Carbon Performance assessment of international shipping: note on methodology

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Simon Dietz, Nikolaus Hastreiter, Antonina Scheer and Filipe Silva

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 over 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.

Nikolaus Hastreiter is a Policy Fellow at the TPI Centre and a PhD student in the Department of Geography and Environment at the London School of Economics and Political Science.

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

Filipe Silva is an Analyst 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 have to date been predominantly based on the Sectoral Decarbonisation Approach (SDA).[2] The SDA translates greenhouse gas emission reduction targets made at the international level (e.g. under the 2015 UN Paris Agreement) into benchmarks against which the performance of individual companies can be compared.

The SDA is built on the principle of recognising 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 the same sector against each other and against sector-specific benchmarks, which establishes the performance of an average company 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' historical 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 companies provide on their business strategy and capital expenditure plans.

2. Applying the SDA to the international shipping sector

2.1. Deriving benchmark pathways

The TPI Centre evaluates companies against benchmark pathways, which translate the emission reductions required by the Paris Agreement goals into a measurable trajectory at the sectoral level. For each sector benchmark pathway, the key inputs are:

- A timeline or economy-wide carbon emissions, which is consistent with meeting a particular climate target (e.g. limiting global warming to 1.5°C) by keeping cumulative carbon emissions within the associated carbon budget.
- A breakdown of this economy-wide emissions pathway into emissions from key sectors (the numerator of sectoral emissions intensity), including the sector in focus.
- Consistent estimates of the timeline of physical production from, or economic activity in, the sector in focus (the denominator of sectoral emissions intensity).

The focus of the TPI's Carbon Performance assessment for the shipping sector is international shipping, which is estimated to account for around 90% of total shipping emissions [2]. The remainder of the emissions from the sector come from domestic shipping, which includes coastal shipping between ports in the same country and inland waterway transport. In addition, the TPI Centre's analysis focuses on freight transport only, as passenger transport (e.g. cruise ships and passenger ferries) represents just a small percentage of international shipping [3].

A key feature of the international shipping sector is the unique way in which its greenhouse gas emissions are governed. Unlike most other sectors, international shipping emissions fall outside the process of setting Nationally Determined Contributions or NDCs to the Paris Agreement. Instead, responsibility for emissions reductions from international shipping lies with the UN's International Maritime Organisation (IMO). In 2018, as part of the Initial IMO Strategy on Reduction of Greenhouse Gas Emissions from Ships, targets were agreed to reduce CO_2 emissions by at least 50% by 2050, to reduce carbon intensity by 40% by 2030 and 'to pursue efforts' to reduce carbon intensity by 70% by 2050, all based on 2008 levels [4].

The measures introduced in 2018 to meet these targets, principally the Energy Efficiency Design Index (or EEDI, an efficiency standard for new ships),[4] were deemed insufficient to meet the IMO targets [5]. In June 2021, the Marine Environment Protection Committee (MEPC 76) of the IMO approved further mandatory measures to cut the carbon intensity of all ships. These measures include a requirement for certain types of ships to calculate an annual Carbon Intensity Indicator (CII) with ship-specific emissions reduction plans, and a requirement to calculate an Energy Efficiency Existing Ship Index (EEXI), which in contrast to the EEDI also covers existing ships. Both measures came into effect on 1 January 2023. Moreover, a prohibition on the use and carriage for use of heavy fuel oil by ships in Arctic waters started to rule on 1 July 2024 [6]. In 2023, IMO updated its initial targets to better reflect the decarbonisation needs of the sector [7].

There are various models available that provide sector-specific emissions pathways and estimates of sectoral activity, under various scenarios.[5] These emissions pathways can be divided by activity to derive

[4] The IMO introduced two additional measures, which apply to ships in operation rather than new vessels: the Ship Energy Efficiency Management Plan (SEEMP) regulation, which aims to improve the monitoring of energy efficiency at an individual vessel level, and the new IMO Data Collection System for Fuel Oil Consumption, which aims to improve reporting of fuel use data across the global fleet from 2020 [7].

[5] Alternatively, in the absence of sectoral activity data, input assumptions on overall economic growth can be used as a measure of sectoral activity (under the assumption that the sector grows at the same rate as the overall economy).

sectoral pathways for emissions intensity. In the case of shipping, the TPI Centre obtains all the necessary inputs from publications by the International Energy Agency (IEA) and the International Transport Forum (ITF).

