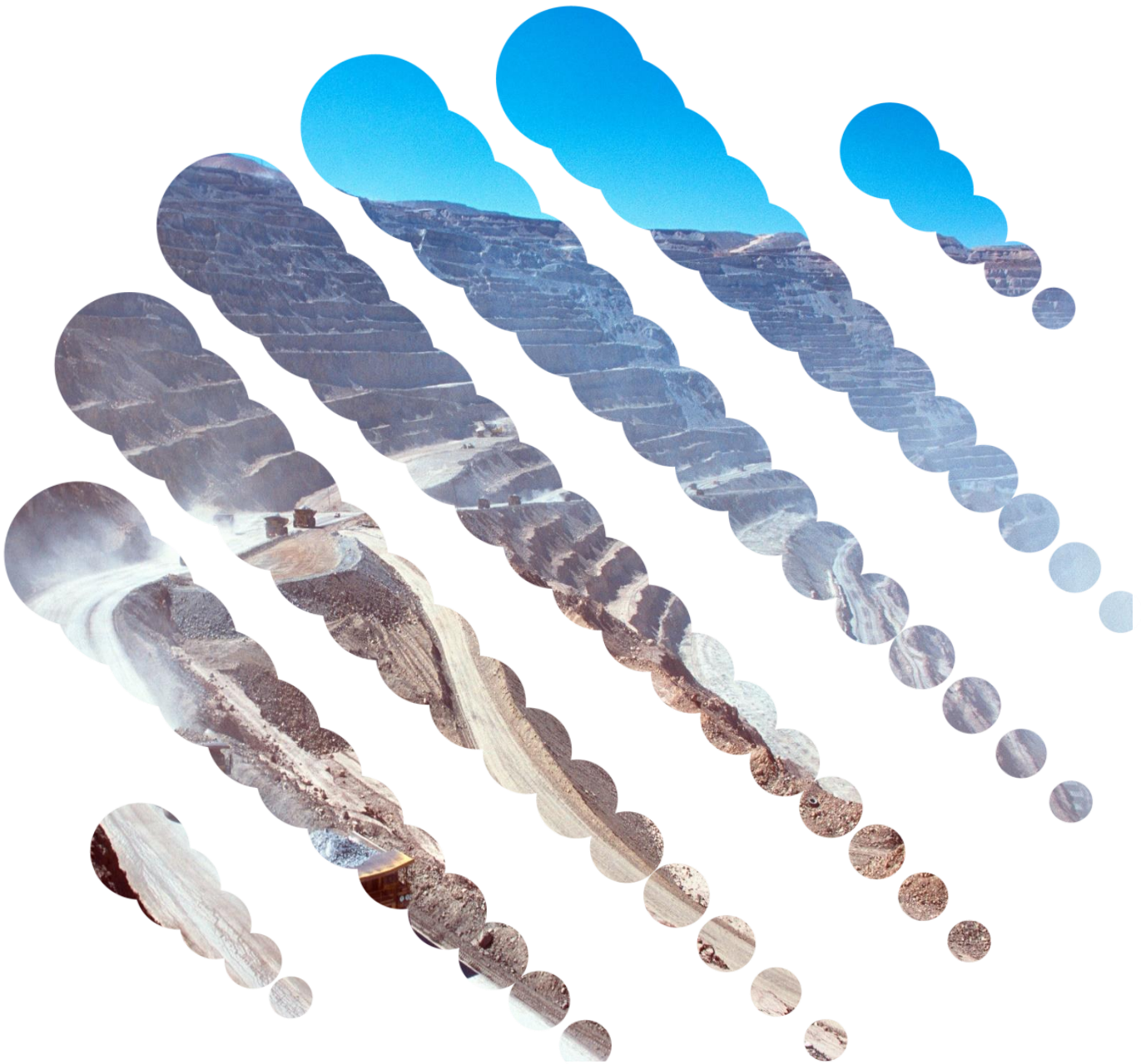


Carbon Performance assessment of diversified mining: note on methodology

October 2024



Simon Dietz, Valentin Jahn, Antonina Scheer and Hayeon Cho

About the LSE Transition Pathway Initiative Centre

The Transition Pathway Initiative Centre (TPI Centre) is an independent, authoritative source of research and data on the progress of corporate and sovereign entities in transitioning to a low-carbon economy.

The TPI Centre is part of the Grantham Research Institute on Climate Change and the Environment, which is based at the London School of Economics and Political Science (LSE). It is the academic partner of the Transition Pathway Initiative (TPI), a global initiative led by asset owners and supported by asset managers, aimed at helping investors assess companies' preparedness for the transition to a low-carbon economy and supporting efforts to address climate change. As of October 2024, over 150 investors globally, representing more than US\$80 trillion combined Assets Under Management and Advice, have pledged support for TPI.¹

The TPI Centre provides research and data on publicly listed equities, corporate bond issuers, banks, and sovereign bond issuers. The TPI Centre's company data:

- Assess the quality of companies' governance and management of their carbon emissions and of risks and opportunities related to the low-carbon transition.
- Evaluate whether companies' current and planned future emissions are aligned with international climate targets and national climate pledges, including those made as part of the Paris Agreement.
- Form the basis for the Climate Action 100+ Net Zero Company Benchmark Disclosure Framework assessments.
- Are published alongside the methods online and fully open access at www.transitionpathwayinitiative.org.

About the authors

Simon Dietz is the Research Director at the TPI Centre and a Professor of Environmental Policy in the Department of Geography and Environment at the London School of Economics and Political Science.

Hayeon Cho is a Research Analyst at the TPI Centre.

Valentin Jahn is the Deputy Director at the TPI Centre.

Antonina Scheer is a Research Project Manager at the TPI Centre.

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¹ This figure is subject to market price and foreign exchange fluctuations and, as the sum of self-reported data by TPI supporters, may double count some assets.

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1. The TPI Centre's use of the Sectoral Decarbonisation Approach (SDA)

The TPI Centre's Carbon Performance assessments to date have been predominantly based on the Sectoral Decarbonisation Approach (SDA).² The SDA translates greenhouse gas emissions targets made at the international level (e.g. under the 2015 UN Paris Agreement) into appropriate benchmarks, against which the performance of individual companies can be compared.

The SDA recognises that different sectors of the economy (e.g. oil and gas production, electricity generation and automobile manufacturing) face different challenges arising from the low-carbon transition, including where emissions are concentrated in the value chain and how costly it is to reduce emissions. Other approaches to translating international emissions targets into company benchmarks have applied the same decarbonisation pathway to all sectors, regardless of these differences [1]. Such approaches may result in suboptimal insights, as not all sectors have the same emissions profiles or face the same challenges: some sectors may be capable of faster decarbonisation, while others require more time and resources.

Therefore, the SDA takes a sector-by-sector approach, comparing companies within each sector against each other and against sector-specific benchmarks, which establish the performance of an average company that is aligned with international emissions targets.

The SDA can be applied by taking the following steps:

- A global carbon budget is established, which is consistent with international emissions targets, for example keeping global warming below 2°C. To do this rigorously, some input from a climate model is required.
- The global carbon budget is allocated across time and to different regions and industrial sectors. This typically requires an integrated assessment model (IAM), and these models usually allocate emissions reductions by region and by sector according to where it is cheapest to reduce emissions and when. Cost effectiveness is, however, subject to some constraints, such as political and societal preferences, and the availability of capital. This step is therefore driven primarily by economic and engineering considerations, but with some awareness of political and social factors.
- In order to compare companies of different sizes, sectoral emissions are normalised by a relevant measure of sectoral activity (e.g. physical production or economic activity). This results in a benchmark pathway for emissions intensity in each sector:

$$\text{Emissions intensity} = \frac{\text{Emissions}}{\text{Activity}}$$

- Assumptions about sectoral activity need to be consistent with the emissions modelled and therefore should be taken from the same economy-energy modelling where possible.

