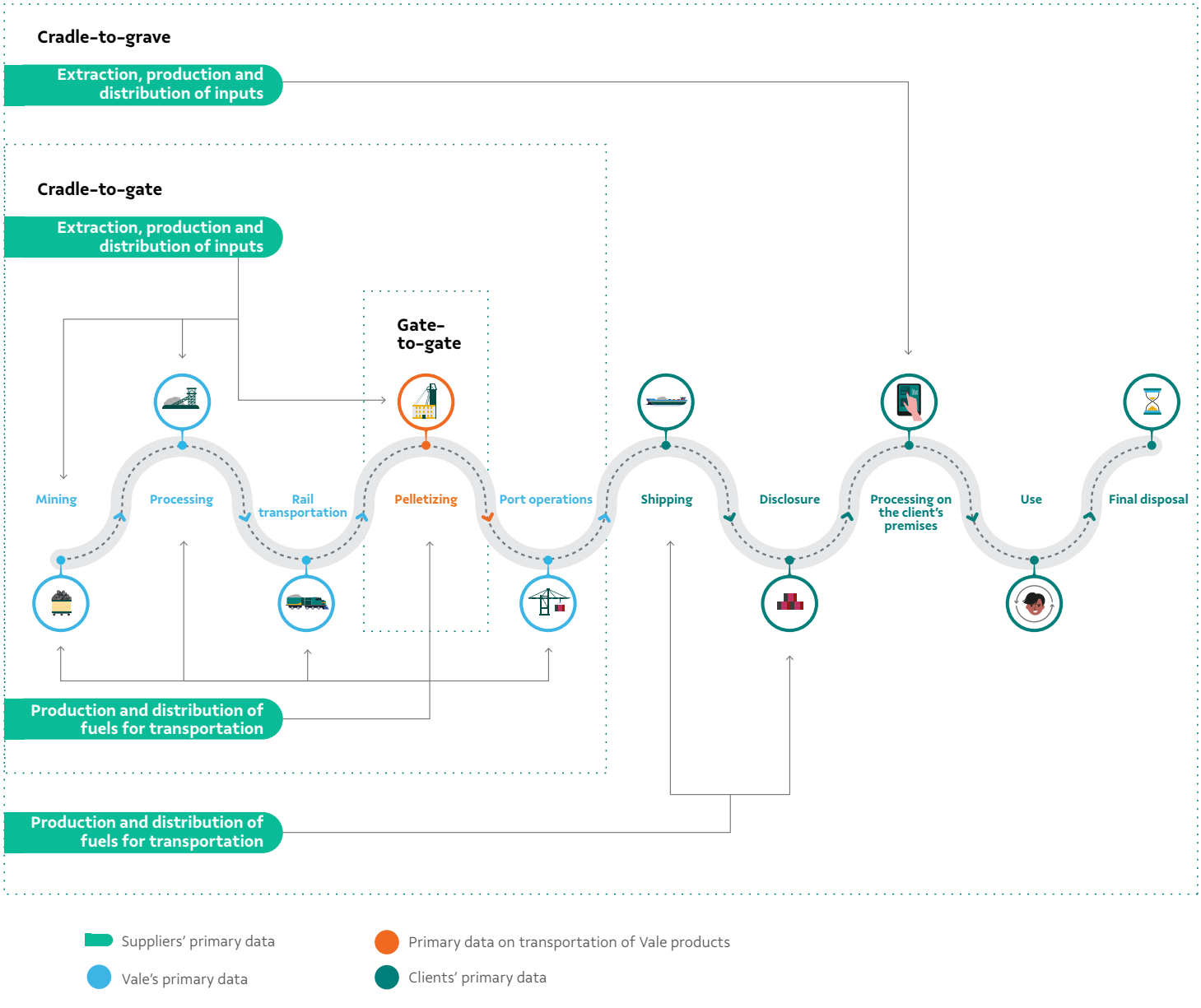

Photograph: Ricardo Teles

The challenge concerning the double counting inherent to the methodology established for corporate inventories requires sectoral efforts and revisions of the methodology itself. Due to the advance of the global climate agenda and the increased pressure on the parties involved, new reporting methodologies are being applied, such as, for example, the carbon footprint left by the products.