The three benchmarks employed for the international shipping sector are:

1. An International 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 [8].
2. A Below 2°C scenario, which is consistent with the overall aim of the Paris Agreement. This scenario is directly derived from the IEA's Announced Pledges Scenario. According to the IEA, there is a 50% probability of this scenario generating a 1.7°C increase in global temperatures from pre-industrial levels in 2010 by 2100 [8].
3. A 1.5°C scenario, which is also 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" [9]. This scenario is directly derived from the IEA's Net Zero Emissions by 2050 Scenario and goes in line with IMO's long-term 2040 emissions target. IMO's new commitment to reducing shipping emissions by at least 70% striving for 80% by 2040, builds on the institution's initial commitments disclosed in 2016 and is more ambitious than IEA's trajectory for the sector [7][4]. While the sector does not reach net zero by 2050, absolute emissions decline by 87% between 2022 and 2050. The scenario gives a probability of 50% of holding the global temperature increase to 1.4°C by 2100 [8].

2.2. Benchmark emissions reduction pathways

In the shipping sector, the TPI Centre obtains the data to calculate benchmarks from the IEA, via its World Economic Outlook 2023 report [8]. 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 key feature of IEA's modelling is that it 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. Thus, the IEA's low-carbon scenarios are cost-effective, within some limits of economic, political, social and technological feasibility. IEA's model includes a specific module for the transport sector, the Mobility Model (known as 'MoMo') [10]. MoMo provides projections of energy demand and carbon emissions for shipping under various scenarios.[6]

In the shipping sector, IEA's historic emissions figures are consistently lower than those used by other organisations, such as the International Transport Forum (ITF), due to their different methods of accounting for fuel use.[7]

A key point to note about the benchmark pathways is that they each represent the average carbon emissions intensity across the entire international shipping fleet. However, carbon intensities vary significantly across vessel types and sizes.

Thus, a shipping company's Carbon Performance, when compared with the benchmarks, will be determined not only by mitigation measures but also by its fleet composition. This issue is likely to be less significant in later years, as emissions intensities of different vessels are expected to eventually converge to meet IMO targets [11].

Currently, the IEA's emission boundaries include both domestic and international activities within the shipping sector, while only international shipping activity is considered when projecting the sector's transport work. To circumvent this mismatch, we use data on transported goods from the ITF and OECD to subtract the share of domestic activity from IEA's emissions data for the sector [12].

Figure 2.1 shows the benchmark emissions intensity pathways for the international shipping sector, while Table 2.1 provides the underlying data on emissions and marine freight traffic. For example, under the International Pledges scenario in 2030, total global tank-to-wheel emissions from the international shipping sector are projected to be 859 million metric tonnes or megatonnes of CO_2. Under the same scenario in 2030, tonne-kilometres are projected to be 148,064 billion. Therefore, the average carbon intensity of a shipping company aligned with the International Pledges pathway is 859 / 148,064 = 0.0058 megatonnes of CO_2 per billion tonne-kilometres, which is equivalent to 5.8 grams per tonne-kilometres. Where the underlying scenario data from the IEA does not provide specific activity and emission values for all the years, the carbon intensities are estimated by linear interpolation of the carbon intensities.

[6] The version of MoMo provided in the IEA's Energy Technology Perspectives 2017 includes emissions for all shipping [13]. More recent IEA publications provide data for international shipping only [8].

[7] ITF's historic figures for international shipping emissions are consistent with those produced in other research (for example, ICCT's inventory study and IMO's fourth greenhouse gas report) that use a bottom-up approach to estimating emissions, based on fuel usage of vessels [2] [3]. In contrast, the IEA estimates international shipping combustion emissions based on fuel sales figures submitted by individual countries. Part of the inconsistency between figures from different sources arises because the split between domestic and international shipping emissions is somewhat arbitrary, as one tank of fuel may be used for both international and domestic voyages [3].