² The Sectoral Decarbonisation Approach (SDA) was created by CDP, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF) in 2015. See <https://sciencebasedtargets.org/resources/files/Sectoral-Decarbonization-Approach-Report.pdf>

- Companies' recent and current emissions intensity is calculated, and their future emissions intensity is based on emissions targets they have set (this assumes companies meet their targets).³ Together, these establish emissions intensity pathways for companies.
- Companies' emissions intensity pathways are compared with each other and with the relevant sectoral benchmark pathway.

³ Alternatively, companies' future emissions intensity could be calculated based on other data provided by companies on their business strategy and capital expenditure plans.

2. Applying the SDA to the diversified mining sector

2.1. Deriving the benchmark pathways

The key inputs to calculating benchmark pathways in any sector are:

- A time path for carbon emissions, which is consistent with the delivery of a particular climate target (e.g. limiting global warming to 1.5°C). Consistency requires that cumulative carbon emissions are within the associated carbon budget.
- A breakdown of this economy-wide emissions path into emissions from key sectors (the numerator of sectoral emissions intensity).
- Consistent estimates of the time path of physical production from, or economic activity in, these key sectors (the denominator of sectoral emissions intensity).

For the diversified mining sector, the TPI Centre obtains all three of these inputs from the International Energy Agency (IEA) (with some minor exceptions discussed further), via its Energy Technology Perspectives [2], Net Zero by 2050 [3] and World Energy Outlook [4] reports. The IEA has established expertise in modelling the cost of achieving international emissions targets. It also provides unprecedented access to the modelling inputs and outputs in a form suitable for applying the SDA.

The IEA's economy-energy model simulates the supply of energy and the path of emissions in different sectors burning fossil fuels, or consuming energy generated by burning fossil fuels, given assumptions about key inputs, such as economic and population growth.

In low-carbon scenarios, the IEA model minimises the cost of adhering to a carbon budget by always allocating emissions reductions to sectors where they can be made most cheaply, subject to some constraints as mentioned above. These scenarios are therefore cost-effective, within some limits of economic, political, social and technological feasibility.

The IEA's work can be used to derive three benchmark emissions pathways, against which companies are evaluated by the TPI Centre:

1. **A National Pledges scenario**, which is consistent with the global aggregate of emissions reductions related to policies introduced or under development as of mid-2023. According to the IEA, this scenario does not take for granted that all government targets will be achieved. Instead, it takes a granular, sector-by-sector look at existing policies and measures. This scenario gives a probability of 50% of holding the global temperature increase to 2.4°C by 2100 [4].
2. **A Below 2°C scenario**, which is consistent with the overall aim of the Paris Agreement to limit warming, albeit at the lower end of the range of ambition. This scenario gives a probability of 50% of holding the global temperature increase to 1.7°C by 2100 [4].
3. **A 1.5°C scenario**, which is consistent with the overall aim of the Paris Agreement to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels" [5]. This scenario gives a probability of 50% of holding the global temperature increase to 1.4°C by 2100 [4].

For each scenario, IEA modelling output provides estimates of emissions paths associated with primary energy use, as well as key industrial processes.⁴ Similarly, the scenarios provide figures for sources of primary energy supply by fuel, as well physical quantities of key industrial materials, such as steel and aluminium. These two sets of projections are needed to construct an emissions intensity benchmark pathway.

As Section 4 explains, diversified mining companies produce a broad range of commodities that can be grouped into three key categories: energy (e.g. thermal coal, oil and gas), ores of key metals (iron ore and bauxite), and other minerals (which includes copper, nickel, diamonds, and a range of other materials). Therefore, from an emissions perspective, all energy system emissions are relevant for the diversified mining sector. This also holds for most industrial process emissions, with the exception of the chemical and cement sectors. The latter emissions are, therefore, excluded from the diversified mining benchmark.

Emissions from energy supply as well as mining-relevant processes are then divided by the total physical volume of mined products. The current volumes and production projections of energy commodities and key metals are given in IEA scenarios directly. In addition, the IEA has published a report on critical minerals [30], which is used as the source for current volumes and production projections for copper, nickel, cobalt and lithium. Other mineral commodities' production values are sourced from various publications and are assumed to grow with GDP. See Section 4.4 for further details. The TPI Centre uses the copper equivalent (CuEq) metric to normalise various physical quantity values across commodities. See Section 4.3 below for further details.

The IEA emissions scenarios only include CO₂. Additionally, non-CO₂ greenhouse gases in the form of methane (CH₄)⁵ are emitted in the process of supplying energy (e.g. fugitive emissions). As diversified miners also supply energy commodities, this is relevant for this sector. In 2010, methane emissions from solid fuels and oil and gas were calculated by the Emissions Database for Global Atmospheric Research (EDGAR) to be 105,108 kilo tonnes of CH₄ [6].⁴ In its Special Report on Global Warming of 1.5°C, the Intergovernmental Panel on Climate Change (IPCC) provides data via the Integrated Assessment Modelling Consortium (IAMC) data explorer for CH₄ emissions from fossil fuels and industry for scenarios consistent with different temperature increases (e.g. 1.5°C low overshoot, Below 1.5°C, 1.5°C high overshoot, Lower 2°C, Reference) [32]. Using EDGAR's 2010 calculation and applying IPCC's pathways, global methane emissions from energy supply are projected to be 0.036 gigatons in 2030 in the 1.5°C scenario. Applying a 100-year global warming potential (GWP) factor of 28 [7], methane emissions will be equivalent to 1.01 gigatons of CO₂. Beyond methane, non-CO₂ greenhouse gases in the form of perfluorocarbons (PFCs) are emitted when alumina is smelted to produce primary aluminium. Given diversified miners' involvement in the aluminium supply chain, we add PFC emissions to our benchmarks as they would be included in the Scope 3 processing (Category 10) emissions of sold bauxite and alumina. We take PFC emissions directly from TPI's aluminium Carbon Performance methodology for the National Pledges and Below 2°C benchmarks. For the 1.5°C benchmark, we take PFC emissions from the International Aluminium Institute's 1.5°C scenario [31].

Dividing relevant emission pathways with physical activity values across the three scenarios, the TPI Centre constructs the benchmark emission intensity pathways. Table 2.1 presents the key underlying datapoints for the three scenarios, and highlights the sources used in their construction.

⁴ Also referred to as Process Emissions – emissions from chemical reactions that are inherent to today's production processes (e.g. during iron ore reduction with coking coal).