Vale seeks partnerships in the value chain and shared responsibility with a focus on decarbonization, increasing the traceability of the emissions of the products that are purchased, produced and sold. The calculation of the GHG emissions for the marketed products in a value chain offers a means of differentiation through the carbon footprint, reduces double counting, and transitions the mineral commodities to a client-focused vision.

Through the *World Business Council for Sustainable Development*, Vale supports the *Partnership for Carbon Transparency* initiative, the central aim of which is to provide specifications and guidance for the calculation of emissions, and safely and reliably share primary information at the product level.

Abridged representation of the pellet value chain and the bordering limits of carbon footprints



5

Definition of the emissions reduction targets

Photograph: Marcelo Coelho

With the aim of establishing a science-based climate strategy, Vale adheres to the C1 and C17 recommendations of the "SBTi Criteria and Recommendations (TWG-INF-002), Version 4.1, April 2020", which definitively requires the establishment of a target for Scopes 1 and 2, and establishment of a target when a company's Scope 3 emissions represent 40% or more of its total emissions (Scopes 1, 2 and 3).

> *"C1 – The targets must cover company-wide Scope 1 and Scope 2 emissions, as defined by the GHG Protocol Corporate Standard"*

> *"C17 – If a company's relevant and mandatory Scope 3 emissions are 40% or more of total Scope 1, 2, and 3 emissions, a Scope 3 target is required."*

For the Scope 1 and 2 emissions, our aim of an absolute reduction of 33% of emissions by 2030 is aligned with the objectives of the Paris Agreement to limit global warming to less than 2°C (WB2D) and is based upon the emissions recorded in 2017. 2030 was established as a target in order to fall into line with the *UN's 2030 Agenda for Sustainable Development*[5].

The target for Scopes 1 and 2 is aligned with the C6 criteria covering a minimum of five years and a maximum of 15 years as of the date the target is submitted to the SBTi for official validation. The tool used to calculate the percentage of reduction necessary for the WB2D scenario was the "Science Based Target Setting Tool – Version 1.1" and the method used by Vale was the "Absolute Contraction Approach", due to the fact that the mining sector does not have a specific method.

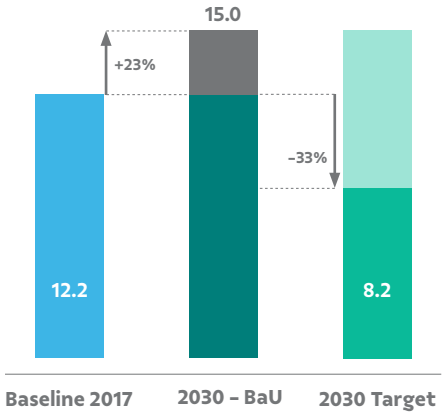
The GHG emissions originating from Vale's Scope 3 represent 98% of the total emissions. As such, in 2020, Vale assumed a commitment to **reduce its Scope 3 net emissions relating to its chain of suppliers by 15% by 2035.** The percentage of reduction takes 2018 as its base year, a year in which 553 million tons of CO_2 ($MtCO_2e$)[10] were calculated as originating from the value chain. The target for Scope 3 was defined using the "Science Based Target Setting Tool", and the "Absolute Contraction Approach" method provided by the Science Based Target Initiative (SBTi), meaning it is aligned with the goal of the Paris Agreement to limit global warming to 2° by the end of the century. Vale will be reviewing its target in 2025 and then once every five years, given the uncertainties that exist concerning low carbon technologies and climate policies.

As recommended by criteria C18 of the reference document, Vale has set an absolute reduction target of 1.23% per year, over a period of 17 years (2018 – 2035), for 2/3 of its Scope 3 emissions (369 $MtCO_2e$ in 2018), to achieve emissions of 292 $MtCO_2e$ in 2035, which is the target year for the plan. As such, assuming that the remaining 1/3 of the Scope 3 emissions remain unaltered (184 $MtCO_2e$), Vale should be emitting a maximum of 476 $MtCO_2e$ in 2035 (an absolute reduction of 14% compared to 2018).

