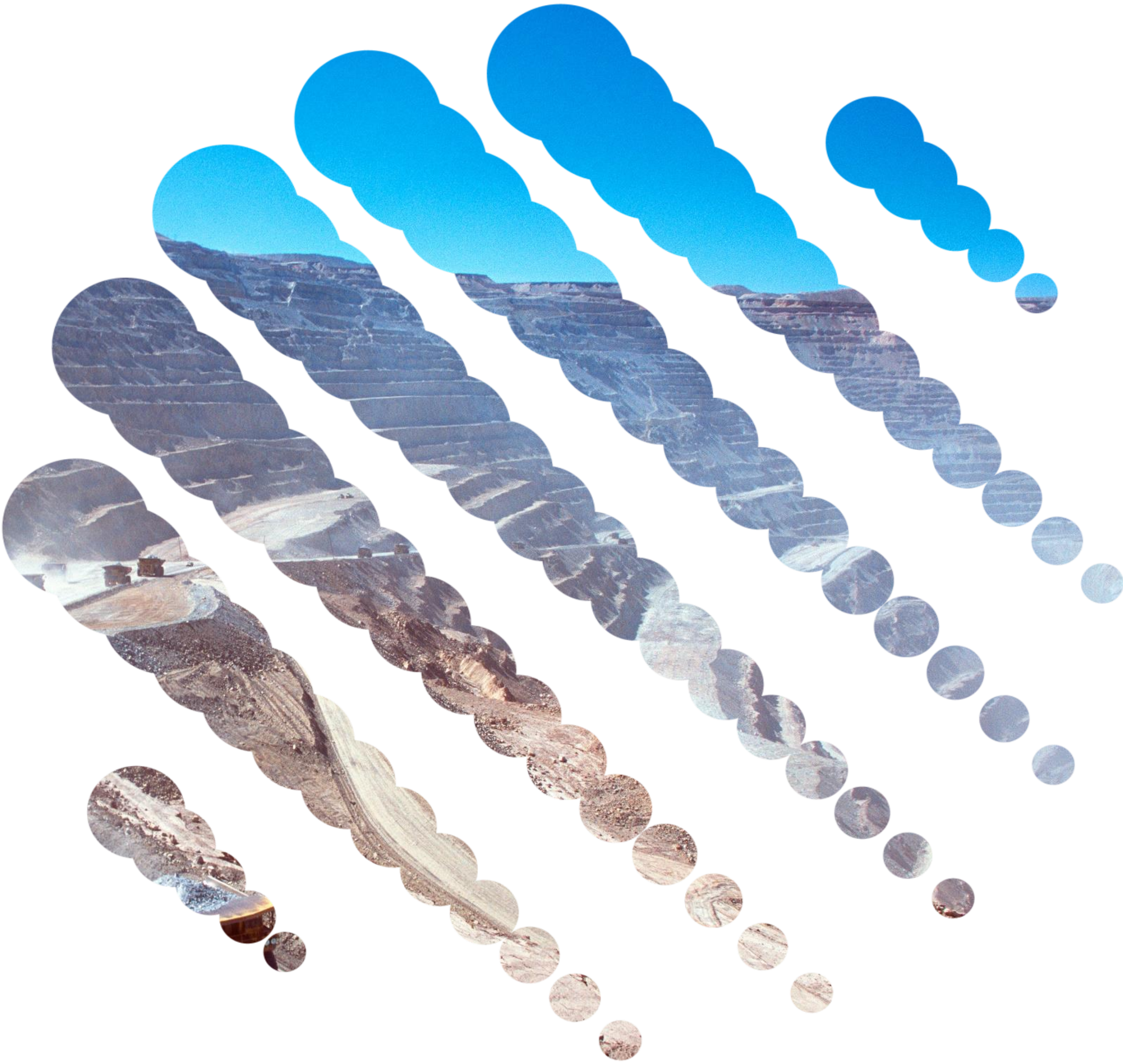
Carbon Performance Assessment of Diversified Mining Methodology Note

June 2022



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Transition Pathway Initiative

CONTENTS

1. INTRODUCTION

The Transition Pathway Initiative (TPI) is a global initiative led by asset owners and supported by asset managers. Established in January 2017, TPI is now supported by over 120 investors globally with over $40 trillion of assets under management.[1]

On an annual basis, TPI assesses how companies are preparing for the transition to a low-carbon economy in terms of their:

- *Management Quality* – all companies are assessed on the quality of their governance/management of greenhouse gas emissions and of risks and opportunities related to the low-carbon transition;
- *Carbon Performance* – in selected sectors, TPI quantitatively benchmarks companies' carbon emissions against international climate targets made as part of the 2015 UN Paris Agreement.