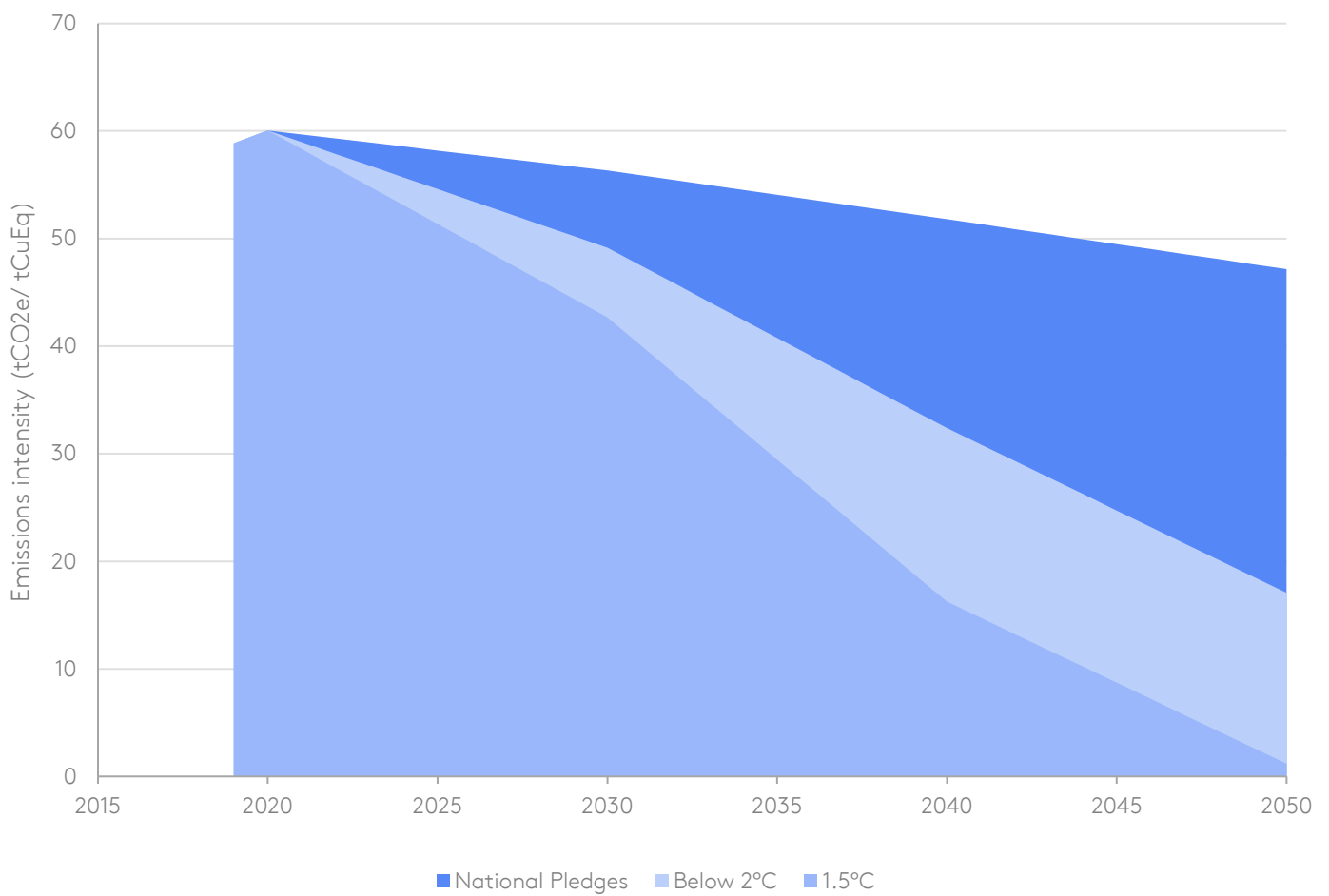
⁵ Other non-CO₂ greenhouse gases such as SO₂ and HFCs are negligible.

Table 2.1. Summary of the emission intensity benchmark

	2020	2030	2040	2050
National Pledges scenario				
Total direct CO ₂ emissions from primary energy and processes (MtCO ₂) (A)	34,156	35,125	31,657	29,696
Chemical and cement process emissions (MtCO ₂) (B)	1,812	1,897	1,920	1,870
Methane emissions from primary energy (MtCO ₂ e) (C)	2,646	2,490	2,462	2,455
PFC emissions from aluminium production (D)	35	36	33	29
Energy products (MtCuEq)	460	487	456	444
Iron ore and aluminium (MtCuEq)	46	53	61	65
Other minerals (MtCuEq)	72	93	119	155
Total mined product (MtCuEq) (E)	578	633	636	664
Emissions intensity (tCO ₂ e / tCuEq) (A-B+C+D)/E	60.6	56.5	50.7	45.6
Below 2°C scenario				
Total direct CO ₂ emissions from primary energy and processes (MtCO ₂) (A)	34,156	30,769	19,217	12,043
Chemical and cement process emissions (MtCO ₂) (B)	1,812	1,723	1,279	837
Methane emissions from primary energy (MtCO ₂ e) (C)	2,646	1,251	713	687
PFC emissions from aluminium production (D)	35	35	28	19
Energy products (MtCuEq)	460	438	317	240
Iron ore and aluminium (MtCuEq)	46	48	46	43
Other minerals (MtCuEq)	72	98	138	220
Total mined product (MtCuEq) (E)	578	583	501	503
Emissions intensity (tCO ₂ e / tCuEq) (A-B+C+D)/E	60.6	52.0	37.3	23.7
1.5°C scenario				
Total direct CO ₂ emissions from primary energy and processes (MtCO ₂) (A)	34,156	24,030	6,471	0
Chemical and cement process emissions (MtCO ₂) (B)	1,812	1,444	660	59
Methane emissions from primary energy (MtCO ₂ e) (C)	2,646	1,013	756	598
PFC emissions from aluminium production (D)	35	29	15	4

	2020	2030	2040	2050
Energy products (MtCuEq)	460	363	175	95
Iron ore and aluminium (MtCuEq)	46	43	44	42
Other minerals (MtCuEq)	72	101	152	271
Total mined product (MtCuEq) (E)	578	508	372	408
Emissions intensity (tCO _{2e} / tCuEq) (A-B+C+D)/E	60.6	46.5	17.7	1.3

Figure 2.1. Global emissions intensity benchmarks by warming scenario for the diversified mining sector



3. Carbon Performance

assessment of diversified miners

3.1. Calculating company emissions intensities

TPI Centre's Carbon Performance assessments are based on public disclosures by companies. Disclosure that is useful to our assessments tends to come in one of three forms:

1. **Emissions intensity.** Some companies disclose their emissions intensity and some companies have also set future emissions targets in intensity terms. Provided these are measured in a way that can be compared with the benchmark scenarios and with other companies (e.g. in terms of scope of emissions covered and measure of activity chosen), these disclosures can be used directly. In some cases, adjustments need to be made to obtain estimates of emissions intensity on a consistent basis. The necessary adjustments will generally involve sector-specific issues.
2. **Absolute emissions.** Some companies disclose their emissions on an absolute (i.e. un-normalised) basis. Provided emissions are appropriately measured, and an accompanying disclosure of the company's activity can be found that is also in the appropriate metric, historical emissions intensities can be calculated.
3. **Absolute emission targets.** Some companies set future emissions targets in terms of absolute emissions. This raises the particular question of what to assume about those companies' future activity levels. The approach taken by the TPI Centre is to assume company activity increases at the same rate as the sector as a whole (i.e. assuming a constant market share), using sectoral growth rates from the same model that is used to derive the benchmark pathways, in order to be consistent. While companies' market shares are unlikely to remain constant, there is no obvious alternative assumption that can be made, that treats all companies consistently. Sectoral growth rates from the National Pledges Scenario (based on IEA's Stated Policies Scenario) are used.

The length of companies' emissions intensity pathways will vary depending on how much information companies provide on their historical emissions, as well as the time horizon for their emissions reduction targets.