> *"C18 – Boundary: Companies must set one or more emission reduction targets and/or supplier or customer engagement targets that collectively cover(s) at least 2/3 of total Scope 3 mandatory emissions in conformance with the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard."*

Scope 1 and 2 emissions

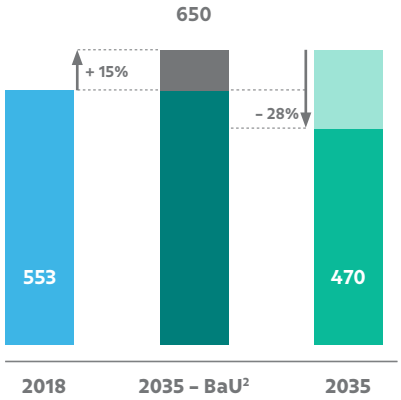
Millions of tons of tCO_2e



N.B.: Business as Usual (BaU) scenarioin accordance with the published Guidance on Volume – 2023 to 2027

Scope 3 net emissions

Millions of tons of tCO_2e



N.B.: Business as Usual (BaU) scenario in accordance with the published Guidance on Volume – 2023 to 2027

[5]More information is available at: https://sdgs.un.org/goals
[10]2022 Integrated Report

As such, with the new commitment to reducing Scope 3 net emissions by 15%, the Company expects to achieve 470 $MtCO_2e$ in 2035, a difference of 83 $MtCO_2e$ in relation to that registered in 2018[11].

Despite this, Vale estimates that the challenge is to achieve a reduction of up to 136 $MtCO_2e$, in a Business As Usual (BaU) scenario, should no measures be taken to reduce the company's emissions. Under this scenario, the company would emit around 606 $MtCO_2e$ in 2035, based on the understanding that the intensity of emissions in 2018 (1,603 $MtCO_2e$ per million tons of iron ore) remains constant until 2035 for the production of 400 Mt of iron ore, and does not take into consideration the use of EAF or other less carbon-intensive initiatives.

Target
Net reduction of 15% by 2035

Total reduction
83 CO_2e[10]

Annual reduction
1.23% per annum

Frequency of revision
Vale is committed to revising the Scope 3 target every five years

Summary of compliance with the SBTi criteria for Vale's Scope 3 target[12]

Criteria[11]	Description / Value
C17 — Requirement to have a Scope 3 target	All relevant categories are calculated in Vale's Scope 3 emissions in accordance with the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard. See items 2.1 to 2.3 of this document
C18 – Boundary	98% of Vale's CO_2 emissions originate from Scope 3. The Scope 3 target covers 2/3 of the Scope 3 emissions measured in the base year of 2018 (369 $MtCO_2e$ in 2018).
C19 – Timeframe	Medium-term target, from 2018 to 2035 (17 years) Period of 15 years as of the target definition date (2020).
C20 – Level of ambition for Scope 3 emissions reductions targets	"Absolute Contraction Approach" method. Level of ambition considering the scenario of a 2°C increase in the global temperature , compared to pre-industrial temperature levels.
C12 – Offsets	Vale's Scope 3 target involves a reduction of net emissions. This means that the company may use carbon credits to meet the target, meaning in turn that it is not compatible with the C12 criteria.

[10]Equivalent to the emissions of New Zealand

[11]Volume equal to the emissions of New Zealand in relation to energy use in the same year, according to a report published by the International Energy Agency

[12]Methodology: SBTi – TWG-INF-002 | Version 4.2 April 2021

Annex – Examples of the application of calculation methodologies per category of Scope 3

Category 1 – Purchased Goods and Services

Parameter	Value in 2022	Unit of Measurement	Reference
Metallurgical coal			
A – Metallurgical Coal	61,502,296.20	kg	Description: Consumption of metallurgical coke used in pelletizing and for non-energy purposes (roasting, sintering and reduction) in the production of metals and ferroalloys in 2022 Source: activity data
B – Co_2e Emission Factor	0.39	kg/kg	Description: emission factor for Scope 3 of coal Source: *Tab: 'WTT- fuels'. DEFRA 2022: 2022 Conversion factors - Full set (for advanced users) - Gov.uk. Expiry: June 7, 2023 Version: 2.0*
C – Emissions of CO_2e	241,790.31	t	Calculation (C = AxB/1000)
Lubricant oils			
A – Lubricant oils	18,968.19	m^3	Description: Purchase of lubricants in 2022 Source: activity data
B – Density	875.00	kg/m^3	Description: Lubricants = 875 kg/m^3 Source: National Energy Balance 2022: Base year 2021. Table VIII.9 – Density and Calorific Values (page 226)
C – Co_2e Emission Factor	875.00	kg/kg	Description: emission factor for Scope 3 of lubricant oil. Source: *1 kg Lubricating oil {RoW}| market for | APOS, U (of project Ecoinvent 3.8 - allocation at point of substitution - Unit)*
D – CO_2 emissions	22,833.05	t	Calculation (D = AxBxC/1000)