TPI publishes the results of its analysis through an open access online tool hosted by the Grantham Research Institute on Climate Change and the Environment at the London School of Economics (LSE): www.transitionpathwayinitiative.org .

Investors are encouraged to use the data, indicators and online tool to inform their investment research, decision making, engagement with companies, proxy voting and dialogue with fund managers and policy makers, bearing in mind the Disclaimer that can be found in section 6. Further details of how investors can use TPI assessments can be found on our website.

The purpose of this note is to provide an overview of the methodology being followed by TPI in its assessment of the Carbon Performance of diversified mining companies.

[1] As of June 2022.

2. THE BASIS FOR TPI'S CARBON PERFORMANCE: SECTORAL DECARBONIZATION APPROACH

TPI's Carbon Performance assessment is based on the Sectoral Decarbonization Approach (SDA)[2]. The SDA translates greenhouse gas emissions targets made at the international level (e.g. under the 2015 UN Paris Climate Agreement) into appropriate benchmarks, against which the performance of individual companies can be compared.

The SDA is built on the principle 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 they are to reduce. Other approaches to translating international emissions targets into company benchmarks have applied the same decarbonization pathway to all sectors, regardless of these differences [1].

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 aligned with international emissions targets.

Applying the SDA can be broken down into 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 economy-energy model, and these models usually allocate emissions reductions by region and by sector according to where it is cheapest to reduce emissions and when (i.e. the allocation is cost-effective). Cost-effectiveness is, however, subject to some constraints, such as political and public 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, economic activity). This results in a benchmark path 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 Decarbonization approach (SDA) was created by CDP, WWF and WRI in 2015 (https://sciencebasedtargets.org/wp-content/uploads/2015/05/Sectoral-DecarbonizationApproach-Report.pdf).

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

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

3. HOW TPI IS APPLYING THE SDA

3.1. Deriving the benchmark paths

The key inputs to calculating the benchmark paths 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, TPI 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.

TPI uses three sectoral benchmark pathways/scenarios, which in most sectors are defined as:

1) *National Pledges*, which is consistent with the global aggregate of emissions reductions pledged by countries as of mid-2020. According to the IEA, this aggregate is currently insufficient to put the world on a path to limit warming to 2°C, even if it will constitute a departure from a business-as-usual trend. This scenario is expected to lead to a global temperature increase of 2.6°C by 2100 with a probability of 50%. [4]
2) *Below 2 Degrees* which is also 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 1.65°C. [4]
3) *1.5 Degrees* 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 1.5°C

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 [6], 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. TPI 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 CO_2. Additionally, non-CO_2 greenhouse gases in the form of methane (CH_4)[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 CH_4 [7]. 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 CH_4 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). [8] 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 [9], methane emissions will be equivalent to 1.01 gigatons of CO_2. Beyond methane, non-CO_2 greenhouse gases in the form of perfluorocarbons

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[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-CO_2 greenhouse gases such as SO_2 and HFCs are negligible.

(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 Degrees 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, TPI constructs the benchmark emission intensity pathways. Table 1 below presents the key underlying datapoints for the three scenarios, as well as highlighting the sources used in their construction.