3.2. Emissions reporting boundaries

Companies disclose emissions using different organisational boundaries. There are two high-level approaches: (i) the equity share approach; and (ii) the control approach, within which control can be defined as financial or operational. Companies are free to choose which organisational boundary to set in their voluntary disclosures, and there is variation across the companies assessed by the TPI Centre.

The TPI Centre accepts emissions reported using any of the above approaches to setting organisational boundaries, as long as:

- The boundary that has been set appears to enable a representative assessment of the company's emissions intensity; and
- The same boundary is used for reporting company emissions and activity, to obtain a consistent estimate of emissions intensity.

Currently, limiting the assessment to one particular type of organisational boundary would severely restrict the breadth of companies that can be assessed.

When companies report historical emissions or emissions intensities using both equity share and control approaches, a reporting boundary is chosen based on which method provides the longest available time series of disclosures or is the most consistent with disclosure on activity and any targets.

3.3. Data sources and validation

All TPI Centre's data are based on companies' own disclosures. The sources for the Carbon Performance assessment include responses to the annual CDP questionnaire, as well as companies' own reports, e.g. sustainability reports.

Given that our Carbon Performance assessment is both comparative and quantitative, it is essential to understand exactly what the data in company disclosures refer to. Company reporting varies not only in terms of what is reported but also in terms of the level of detail and explanation provided. The following cases can be distinguished:

- Companies that provide data in a suitable form and with enough detail for analysts to be confident that appropriate measures can be calculated or used.
- Companies that provide enough detail in their disclosures, but not in a form that is suitable for the assessment (e.g. they do not report the measure of company activity needed). These companies cannot be included in the assessment.
- Companies that do not provide enough detail on the data disclosed (e.g. the company reports an emissions intensity estimate but does not explain precisely what it refers to). These companies are also excluded from the assessment.
- Companies that do not disclose their greenhouse gas emissions or activity.

Once a preliminary Carbon Performance assessment has been made, it is subject to the following procedure to provide quality assurance:

- **Internal review:** the preliminary assessment is reviewed by an analyst who was not involved in the original assessment.
- **Company review:** the reviewed assessment is sent to the company, which has the opportunity to review it and confirm the accuracy of the disclosures used. This review includes all companies, including those who provide unsuitable or insufficiently detailed disclosures.
- **Final assessment:** feedback from the company is reviewed and incorporated if it is considered appropriate. Only information in the public domain can be accepted as a basis for any change.

3.4. Responding to companies

Giving companies the opportunity to review their Carbon Performance assessments is an integral part of the TPI Centre's quality assurance process. Each company receives its draft assessment and the data that underpins the assessment, offering them the opportunity to review and comment on the data and assessment. We also allow companies to contact us at any point to discuss their assessment.

If a company seeks to challenge its result or representation, our process is as follows:

- The TPI Centre reviews the information provided by the company. At this point, additional information may be requested.
- If it is concluded that the company's challenge has merit, the assessment is updated.
- If it is concluded that there are insufficient grounds to change the assessment, the original assessment is published.
- If the company requests an explanation regarding its feedback after the publication of its assessment, the TPI Centre explains the decisions taken.
- If a company requests an update of its assessment based on data publicly disclosed after the research cut-off date communicated to the company, the new disclosure is noted. For corrections, we take this into consideration immediately, whereas general assessment updates will be incorporated in the next assessment cycle.

If a company chooses to further contest the assessment and reverts to legal means to do so, the company's assessment is withheld from the TPI Centre website and the company is identified as having challenged its assessment.

3.5. Presentation of assessment on the TPI Centre website

The results of the Carbon Performance assessments are posted on the TPI Centre's online tool (www.transitionpathwayinitiative.org/tpi/sectors). On each company page, its emissions intensity pathway is plotted on the same chart as the benchmark pathways for the relevant sector. Different companies can also be compared on the toolkit main page, with the user free to choose which companies to include in the comparison.

4. Specific considerations for the assessment of diversified miners

4.1. Measure of emissions intensity

In applying the SDA to the diversified mining sector, a key consideration is that the vast majority of lifecycle emissions stem from processing and use of companies' sold products, e.g. processing of iron ore to manufacture steel, and burning of thermal coal. Therefore, the scope of a company assessment should include emissions from processing and use of sold products, as well as the contribution from direct and indirect operational emissions (i.e. Scope 1 and 2).

To arrive at a single emission intensity metric, the TPI Centre needs a single common denominator that would capture all mining relevant products. Therefore, we use the Copper Equivalent (CuEq) metric to normalise physical quantity values across multiple commodities.

Hence, in the diversified mining sector, the specific measure of emissions intensity used by the TPI Centre is:

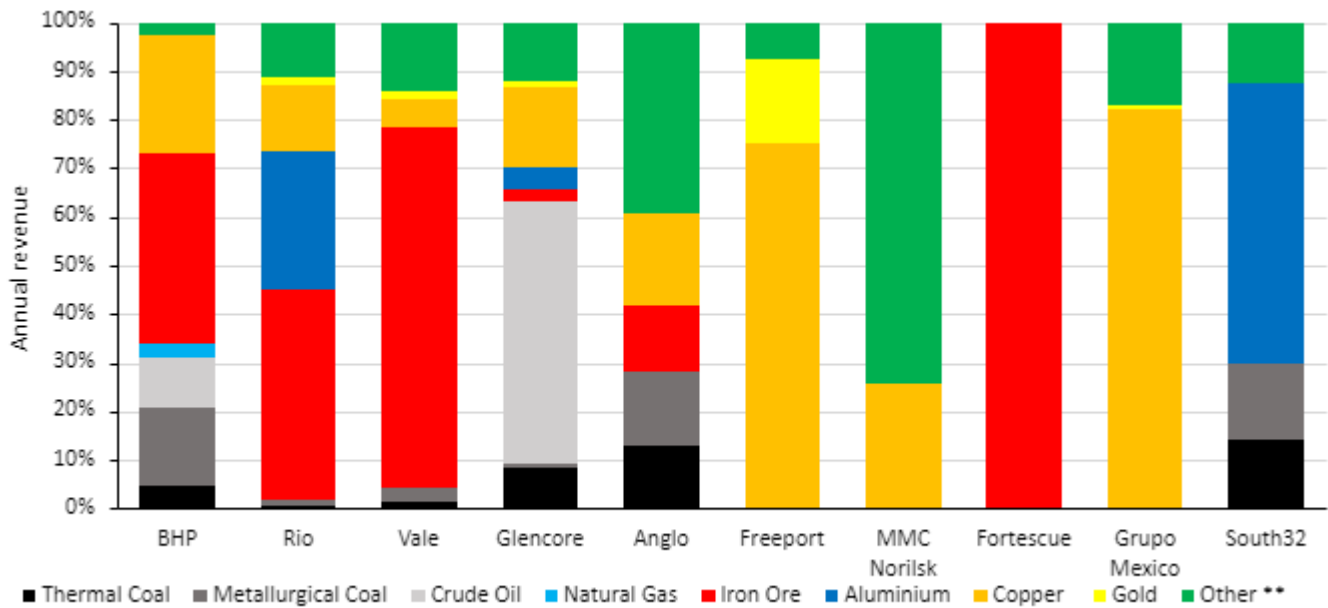
- Scope 1, 2 and 3 (Categories 10 and 11, processing of sold products and use of sold products, respectively) greenhouse gas emissions from externally sold products in units of tonnes of CO₂ equivalent (tCO₂e) per tonne of Copper Equivalent material (tCuEq).