Category 2 – Capital Goods

Parameter	Value in 2022	Unit of Measurement	Source
Concrete sleepers			
A – Concrete sleepers	154,818.00	units	Purchase of concrete sleepers in 2022 Source: activity data
B – Conversion factor	0.24	m^3/unit	Description: conversion factor of units per m^3 of concrete Source: Brazil specification – Specifications DNIT/PIM 15–Concrete Sleeper. Volume calculated: 2.80 m x 0.34 m x 0.25m= 0.238m^3
C – Co_2e Emission Factor	284.71	kg/m^3	Description: emission factor for Scope 3 of concrete. Source: *Emission factor for 1m^3 concrete {RoW}, market for Allocation at point of substitution – APOS, S, IPCC 2007 GWP 100a, ecoinvent database version 3*
D – CO_2 emissions	10,490.71	t	Calculation (D = AxBxC/1000)

3 – Fuel and Energy Related Activities not included in Scope 1 or Scope 2

Category 3.a – Fuel

Parameter	Value in 2022	Unit of Measurement	Source
Biodiesel			
A – Biodiesel	69,199.67	m^3	Description: Total consumption of biodiesel in the Vale manufacturing processes in 2022 Source: activity data
B – Density	880.00	kg/m^3	Description: Biodiesel (B100) = 880 kg/m^3 Source: National Energy Balance 2022: Base year 2018 Table VIII.9 – Density and Calorific Values (page 227)
C – Co_2e Emission Factor	0.41	kg/kg	Description: factor adopted for biodiesel Source: *Tab: 'WTT– bioenergy'. DEFRA 2022: 2022 Conversion factors – Full set (for advanced users). Gov.uk. Expiry: June 7, 2023 Version: 2.0*
D – CO_2 emissions	24,860.07	t	Calculation (C = AxBxC/1,000)

Parameter	Value in 2022	Unit of Measurement	Source
Diesel			
A – *Diesel*	622,797.05	m^3	Description: Total consumption of diesel in the Vale manufacturing processes in 2022 Source: activity data
B – Density	840.00	kg/m^3	Description: Diesel Oil = 840 kg/m^3 Source: National Energy Balance 2022: Base year 2018 Table VIII.9 – Density and Calorific Values (page 227)
C – Co_2e Emission Factor	0.75	kg/kg	Description: factor adopted for 100% of mineral diesel Source: *Tab: 'WTT– fuels'. DEFRA 2022: 2022 Conversion factors – Full set (for advanced users) – Gov.uk. Expiry: June 7, 2023 Version: 2.0*
D – CO_2 emissions	390,102.79	t	Calculation (C = AxBxC/1000)
Natural gas			
A – Natural Gas	607,372,895.32	m^3	Description: Total consumption of natural gas in the Vale manufacturing processes in 2022 Source: activity data
B – Co_2e Emission Factor	0.34	kg/m^3	Description: factor adopted for Natural Gas Source: *ABA: 'WTT– fuels' DEFRA 2022: 2022 Conversion factors – Full set (for advanced users) – Gov.uk. Expiry: June 7, 2023 Version: 2.0*
C – Emissions of CO_2e	208,571.85	t	Calculation (C = AxB/1000)

Category 3.c – Energy

Parameter	Value in 2022	Unit of Measurement	Source
Losses in the transmission and distribution system			
A – Electricity	6,582,938.49	MWh	Description: Total electricity consumption of Vale operations in Brazil in 2022 Source: activity data
B – Loss %	0.19	%	Brazil: 2022 Electricity Statistics Yearbook – – Base year 2021 – Excel file. Table 2.11 – Losses and Differences (%) – National Interconnected Grid– SIN Other countries: *The World Bank – World Development Indicators. Indicator: Electric power transmission and distribution losses (% of output). Last update: December 22, 2022. Data from 2014.*
C – Co_2e Emission Factor	0.04	tCO_2e/ MWh	Description: emission factor for the Brazil National Interconnected Grid in 2022 Source: MCTI, 2022 – referenced on 26–Jan–2023; Link https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/dados-e-ferramentas/fatores-de-emissao
D – CO_2 emissions	64,503.08	t	Calculation (D = ((A/(1–B))–A)xC)