Figure 1 Emission intensity benchmark pathways

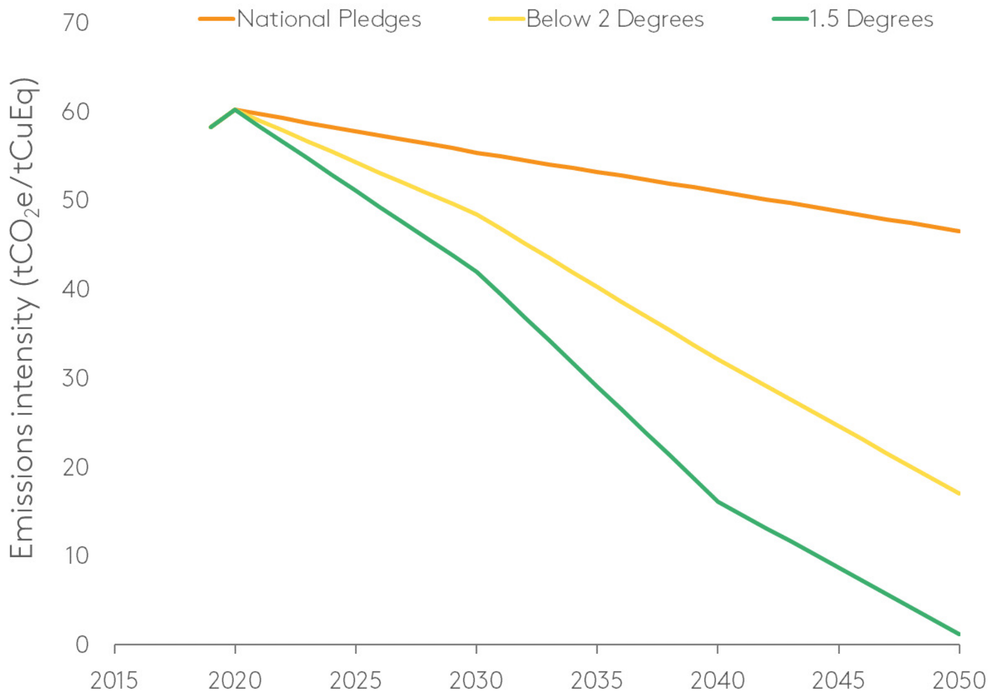


Table 1 Summary of the emission intensity benchmark

	2020	2030	2040	2050
National Pledges scenario				
Total direct CO_2 emissions from primary energy and processes ($MtCO_2$) (A)	*34,156*	*36,267*	*35,312*	*36,903*
Chemical and cement process emissions ($MtCO_2$) (B)	1,812	1,999	2,008	1,912
Methane emissions from primary energy ($MtCO_2e$) (C)	2,646	2,490	2,462	2,455
PFC emissions from aluminium production (D)	35	36	33	29
Energy products (MtCuEq)	459	496	494	486
Iron ore and aluminium (MtCuEq)	47	55	62	66
Other minerals (MtCuEq)	75	98	130	173
Total mined product (MtCuEq) (E)	*581*	*649*	*686*	*725*
Emissions intensity (gCO_2e / MtCuEq) (A-B+C+D)/E	60.2	56.7	52.2	47.6
Below 2 Degrees scenario				
Total direct CO_2 emissions from primary energy and processes ($MtCO_2$) (A)	*34,156*	*28,487*	*16,441*	*8,170*
Chemical and cement process emissions (MtCO2) (B)	1,812	1,825	1,187	553
Methane emissions from primary energy ($MtCO_2e$) (C)	2,646	1,251	713	687
PFC emissions from aluminium production (D)	35	35	28	19
Energy products (MtCuEq)	459	414	298	212
Iron ore and aluminium (MtCuEq)	47	48	46	43
Other minerals (MtCuEq)	75	102	145	225
Total mined product (MtCuEq) (E)	*581*	*564*	*488*	*480*
Emissions intensity (gCO_2e / MtCuEq) (A-B+C+D)/E	60.2	49.6	32.8	17.3
1.5 Degrees scenario				
Total direct CO_2 emissions from primary energy and processes ($MtCO_2$) (A)	*34,156*	*21,147*	*6,316*	*0*
Chemical and cement process emissions (MtCO2) (B)	1,812	1,387	679	96
Methane emissions from primary energy ($MtCO_2e$) (C)	2,646	1,013	756	598
PFC emissions from aluminium production (D)	35	29	15	4
Energy products (MtCuEq)	459	335	187	109
Iron ore and aluminium (MtCuEq)	47	43	44	41
Other minerals (MtCuEq)	75	106	159	270
Total mined product (MtCuEq) (E)	*581*	*484*	*390*	*420*
Emissions intensity (gCO_2e / MtCuEq) (A-B+C+D)/E	60.2	43.0	16.4	1.2