4.2. Defining the diversified mining sector

Our definition of diversified miners includes companies in the 'Non-ferrous metals', 'Iron and Steel' and 'General Mining' subsectors (ICB: 1755, 1757 and 1775 respectively). Steel manufacturers are part of the 'Iron and Steel' subsector (1755) and are already covered as a separate sector by the TPI Centre [8]. They are therefore excluded from this methodology to ensure the focus is on mining companies. Rio Tinto, Vedanta, and South32 are included in the diversified mining sector, however their aluminium businesses are also assessed as stand-alone activities by the TPI Centre [9].

Diversified mining companies extract a wide variety of natural resources from the earth's crust, including energy products (e.g. coal, crude oil and natural gas), ores requiring processing (e.g. iron ore into steel, or bauxite into alumina), metals needing to be processed into a finished product (e.g. copper, gold, silver and nickel), and precious gems such as diamonds [10]. As Figure 4.1. highlights, some companies produce a wide range of outputs, whilst others are more focussed. Portfolios also vary substantially between companies. Of the ten largest companies in the sector, no two have an identical, or even strongly similar, portfolio.

Figure 4.1. Revenue by product for the ten largest diversified mining companies*



* Based on investible market capitalisation. Revenue breakdown based on reporting from January 2020. Includes Glencore’s trading activities but excludes Grupo Mexico’s Transportation and Infrastructure divisions.

** “Other” includes cobalt, ferroalloys, lead, manganese, molybdenum, nickel, palladium, platinum, salt, silver, titanium dioxide, uranium, zinc, borate and diamonds. Lithium was added to the benchmarks in June 2022, while tungsten and niobium were added to the benchmark in June 2023, but none of the companies in this figure produce lithium, tungsten and niobium at this time.

4.3. Establishing a common denominator: copper equivalent

Finding an activity measure – the denominator of emissions intensity – that is relevant to companies with such different and often diverse portfolios is another challenge. In developing this methodology, we have considered a number of different denominators.

Metrics that exclusively rely on the volume of physical output (e.g. tonnes of rock mined/milled/metal output) struggle to capture both energy products and the full range of mining products. A company focused on high-value, low-volume products (e.g. precious metals) would have, *ceteris paribus*, a much higher intensity than one focused on high-volume commodities.

A revenue-based denominator was also considered. Using revenue would allow commodities of different values to be compared with relative ease. However, there are two drawbacks to this approach. First, revenue is volatile, which exposes the methodology to year-on-year fluctuations in commodity prices. Second and more importantly, it is difficult to make long-term revenue projections for the diversified mining sector. These projections are essential for benchmarking (see below).⁶

Instead, the methodology developed here uses a **copper equivalent (Cu Eq)** denominator. Cu Eq volume is defined as the weight (in tonnes) of copper that has a revenue equal to that of the commodity in question. Calculating Cu Eq requires establishing the market price of copper and the product to be converted. The ratio of these two prices is called the “price factor”. Table 4.1. illustrates how production is converted into a Cu Eq measure using iron ore as an example.

⁶ One could assume revenue grows at the same rate as GDP; GDP growth projections are widely available. However, structural change generally dictates that the size of the primary sector, including mining, shrinks over time, so revenue would not be expected to grow at the same rate as GDP.

Table 4.1. Conversion into Copper Equivalent (Cu Eq) volume (three-year average)

Calculation step	2018	Source
A Iron ore sales (Mt)	250	Company A
B 3-year iron ore price average (US\$/t)	67	World Bank [3]
C 3-year copper price average (US\$/t)	5856	World Bank [3]
D 3-year average price factor (B/C)	0.011	-
E Copper equivalent volume (Mt of CuEq) (A x D)	2.85	-

Since calculating Cu Eq requires inputting market prices, it is subject to fluctuation, like revenue. However, Cu Eq is less volatile than underlying commodity prices, because of covariation between the price of copper and the price of other commodities. To further reduce volatility, we use average price data. Table 4.1. shows an average over three years for illustrative purposes. The current assessments **use 10-year rolling averages** where consistent price data are available, and an average based on the maximum length of consistent data otherwise.

We estimate the historical and future Cu Eq volumes of all mining-relevant commodities for the benchmark denominator (see Section 4.4. for further details), as well as in individual company assessments. Price data are taken from two broad groups of sources: global commodity price indices [11–15], and individual company reported realised prices. We use average price indices to construct the benchmark denominator, but to estimate individual companies' total production in Cu Eq we use company-reported realised prices, as they likely better reflect the grade of commodity that the company produces.

We believe this Cu Eq metric is relatively well understood in the mining sector. Metal equivalent calculations are often used by mining companies and analysts to compare commodities of different value and where production has different grades or contains multiple metals.

4.4. Establishing and forecasting a global Cu Eq benchmark

Determining the alignment of diversified mining companies with the Paris Agreement goals requires constructing global benchmarks from this Cu Eq denominator. We do this in a bottom-up fashion, aggregating data from individual products to estimate global Cu Eq.

We use IEA data to estimate global hydrocarbon energy production (coal, segmented by type, plus crude oil, and natural gas). We also use IEA scenario data to estimate global primary aluminium and steel production (with iron ore production converted from steel production using a ratio of 1.37 tonnes of iron ore to 1 tonne of steel [16]). The IEA is also used as the source of production data for copper, nickel, cobalt, and lithium [30]. Estimates for 16 additional commodities are collated from a variety of sources [17–21].

We then project future production corresponding to our three benchmark scenarios. IEA projections are available for the energy products, aluminium, iron ore, copper, nickel, cobalt, and lithium. Long-term projections of production are generally unavailable for other commodities, so we link production growth for these 16 commodities with real GDP growth projections from the underlying IEA scenarios, to enhance consistency.

4.5. Establishing company activity boundary

One challenge posed by such a diverse sector is establishing the assessment boundary. In this case, the question is which activities and commodities to include, and which to exclude. We have made our assessment of diversified mining companies as broad as possible, including as many commodities as feasible. This is guided by the principles of: (i) fully reflecting companies' transition risk; and (ii) taking into account the critical role of commodity portfolio diversification in enabling diversified mining companies to transition to a low-carbon economy.

Along the way we have considered and rejected various options to limit the assessment boundary. One option we looked at was distinguishing between energy (coal, oil and natural gas) and non-energy products. As Figure 4.1. highlights, out of the ten largest diversified miners only Glencore and BHP sell substantial volumes of oil and gas. Energy products are much more emissions-intensive than most other mining products. Given the TPI Centre assesses oil and gas producers separately [22], there is an argument to exclude some or all energy products from the methodology for diversified miners and focus on non-energy products. However, we believe that including companies' energy products enables us to fully capture companies' transition risks and is therefore more useful to investors.