Category 4 – Upstream Transportation and Distribution

Category 4 – Upstream Transportation and Distribution – Fuel Consumption

Parameter	Value in 2022	Unit of Measurement	Reference
HFO – Ships			
A – HFO	1,882,714,300.00	t	Consumption of HFO on ships chartered by Vale in 2022, for iron ore transportation Source: Activity data
B – Co_2e Emission Factor	3.16	kg/kg	Description: emission factor for Marine HFO Source: *IMO, Third GHG Study 2014 – Table 32: Emission factors for bottom-up emissions due to the combustion of fuels – Page 253*
C – Emissions of CO_2e	5,955,213.60	t	Calculation (C = AxB)

Category 4 – Upstream Transportation and Distribution – Distance Traveled

Parameter	Value in 2022	Unit of Measurement	Reference
***Diesel*–B7 – Trucks**			
A– *Diesel* B7	2,660,494.00	km	Description: Kilometers traveled by trucks transporting inputs to a specific Vale unit in 2022, consuming B7 Diesel Source: Activity data
B – Efficiency of the equipment	2.50	km/L	Description: Yield or efficiency of a highway truck per liter of diesel consumed Source: Activity data
C– *Diesel* B7	1,064.20	m^3	Calculation: (C = AxB/1000) Consumption of Diesel B7 in trucks at a specific Vale unit in 2022
D – Co_2e Emission Factor	2.64	t/m^3	Description: emission factor for the use of B7 Diesel in transportation performed by third parties Source: *IPCC 2006, Volume 2, Chapter 1, Table 1.3 (Gas/Diesel Oil – Carbon content). IPCC 2006, Volume 2, Chapter 3, Table 3.3.1 (Off-road source – Industry – Diesel – CH_4 and N_2O emission factors)*
E – CO_2 emissions	2,808.78	t	Calculation (E = CxD)

Category 6 – Business Travel

Parameter	Value in 2022	Unit of Measurement	Reference
Air Travel – Long Haul (> 3,700km)			
A – Total distance	2,266,348.68	km	Description: distance between airports, GCD (great circle distance) Source: distance obtained at base www.world-airport-codes.com
B – CO2e Emission Factor – Long Haul	0.09	kg CO_2e/P.km	Description: emission factor adopted for long-haul flights (> 3,700km) to/from UK, Average passenger, Without RF" Source: *Business travel – air tab, DEFRA 2022: 2022 Conversion factors – Full set (for advanced users) – Gov.uk. Expiry: June 7, 2023 Version: 2.0*
C – Co_2e Emissions – Long Haul	443.90	t	Calculation (F = CxDxE/1000)
Air Travel – Average Distance (between 500km and 3,700km)			
D – Total Distance	1,188,916.92	km	Description: distance between airports, GCD (great circle distance) Source: distance obtained at base www.world-airport-codes.com
F – CO_2e Emission Factor – Average Distance	0.07	kg CO_2e/P.km	Description: emission factor adopted for medium-haul flights (500km to 3,700km) "Flights, Short-haul, to/from UK, Average passenger, Without RF" Source: *Business travel – air tab, DEFRA 2022: 2022 Conversion factors – Full set (for advanced users) – Gov.uk. Expiry: June 7, 2023 Version: 2.0*
G – Co_2e emissions – Average Distance	11,362.24	t	Calculation (F = CxDxE/1000)
Air Travel – Short Haul (< 500km)			
H – Distance per leg	97,470.00	km	Description: distance between airports, GCD (great circle distance) Source: distance obtained at base www.world-airport-codes.com
I – CO_2e Emission Factor – Short Distance	0.12	kg CO_2e/P.km	Description: emission factor adopted for medium-haul flights (< 500km) "Flights, Domestic-haul, to/from UK, Average passenger, Without RF" Source: *Business travel – air tab, DEFRA 2022: 2022 Conversion factors – Full set (for advanced users) – Gov.uk. Expiry: June 7, 2023 Version: 2.0*
J – CO_2e Emissions – Short Distance	1,963.03	t	Calculation (R = OxPxQ/1000)
Air Travel – Total			
K – CO_2e Emissions – Total Air Travel	13,769.17	t	Calculation (S = F + L + R)