3.2. Calculating company emissions intensities

TPI'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 recent and current 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 the case of diversified mining, emission

intensities for each company are recalculated based on their commodity volume sales data (see Section 4.7 for further details)

2. **Absolute emissions:** some companies disclose their recent and current 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, recent and current emissions intensity can be calculated by TPI.
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 in the TPI is to assume company activity increases at the same rate as the sector as a whole (i.e. this amounts to an assumption of constant market share), using sectoral growth rates from the IEA in order to be consistent with the benchmark paths. While companies' market shares are unlikely to remain constant, there is no obvious alternative assumption that can be made, which treats all companies consistently. Sectoral growth rates from the National Pledges scenario are used.

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

3.3. Emissions reporting boundaries

Companies disclose emissions using different organisational boundaries. There are two high-level approaches: the equity approach and the control approach, and within the control approach there is a choice of financial or operational control. Companies are free to choose which organisation boundary to set in their voluntary disclosures and there is variation between companies assessed by TPI.

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

1. The boundary that has been set appears to allow a representative assessment of the company's emissions intensity;
2. The same boundary is used for reporting company emissions and activity, so that a consistent estimate of emissions intensity is obtained.

At this point in time, limiting the assessment to one particular type of organisational boundary would severely restrict the breadth of companies TPI can assess.

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

3.4. Data sources and validation

All TPI's data is 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 TPI's 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:

- Some companies provide data in a suitable form and they provide enough detail on those data for analysts to be confident appropriate measures can be calculated or used. For diversified mining companies, TPI accepts production and sales data in units of weight, volume and energy.
- Some companies also provide enough detail, but from the detail it is clear that their disclosures are not in a suitable form for TPI's Carbon Performance assessment (e.g. they do not report the measure of company activity needed). These companies cannot be included in the assessment.
- Some companies do not provide enough detail on the data disclosed and these companies are also excluded from the assessment (e.g. the company reports an emissions intensity estimate, but does not explain precisely what it refers to).
- Some companies do not disclose their carbon emissions and/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 that was not involved in the original assessment.
- *Company review*: the reviewed assessment is sent to the company, which then has the opportunity review it and confirm the accuracy of the disclosures used. Only information in the public domain can be accepted as a basis for any change. This review includes all companies including those who provide unsuitable or insufficiently detailed disclosures.
- *Final assessment*: feedback from the company is reviewed and, if it is considered appropriate, incorporated.

3.5. Responding to companies

Allowing companies the opportunity to review their assessments is an integral part of TPI's quality assurance process. Each company receives its draft TPI 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/representation, our process is as follows:

- TPI 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, and the company is informed.
- If it is concluded that there are insufficient grounds to change the assessment, TPI publishes its original assessment.
- If the company requests an explanation regarding its feedback after the publication of its assessment, TPI 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, TPI can note the new disclosure on the company's profile on the TPI website.
- 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 website and the company is identified as having challenged its assessment.

3.6. Presentation of assessment on TPI website

The results of the Carbon Performance assessment are posted on the TPI website, within the TPI tool (https://www.transitionpathwayinitiative.org/sectors). A company's emissions intensity path is plotted alongside the relevant sector benchmark on a company specific page and different companies can be selected for comparison on the main sector page.

4. SPECIFIC CONSIDERATIONS IN 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, TPI 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 TPI is:

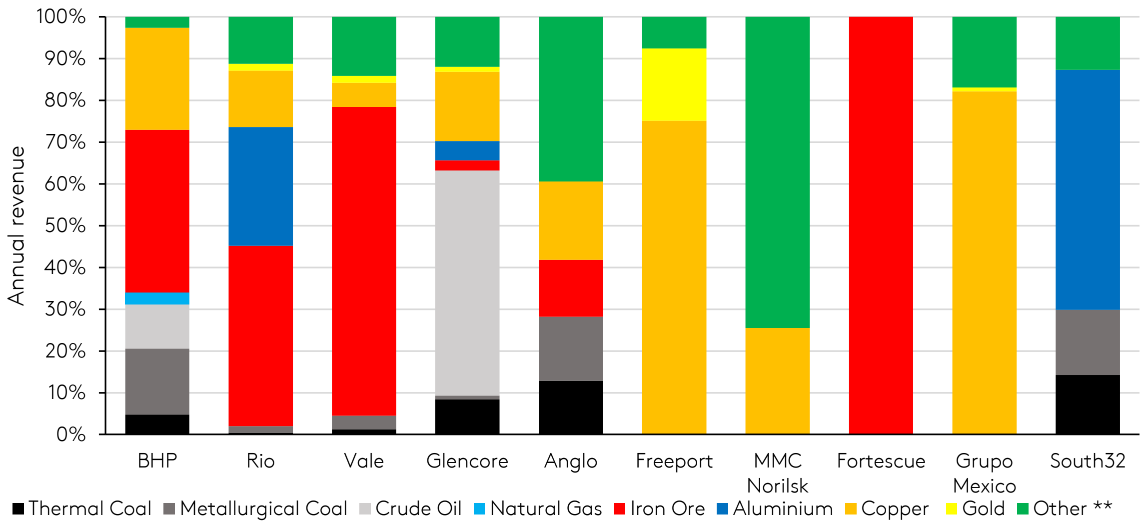
- Scope 1, 2 and 3 (Categories 10 and 11, processing of sold products and use of sold products, respectively) greenhouse gas emissions from externally sold products in units of tonnes of CO_2 equivalent (tCO_2e) per tonne of Copper Equivalent material (tCuEq).

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 TPI [10]. 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 TPI [10].

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 [12]. As Figure 2 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 2. 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, but none of the companies in this figure produce lithium 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 focussed 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

[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.

establishing the market price of copper and the product to be converted. The ratio of these two prices is called the "price factor". Table 2 illustrates how production is converted into a Cu Eq measure using iron ore as an example.

Table 2. 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$/t)	67	World Bank [13]
C	3-year copper price average (US$/t)	5856	World Bank [13]
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 2 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 [13-17], 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. Estimating 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 1.4 tonnes of iron ore to 1 tonne of steel [18]). The IEA is also used as the source of production data for copper, nickel, cobalt, and lithium [6]. Estimates for 18 additional commodities are collated from a variety of sources [19-23].

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 14 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.

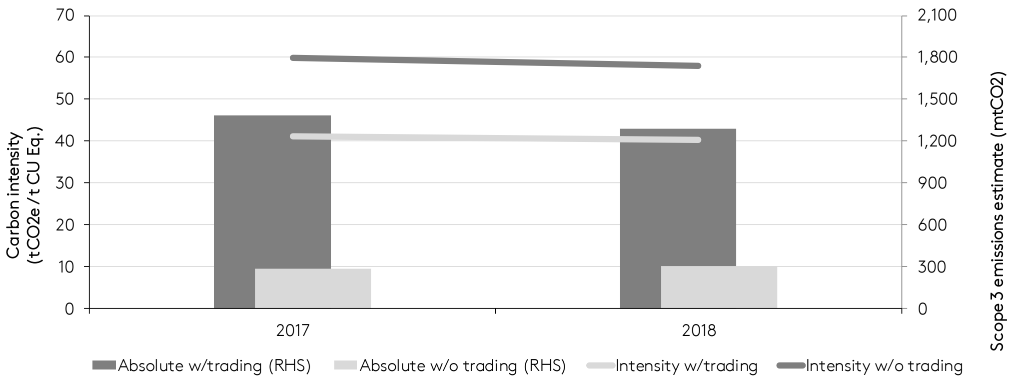
Along the way we have considered and rejected various options to limit the assessment boundary. One option we looked at was distinguishing between energy (coal, oil and natural gas) and non-energy products. As Figure 2 highlights, out of the ten largest diversified miners only Glencore and BHP sell substantial volumes of oil and gas. Energy products are much more emissions-intensive than most other mining products. Given TPI assesses oil and gas producers separately [24], 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 up 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 3 highlights, including trading activities increases our estimate of Glencore's absolute emissions nearly fivefold, but cuts intensity by 18 percentage points.