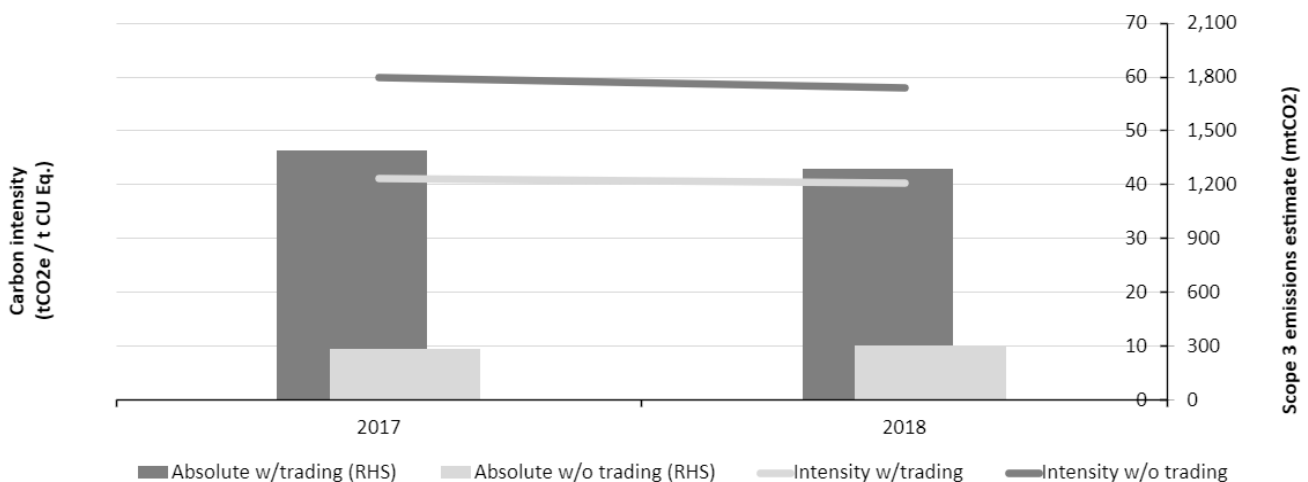
The objective of making the scope of our assessment as broad as possible also leads us to include natural resource marketing/trading activities. For some miners, these activities account for a considerable share of revenues. Whilst operationally very different to natural resource extraction, trading carbon-intensive products also creates transition risks, given the dependence of companies' revenues on underlying carbon-intensive products. Excluding them opens a decarbonisation strategy that would simply transfer transition risk to an unassessed activity without any decarbonisation taking place.

We do aim to exclude "financial trading", in which no change in ownership of the underlying asset takes place. However, it is not always straightforward to distinguish this from physical trading based on public disclosure. In addition, some mining companies trade emissions-intensive products, but do not disclose volumes. We encourage companies to explicitly disclose financial and physical trading volumes.

Recognising that investors may want to understand the impact of trading, we show the effect of including trading on Glencore's assessment. As Figure 4.2. highlights, including trading activities increases our estimate of Glencore's absolute emissions nearly fivefold, but cuts intensity by 18 percentage points.

While we aim to cover a broad range of activities within this methodology, we do not intend to include activities outside the natural resources sector. Consequently, we do not intend to capture Grupo Mexico's Transportation and Infrastructure divisions (25% of its 2018 revenues). We aim to exclude Scope 1 and 2 emissions from non-mining business segments in companies' assessments whenever these are publicly disclosed.

Figure 4.2. The impact of trading on Glencore's emissions intensity and absolute emissions



Source: Based on original assessment published in May 2020 (see [Carbon Performance Assessment in the Diversified Mining Sector: Discussion document](#)).

4.6. Establishing the assessment emissions boundary

Following the establishment of a broad assessment boundary, our assessments need to capture the most material emission scopes to reflect the transition risk in the diversified mining sector.

Operational (Scope 1 and 2) emissions

The extraction, grinding and transportation processes that characterise the diversified mining sector typically consume large amounts of energy and consequently generate substantial operational (Scope 1 and 2) carbon emissions. The emissions intensity of operations varies widely by natural resource, location and extraction method. A mineral located close to the surface and/or near the primary processing site will require significantly less energy to produce. Typically, diversified mining companies disclose Scope 1 and 2 emissions, and we incorporate this data in our company assessments.⁷

Scope 3 emissions

The downstream processing and use of natural resources produced and sold by mining companies (i.e. outside the companies' boundaries) can be very emissions intensive. Emissions from the burning of thermal and metallurgical coal and the processing of iron and bauxite ores are estimated to be on average 10x greater than the associated operational emissions from mining and can be up to 30x greater [23]. Therefore, we include selected downstream Scope 3 emissions in the company assessments.

Two Scope 3 categories that are particularly relevant for the mining sector are included in company assessments:

1. **Processing of sold products (Category 10).** Iron ore and bauxite require substantial energy inputs to be converted into useful products. The processing required to produce finished gold and copper products also requires energy. We apply factors calculated by industry and academic research to these products to estimate their Scope 3 emissions (see section 4.7 for further details). For some metals, we were either unable to locate emissions factors or we deem the downstream processing-based emissions to be immaterial.
2. **Use of sold products (Category 11).** Hydrocarbon-based energy products (coal, crude oil and natural gas) release CO₂ when burned. We apply IPCC factors [24] to these energy products to calculate Scope 3 emissions.

4.7. Estimating company carbon intensity

Data availability: disclosure of historical emissions intensity

TPI Centre is a disclosure-based framework that uses the emissions data companies publish as the basis of the assessment. Unless a company discloses Scope 1 and 2 emissions, we cannot calculate its Carbon Performance.

While some companies disclose Scope 3 emissions in some form, the method used to calculate these figures varies significantly:

- Some miners disclose a single Scope 3 emission figure covering all categories.
- Others disclose Scope 3 emissions disaggregated by category, but without disclosing underlying assumptions about the emissions intensity of downstream metals processing.
- Some miners disclose Scope 3 emissions for Categories 10 and 11, broken down by commodity and sometimes include associated emissions factors. This level of detail is ideal for the purposes of TPI Centre's Carbon Performance assessment, although given uneven quality of disclosure between companies, we continue to calculate Scope 3 emissions ourselves using disclosed sales volumes and third-party sources for relevant emissions factors.

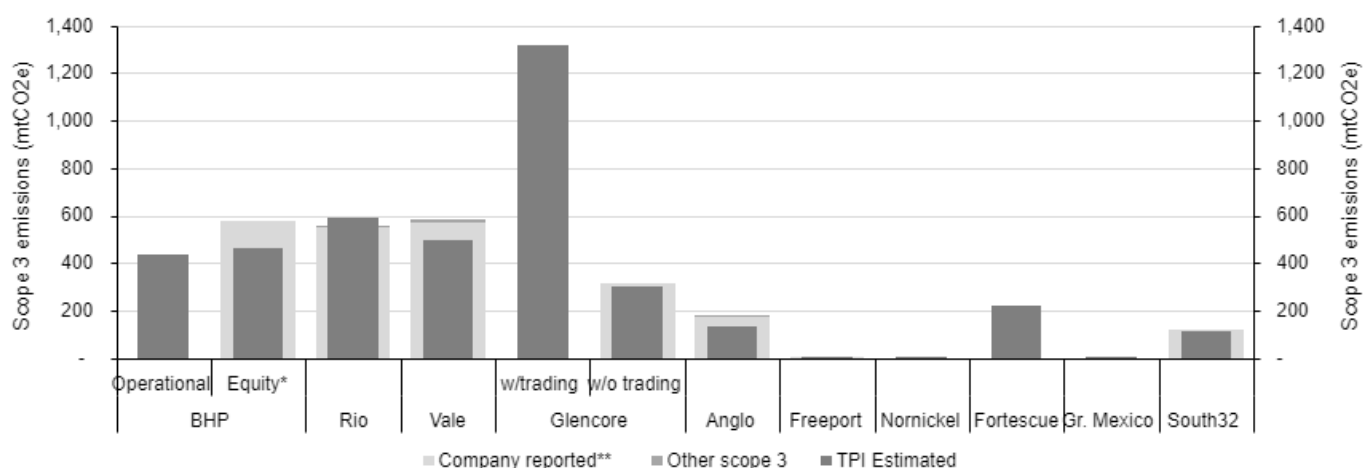
⁷ We do not need to separately estimate Scope 1 and 2 emissions for the benchmarks, because they are already included in global primary energy emissions.