Category 7 – Commuting (Employee Commuting)

Parameter	Value in 2022	Unit of Measurement	Reference
Diesel			
A – *Diesel*	77.87	E	Diesel Consumption on buses (mobile engines) by a contracted company, in 2022, for employee commuting Source: Activity data
B – Co_2e Emission Factor	2.64	t/m^3	Description: emission factor for the use of Diesel (0% biodiesel) in transportation performed by third parties Source: *IPCC 2006, Volume 2, Chapter 1, Table 1.3 (Gas/Diesel Oil – Carbon content). IPCC 2006, Volume 2, Chapter 3, Table 3.3.1 (Off-road source – Industry – Diesel – CH_4 and N_2O emission factors)*
C – Emissions of CO_2e	205.53	t	Calculation (C = AxB)

Category 9 – Downstream transportation and distribution

Category 9.a – Downstream transportation and distribution – Fuel Consumption

Parameter	Value in 2022	Unit of Measurement	Reference
HFO – Ships			
A – HFO	375,310,700.00	kg	Consumption of HFO on ships chartered by suppliers and clients, in 2022, for iron ore transportation Source: Activity data
B – Co_2e Emission Factor	3.16	kg/kg	Description: emission factor for Marine HFO Source: *IMO, Third GHG Study 2014 – Table 32: Emission factors for bottom-up emissions due to the combustion of fuels – Page 253*
C – Emissions of CO_2e	1,187,145.28	t	Calculation (C = AxB)

Category 9.b – Downstream transportation and distribution – Distance Traveled

Parameter	Value in 2022	Unit of Measurement	Reference
***Diesel* B7 – Trucks**			
A– *Diesel* B7	18,318.00	km	Description: Kilometers traveled by trucks transporting raw materials to a specific Vale unit in 2022, consuming Diesel B8 Source: Activity data
B – Efficiency of the equipment	3.40	km/L	Description: Yield or efficiency of a highway truck per liter of diesel consumed Source: Activity data
C – *Diesel* B8	5.39	m^3	Calculation (C = AxB/1000) Consumption of Diesel B8 in trucks at a specific Vale unit in 2022
D – Co_2e Emission Factor	2.64	t/m^3	Description: emission factor for the use of Diesel B8 in transportation performed by third parties Source: *IPCC 2006, Volume 2, Chapter 1, Table 1.3 (Gas/Diesel Oil – Carbon content). IPCC 2006, Volume 2, Chapter 3, Table 3.3.1 (Off-road source – Industry – Diesel – CH_4 and N_2O emission factors)*
E – CO_2e emissions	14.22	t	Calculation (E = CxD)

Category 10 – Processing of sold products

Category 10.a – Iron ore (fines) – Blast furnace route

Parameter	Value in 2022	Unit of Measurement	Reference
Iron ore (fines) – Blast furnace route – Sintering/BF/BOF			
A – Sinter Feed Sales	263,321,612.97	t	Description: Amount of sinter feed sold by Vale in 2022 Source: Activity data, commercial area
B – Proportion of Sinter Feed used to produce Sinter	0.81	t/t	Description: Proportion of iron ore (sinter feed) used to produce sinter: 0.8131 t sinter feed / t sinter Source: *2013, Joint Research Center of the European Commission. Best Available Techniques (BAT) Reference Document for Iron and Steel Production. Industrial Emissions Directive 2010/75/EU. Chapter 3 Sinter Plants. Table 3.2: Input raw materials for sinter production in the EU 25 for 2004.*
C – Sinter Production	323,848,989.01	t	Calculation (C = A/B) Sinter production using sinter feed sold by Vale in 2022