Figure 3. The impact of trading on Glencore's emissions intensity and absolute emissions*



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

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.

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 [25].

[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.

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 CO_2 when burned. We apply IPCC factors [26] to these energy products to calculate Scope 3 emissions.

4.7. Estimating company carbon intensity

Data availability: disclosure of historical emissions intensity

TPI 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, TPI cannot calculate its Carbon Performance.

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

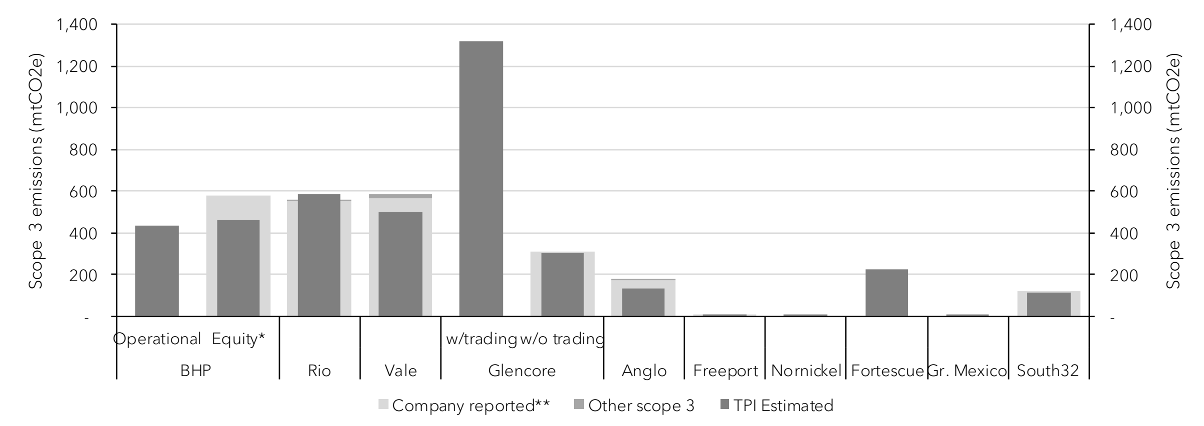
- Some miners disclose a single Scope 3 emission figure covering all categories.
- Others disclose Scope 3 emissions disaggregated by category, but without disclosing underlying assumptions about the emissions intensity of downstream metals processing.
- Some miners disclose Scope 3 emissions for Categories 10 and 11, broken down by commodity and sometimes include associated emissions factors. This level of detail is ideal for the purposes of TPI'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.

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, TPI 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 [24].

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. 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. A comparison of TPI's Scope 3 estimates with company disclosure



* Based on original assessments published in May 2020. BHP disclosure of 576mt CO_2e Scope 3 emissions from category 10 and 11 in FY18 but makes no adjustment for emissions from metallurgical coal. TPI estimate of emissions without any adjustment is also 576mtCO_2e ** 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 [24].

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 0.57x the company's iron ore production. This 0.57x factor represents the ratio of metallurgical coal needed to make steel from any given amount of iron ore according to the World Steel Association [18]: 0.8t of metallurgical coal and 1.4t of iron ore are typically required to make 1t of steel (0.8 / 1.4 = 0.57). In case metallurgical coal makes up more than 57% 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 [26].

Iron ore: we use an emissions factor of 1.35 tCO_2/t. This figure is based on the WSA [18] estimate of 1.89 tCO_2/t of steel produced and assumes 1.4 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 tCO_2/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 tCO_2/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 tCO_2e/t primary aluminium [28] 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 tCO_2/t (90% x 16 $tCO_2e/2t$). If the mining company sells bauxite, all 16tCO_2e are effectively Scope 3. Assuming five tonnes of bauxite are converted to a tonne of aluminium, the effective emissions factor for bauxite is therefore 3.2tCO_2e/t.

<u>Copper:</u> we apply similar adjustments to copper output to reflect downstream processing emissions. Several companies remarked that a 4.2 tCO_2/t lifecycle factor applied to their copper output was too high. Based on the IEA [6], we have adjusted the emissions factor applied to mined copper as 1.6 tCO_2e 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.