Calculating Scope 3 is complicated, publishing is voluntary, and figures appear to be provided on a “best effort” basis. Disclosure is improving, but in our view published figures do not currently provide a reliable indicator of performance over time or enable meaningful comparison between companies.

In the absence of suitable and consistent Scope 3 disclosure, the TPI Centre calculates those emissions in a bottom-up way. To do so requires disclosure of sales volumes segmented by natural resource (production data can be used where they provide greater granularity). Applying the appropriate emissions factor to these sales data enables emissions from processing and use of sold products (Category 10 and 11 respectively) to be estimated. Where companies publish a Scope 3 breakdown, these categories typically account for over 95% of emissions. Overall, the approach is similar to the one we have developed for the oil and gas production sector [22].

All companies assessed provided sufficient segmentation of sales volumes to make this calculation possible, however the reporting boundary used (equity or operational), the precise nature of the product, and the level of production consumed internally is not always clear. We highlight the impact of reporting boundary in Figure 4.3. In general, we try to ensure consistent boundaries for operational (Scope 1 and 2) and Scope 3 emissions and the Cu Eq denominator. However, we also prefer our assessments to be as broad as possible, particularly where a narrower consolidation boundary excludes emissions-intensive activities.

Figure 4.3. A comparison of TPI’s Scope 3 estimates with company disclosure



* Based on original assessments published in May 2020. BHP disclosure of 576mt CO₂e Scope 3 emissions from category 10 and 11 in FY18 but makes no adjustment for emissions from metallurgical coal. TPI Centre estimate of emissions without any adjustment is also 576mtCO₂e ** Sum of category 10 and 11 where specified but if no breakdown disclosed, just reflects total.

As discussed in Section 4.5, we propose to include all natural resource-related activities within our company assessments. This enables the methodology to include Glencore’s marketing division, which trades third party products and generates 80% of the company’s sales, for example. We exclude activities that are not related to natural resources, such as the 25% of Grupo Mexico’s revenues generated from its Transportation and Infrastructure divisions.

Data availability: targets

Most companies in our sample publicly disclose emission reduction targets. These targets differ by scope (operational only vs Scope 3 inclusive), and type (intensity vs absolute targets). To enable consistent assessment of the sector, we convert all accepted targets into company-wide intensity targets:

- **Intensity targets:** the percentage reduction is applied to emissions intensity within the target (typically Scope 1 and 2) in the elected base year. In case Scope 3 emissions are not covered under a target, the residual intensity is assumed to remain flat from the last calculated year.
- **Absolute targets:** emissions within the target are converted to intensity using the Cu Eq denominator. Cu Eq production is projected into the future under the assumption that it grows with the same rate as the *National Pledges* scenario denominator. Emissions outside the target are assumed to remain at a constant intensity relative to the most recent disclosed data. This approach is consistent with the methodology TPI has adopted in other sectors.

Calculating company-level intensity

Companies' Cu Eq volumes are calculated using disclosed sales data by raw material (production data can be used where it provides greater detail). Price factors are used to convert these data to Cu Eq following the approach described in Section 4.3. For a company not reporting on a calendar-year schedule, data from the financial year-end closest to the calendar year-end is used.

Our proposed approach also aims to adjust for internally sold products (the sale of raw material into "downstream" activities owned by the same company) to minimise double counting. The inclusion of trading and focus on "all externally sold product" is consistent with the approach we use for downstream oil and gas [22].

Total emissions are calculated by adding disclosed Scope 1 and 2 emissions to our estimate of Scope 3 emissions. We also adjust the calculated Scope 3 figures to prevent double counting of Scope 3 emissions from iron ore and metallurgical coal sold by the same company. This follows from the assumption that metallurgical coal will be used in iron ore manufacturing, and therefore its emissions would already be included in the iron ore emission factor used in the company's assessment. We remove emissions from metallurgical coal up to 0.58x the company's iron ore production. This 0.58x factor represents the ratio of metallurgical coal needed to make steel from any given amount of iron ore according to the World Steel Association [16]: 0.8t of metallurgical coal and 1.37t of iron ore are typically required to make 1t of steel ($0.8 / 1.37 = 0.58$). In case metallurgical coal makes up more than 58% of company's iron ore sales, the excess emissions are added back in.

Emissions factors used

The choice of emissions factors has a material impact on company emissions estimation. Therefore, we aim to communicate the factors used transparently, and update them as better information becomes available.

- **Energy commodities:** we use IPCC standard emission factors for fossil fuel energy commodities, i.e. oil, gas, and coal [24].
- **Iron ore:** we use an emissions factor of 1.38 tCO₂/t. This figure is based on the WSA [16] estimate of 1.89 tCO₂/t of steel produced and assumes 1.37 tonnes of iron ore per tonne of steel produced. However, it is not clear the extent to which operational emissions from iron ore suppliers are already included in this factor and it may be appropriate to apply lower emissions factors to part-processed products like fines and pellets. Our assessment of steel companies suggests an emissions factor of 1.89 tCO₂/t is an appropriate Scope 3 factor to use for mining, but this does include some production from scrap. The ten most emissions-intensive steelmakers average 2.2 tCO₂/t.
- **Aluminium:** the effective downstream emissions factor we apply varies according to the type of product the company sells: bauxite, alumina, or aluminium. Diversified mining companies predominantly supply bauxite and alumina but may be involved in all parts of the production process and may sell produce at one stage to its downstream operations. In cases where a company uses its own alumina to produce aluminium internally, the amount of alumina embodied in the aluminium produced is subtracted using a conversion factor of 2 tonnes of alumina per 1 tonne of aluminium.

We assume a lifecycle factor of 16 tCO₂e/t primary aluminium [26] with emissions predominantly released at two main stages of the production process: alumina refining and aluminium smelting. If a company produces a (finished) aluminium product, all processing emissions will be reported in the company's Scope 1 or 2 disclosure and no Scope 3 emissions factor is applied. However, smelting consumes significant energy and hence generates c. 90% of the emissions. Assuming two tonnes of alumina are needed to make one tonne of aluminium, the effective downstream Scope 3 "processing of sold products" emissions factor we use for alumina is 7.2 tCO₂/t ($90\% \times 16 \text{ tCO}_2\text{e}/2\text{t}$). If the mining company sells bauxite, all 16tCO₂e are effectively Scope 3. Assuming five tonnes of bauxite are converted to a tonne of aluminium, the effective emissions factor for bauxite is therefore 3.2tCO₂e/t.

- **Copper:** we apply similar adjustments to copper output to reflect downstream processing emissions. Several companies remarked that a 4.2 tCO₂/t lifecycle factor applied to their copper output was too high. Based on the IEA [30], we have adjusted the emissions factor applied to mined copper as 1.6 tCO₂e per tonne of metal content. When companies sell copper cathode, we count its Scope 3 emissions as zero, as all manufacturing processes are already accounted in the relevant Scope 1 and 2 figures.
- **Cobalt, lithium, nickel, zinc:** emissions factors for these commodities, excluding emissions from mining, are taken from p.195 of the IEA's report on critical minerals [30].
- **Other minerals:** we assume the downstream processing emissions from other minerals sold by miners as immaterial. The only exception is gold, where we apply a factor of 23,435 tCO₂/tAU [27]. We continue to develop our methodology further, by expanding Scope 3 calculation further, to key future facing commodities.