Parameter	Value in 2022	Unit of Measurement	Reference
Iron ore (fines) – Blast furnace route – Sintering/BF/BOF			
D – Co_2e Emission Factor–	0.21	t/t	Description: emission factor for the sintering process, with sinter production Source: *IPCC 2022 Refinement: Guidelines for National GHG Inventories. Volume 3, Chapter 4: Metal Industry Emissions. Table 4.1b (New) Tier 1 Default Co_2 Emission Factors for Iron & Steel Production*
E – CO_2 emissions – Sintering	68,008,287.69	t	Calculation (E = CxD)
F – Proportion of Metallic Load charged in blast furnaces	1.61	t/t	Description: Proportion of metallic load charged in blast furnaces to produce hot metal: 1,595 t metallic load / t hot metal (liquid pig iron) Source: *Stoichiometric ration:* % Fe hot metal / % Fe metal load = 95% / 59,54 % = 1,595 t metal load / t hot metal (liquid pig iron)
G – Production of *Hot Metal* (liquid pig iron)	200,956,820.03	t	Calculation (G = C/F) Production of *Hot Metal* (liquid pig iron) using Sinter feed sold by Vale in 2022
H – CO_2e Emission Factor – Blast Furnaces	1.43	t/t	Description: emission factor for the blast furnace reduction process, with liquid pig iron production Source: *IPCC 2022 Refinement: Guidelines for National GHG Inventories. Volume 3, Chapter 4: Metal Industry Emissions. Table 4.1b (New) Tier 1 Default Co_2 Emission Factors for Iron & Steel Production*
I – Co_2e emissions – Blast furnace	287,368,252.64	t	Calculation (I = GxH)
J – Proportion of *Hot Metal* (liquid pig iron) charged in BOF (Basic Oxygen Furnace)	0.92	t/t	Description: Proportion of liquid pig iron charged in BOF (Basic Oxygen Furnace) to produce liquid steel: 0,850 t *hot metal* (liquid pig iron) / t liquid steel Source: operational practice
K – Production of Liquid Steel	219,624,939.92	t	Calculation (K = G/J) Liquid steel production using Sinter feed sold by Vale in 2022
L – Co_2e Emission Factor – BOF	0.17	t/t	Description: emission factor for the BOF (Blast–Oxygen Furnace) refining process, with production of liquid steel Source: calculated using emission factors for steel production (via the BF/BOF route) and the emission factor for production of hot metal (via the BF/BOF route). *IPCC 2022, Volume 3, chapter 4, table 4.1b (New)*
M – CO_2e emissions – BOF	38,214,739.55	t	Calculation (M = KxL)
N – Co_2e emissions – Sintering + Blast furnace + BOF	393,591,279.88	t	Calculation (N = E+I+M)

Category 10.b – Iron Ore (pellets) – Direct Reduction Route

Parameter	Value in 2022	Unit of Measurement	Reference
Iron Ore (pellets) – Direct Reduction Route – DRI/EAF			
A – Sale of Pellets	17,237,367.18	t	Description: Amount of direct reduction pellets sold by Vale in 2022 Source: Activity data, commercial area
B – Proportion of Metallic Load charged in the direct reduction furnace	1.46	t/t	Description: Proportion of metallic load charged in the direct reduction furnace to produce DRI (direct reduced iron): 1,360 t metallic load / t DRI Source: *Stoichiometric ration: % Fe DRI / % Fe metal load = 92% / 67,65 % = 1,360 t metal load / t DRI*
C – DRI Production	11,846,424.35	t	Calculation (C = A/B) DRI production using reduction pellets sold directly by Vale in 2022
D – Co_2e Emission Factor – DRI	1.43	t/t	Description: emission factor for the reduction process in a direct reduction furnace, with DRI production Source: *IPCC 2022 Refinement: Guidelines for National GHG Inventories. Volume 3, Chapter 4: Metal Industry Emissions. Table 4.1b (New) Tier 1 Default Co_2 Emission Factors for Iron & Steel Production*
E – CO_2e emissions – DRI	16,940,386.82	t	Calculation (E = CxD)
F – Proportion of DRI charged in EAF (Electric Arc Furnace)	0.92	t/t	Description: Proportion of DRI charged in EAF (Arc Furnace) to produce liquid steel: 0.900 t DRI / t liquid steel Source: operational practice
G – Production of Liquid Steel	12,946,911.86	t	Calculation (G = C/F) Liquid steel production using reduction pellets sold directly by Vale in 2022
H – Co_2e Emission Factor – EAF	0.17	t/t	Description: emission factor for the EAF (Electric Arc Furnace) refining process, with production of liquid steel Source: *IPCC 2022 Refinement: Guidelines for National GHG Inventories. Volume 3, Chapter 4: Metal Industry Emissions. Table 4.1b (New) Tier 1 Default Co_2 Emission Factors for Iron & Steel Production*
I – CO_2e emissions – EAF	2,252,762.66	t	Calculation (I = GxH)
J – Co_2e emissions – Sintering + Blast furnace + BOF	19,193,149.48	t	Calculation (J = E+I)