<u>Cobalt, lithium, nickel, zinc:</u> emissions factors for these commodities, excluding emissions from mining, are taken from p.195 of the IEA's report on critical minerals [6].

<u>Other minerals:</u> 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 tCO_2/tAU [29]. 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 [30]. 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 TPI in assessing the Carbon Performance of the diversified mining sector. The approach aims to be easy to both understand and use, while also being robust. However, there are inevitably nuances and judgements made in the development of the methodology, as well as individual company assessments. Investors may wish to dig deeper to understand these.

5.1. General issues

The methodology builds on the SDA, which compares a companies' 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 uses the modelling of the IEA to calculate the benchmark paths. The IEA modelling has several advantages, but it is also subject to limitations, like all other economy-energy modelling. 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 TPI plans to update 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.

TPI predominantly uses disclosed emissions and activity data to derive emissions intensity paths. While much of this data is audited, the emissions intensity estimates can only be as accurate as the underlying disclosures.

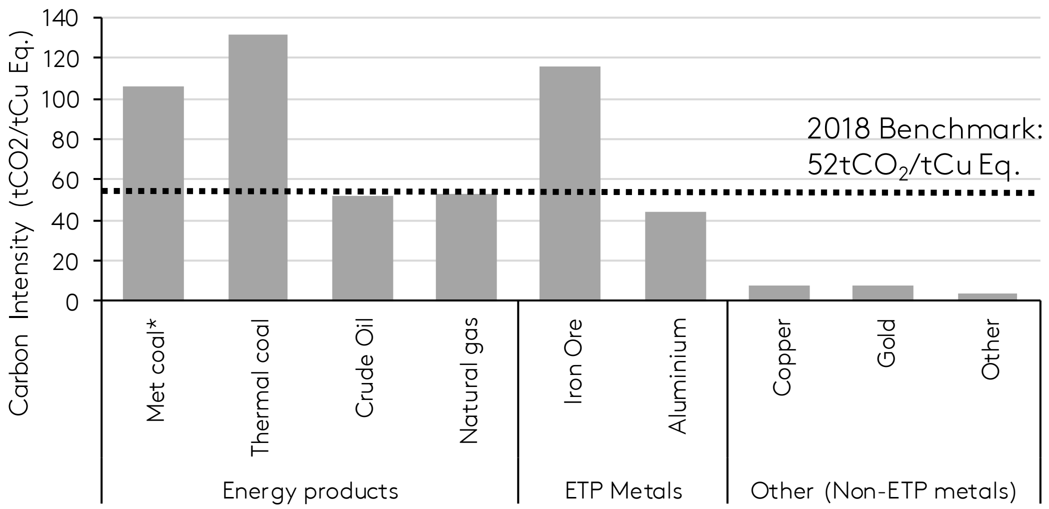
Estimating the recent, current, and especially the future emissions intensity of companies involves several assumptions. Therefore, it is important to bear in mind that, in some cases, the emissions path drawn for each company is an estimate made by TPI, based on information disclosed by companies, rather 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 path.

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). Energy products generally have high emissions intensities. We estimate that lifecycle (i.e. including Scope 3) emissions intensities range from 52 tCO_2/tCu Eq for crude oil to an average of 132 tCO_2/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 tCO_2/tCu Eq.

Figure 5. Lifecycle emissions intensity by product (CO_2 only) *



* Based on original assessment published in May 2020 (see Carbon Performance Assessment in the Diversified Mining Sector: Discussion document). Emissions factors used in company assessments will vary according to grade. Assumes 4.0 tCO_2/tCU Eq in operational emissions for all products with the exception of aluminium and copper, where lifecycle factors of 14.4 tCO_2e/tAl. and 4.2 tCO_2/tCu are used respectively. A gross CO_2-based benchmark is chosen, as allocating negative emissions and non-CO_2 emissions by product is difficult.

As our benchmarks include most global energy system and process emissions, it is biased by the inclusion of fossil fuels. As Figure 2 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 [10], 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.

6. DISCLAIMER

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