Treatment of carbon capture and offsets

Our benchmarks include the impact of CCS and negative emissions, as we believe these are in general a legitimate path to decarbonisation for some sectors. As such, we also aim to include them in our company assessments and understand that some companies already factor them into their emissions disclosure and expect to make use of them to meet long-term targets. However, not all offsets are equally valid and company disclosure in this area varies [28]. We believe companies should publish the impact of carbon capture and offsets on their disclosed figures and indicate the extent to which they intend to rely on them to meet emissions reduction targets.

5. Discussion

This note describes the methodology followed by the TPI Centre in assessing the Carbon Performance of the diversified mining sector.

The Carbon Performance assessment is designed to be robust yet easy to understand and use. There are inevitably many nuances surrounding each company's individual performance, how it relates to the benchmarks, and why. Investors may wish to dig deeper into companies' assessments in their engagements with them to better understand these.

5.1. General issues

The methodology builds on the SDA, which compares a company's emissions intensity with sector-specific benchmarks that are consistent with international targets (i.e. limiting global warming to 1.5°C, well below 2°C, and the sum of National Pledges).

TPI Centre uses the modelling of the IEA to calculate the benchmark paths. While such economy-energy models offer a number of advantages, they are also subject to limitations. In particular, model projections often turn out to be wrong. This would impact the accuracy of the benchmark and potentially lead to investors drawing inaccurate conclusions about a company's alignment. The IEA updates its modelling every two years and the TPI Centre updates its benchmark calculations accordingly. Nevertheless, in such a forward-looking exercise there is no way to avoid the uncertainty created by projecting into the future.

We use companies' self-reported emissions and activity data to derive emissions intensity pathways. Therefore, companies' pathways are only as accurate as the underlying disclosures.

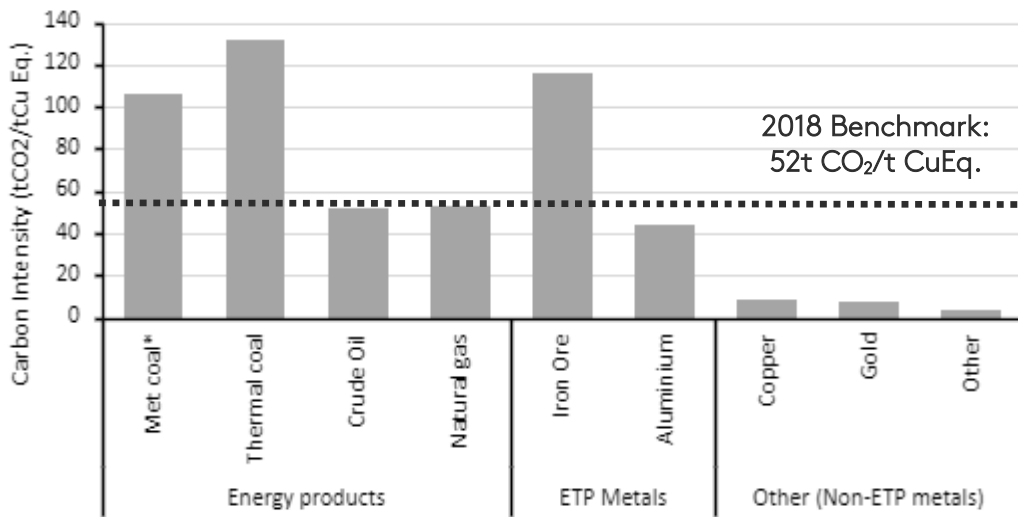
Estimating the historical and especially the future emissions intensity of companies involves a number of assumptions. Therefore, it is important to bear in mind that, in some cases, the emissions pathway drawn for each company is an estimate made by the TPI Centre, based on information disclosed by companies, rather than the companies' own estimate or target. In other cases, the information disclosed by companies is sufficient on its own to completely characterise the emissions intensity pathway.

5.2. Issues specific to the diversified mining sector

Sensitivity of benchmark to product mix

The natural resources in our benchmark include commodities with very different emissions intensities (see Figure 5.1). Energy products generally have high emissions intensities. We estimate that lifecycle (i.e. including Scope 3) emissions intensities range from 52 tCO₂/tCu Eq for crude oil to an average of 132 tCO₂/tCu Eq for thermal coal. Non-energy products (ETP Metals and Other) have much lower intensities in general, although iron ore is a notable exception: emissions from steel-making result in a lifecycle emissions intensity of 112 tCO₂/tCu Eq.

Figure 5.1. Lifecycle emissions intensity by product (CO₂ only)



Note: Emissions factors used in company assessments will vary according to grade. Assumes 4.0 tCO₂/tCu Eq in operational emissions for all products with the exception of aluminium and copper, where lifecycle factors of 14.4 tCO₂e/tAl. and 4.2 tCO₂/tCu are used respectively. A gross CO₂-based benchmark is chosen, as allocating negative emissions and non-CO₂ emissions by product is difficult.

Source: Based on original assessment published in May 2020 (see [Carbon Performance Assessment in the Diversified Mining Sector: Discussion document](#)).

As our benchmarks include most global energy system and process emissions, it is biased by the inclusion of fossil fuels. As Figure 4.1. highlighted, of the ten largest diversified mining companies, only Glencore and BHP sell substantial volumes of oil and gas (54% and 11% of 2018 revenues respectively). As long as industry leaders are engaged in this emissions-intensive activity, we believe it is important to capture it within our benchmarks. However, if BHP were to divest from its drilling activity and/or Glencore to reduce crude oil trading, inclusion of oil and gas within the benchmark would be more difficult to justify.

Several of the largest diversified miners produce either thermal or metallurgical coal. Therefore, the inclusion of coal in the benchmark is not in question. However, its exceptionally high emissions intensity results in a sector benchmark that is relatively easy for mining companies without coal exposure to be aligned with. If and when further diversified mining companies exit from thermal coal, it may become appropriate to exclude it from diversified mining benchmarks. Excluding all energy products, including thermal coal, would substantially lower the benchmarks.

The wide variation in intensity by product highlights the potential for diversified mining companies to align with the benchmarks by shifting their portfolio away from energy products (particularly coal) and iron ore.

Reflecting improvements in the efficiency of customers' production

Using industry-wide emissions factors improves comparability of our intensity estimates for the sector. However, a potential limitation of this approach is that it does not encourage diversified mining companies to focus on selling to customers deploying the best available technologies to improve efficiency and reduce emissions. We see this as a legitimate decarbonisation strategy and arguably the only one that will enable diversified miners to retain a significant iron ore business while claiming alignment with climate goals. Given the limited variation in the emissions intensity of listed steel manufacturers at present [8], we do not see this as a significant issue at this point but believe it will become so over time. We continue to welcome feedback on how emissions factors that reflect the efficiency of a customers' production could be reliably calculated. One option we will consider for future developments of this methodology is to use the average emissions factors associated with customers' use and processing of a mining companies' sold products if these emissions factors are disclosed by the mining company.

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LSE Transition Pathway Initiative Centre

Grantham Research Institute on Climate Change
and the Environment

London School of Economics and Political Science

Houghton Street

London WC2A 2AE, UK

T +44 (0)20 7107 5027

E tpi@lse.ac.uk

Transition Pathway Initiative

c/o UNPRI Association

5th Floor, 25 Camperdown Street

London E1 8DZ, UK

T +44 (0)20 3714 3141

E info@transitionpathwayinitiative.org

@tp_initiative

transitionpathwayinitiative.org