Category 10.c – Copper

Parameter	Value in 2022	Unit of Measurement	Reference
Copper – Production of Blister Copper and Copper Wire			
A – Copper Sales (concentrated)	225,079.54	t	Description: Amount of copper concentrate sold by Vale in 2022 Source: Activity data, commercial area
B – % of Cu contained in Copper Concentrate	0.35	%	Description: % of Copper contained in the iron ore concentrated by Vale, average for 2022 Source: Activity data, commercial area
C – Copper concentrate charge factor for the production of blister copper	3.33	t concentrated Cu / t blister Cu	Description: Copper concentrate charge factor for blister copper: 4.062 kg copper concentrate / kg of *blister* copper Source: *1 kg Copper, blister-copper {RoW}| production | APOS, S (of project Ecoinvent 3 – allocation at point of substitution – system)* *method:* IPCC 2007 GWP 100a V1.02 OBS: Does not include the copper cycle (3.911 tCO_2/t)
D – Production of Blister Copper	193,450.09	t	Calculation (D = A/(BxC)) Production of blister copper using copper concentrate iron ore sold by Vale in 2022
E – CO_2e Emission Factor – Blister Copper	1.48	t/t	Description: emission factor for the *blister* copper production process
F – Co_2e emissions – Blister Copper	286,184.26	t	Calculation (F = DxE)
G – Copper Sales (cathodes)	9,465.13	t	Description: Amount of copper cathodes sold by Vale in 2022 Source: Activity data, commercial area
H – CO_2e Emission Factor – Copper Wiring	3.66	t/t	Description: emission factor for the copper wiring production process, 0.0378 CO_2e/m of copper wiring, composed of 0.00892 kg of copper/m of wiring Source: *The Environmental Profile of Copper Products – A 'cradle-to-gate' life-cycle assessment for copper tube, sheet and wire produced in Europe (page 7). Copper Alliance, 2012. N.B.: Deducted from copper blister production*
I – Co_2e emissions – Copper Wiring	34,676.73	t	Calculation (I = GxH)
J – Co_2e emissions – Blister Copper + Copper Wiring	357.89	t	Calculation (J = F+I)

Category 10.d – Nickel

Parameter	Value in 2022	Unit of Measurement	Reference
Nickel – Production of Stainless Steel using Nickel			
A – Nickel Sales	180,799.87	t	Description: Amount of contained nickel sold by Vale in 2022 Source: Activity data, commercial area
B – % of nickel converted into stainless steel	0.69	%	Description: % of nickel converted into stainless steel Source: *Conversion factor for first use of nickel – Stainless Steel, Nickel Institute. Link: https://nickelinstitute.org/about-nickel/#04-first-use-nickel*
C – Nickel charge factor for the production of stainless steel	0.08	t Ni / t Stainless steel	Description: Nickel charge factor for the production of stainless steel: 0.321Kg of Ferronickel (25% Ni) per kg of stainless steel Source: *1 kg Steel, chromium steel 18/8, hot rolled {GLO}| market for | APOS, U (of project Ecoinvent 3 – allocation at point of substitution – unit)*
D – Production of Stainless steel	1,559,398.88	t	Calculation (D = AxB/C) Stainless steel production using nickel sold by Vale in 2022
E – CO_2e Emission Factor – Stainless Steel	1.67	t/t	Description: emission factor for the Stainless steel production process: 5.12 kg CO_2e / kg steel. Source: *1 kg Steel, chromium steel 18/8, hot rolled {GLO}| market for | APOS, U (of project Ecoinvent 3 – allocation at point of substitution – unit).* Does not include the nickel or pig iron cycles
F – Co_2e emissions – Blister Copper	2,607,314.93	t	Calculation (F = DxE)

VALE

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