Figure 2.1. Global emissions intensity benchmarks by warming scenario for the international shipping sector

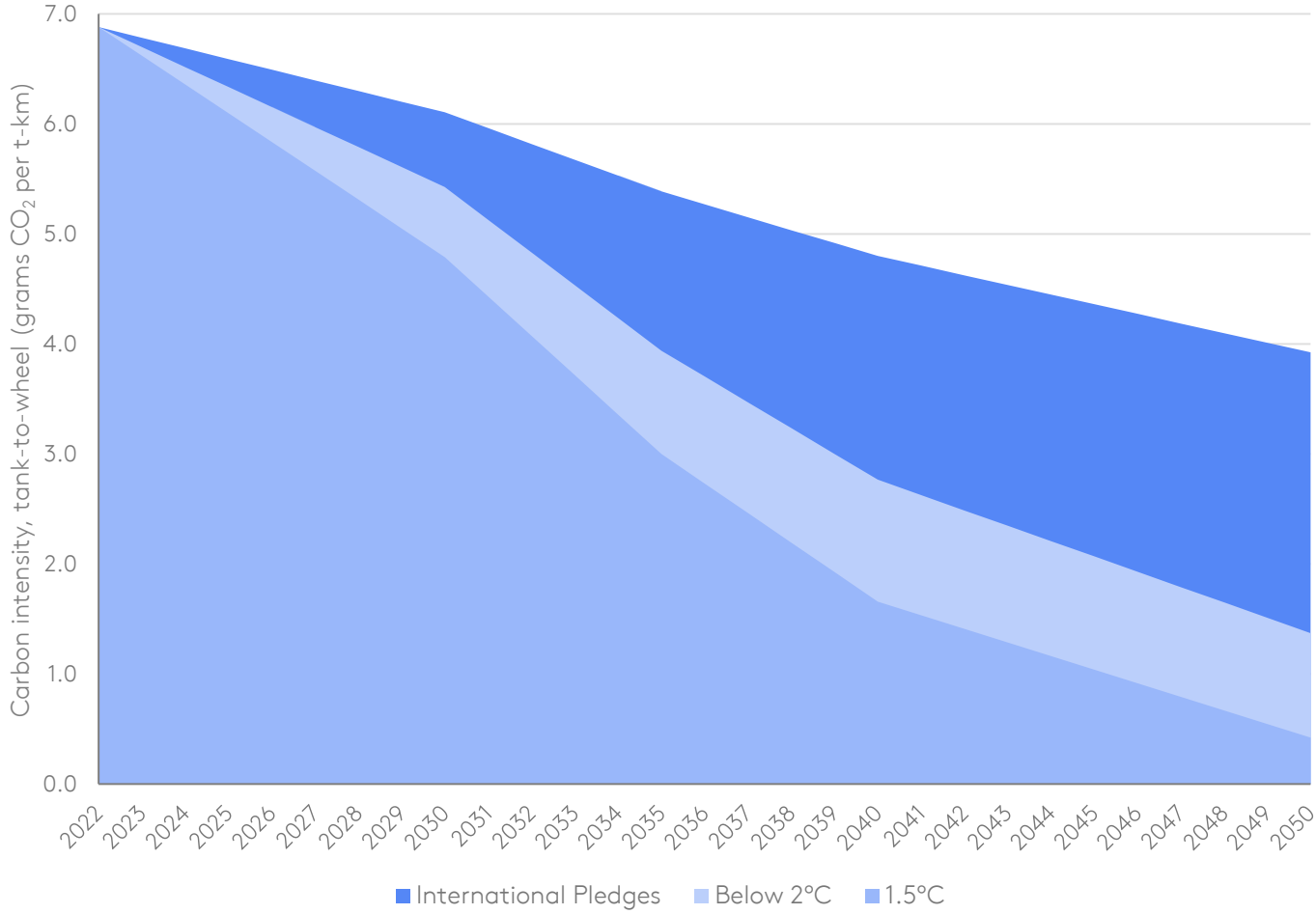

Table 2.1. Projections of CO_2 emissions and tonne-kilometres used to calculate emissions intensity benchmarks

	2022	2030	2040	2050
International Pledges scenario				
TTW CO_2 emissions (Mt)	812	859	896	1,043
Tonne-kilometres (t-km) (billion)	124,272	148,064	196,465	279,868
Carbon intensity (gCO_2 / t-km)	**6.54**	**5.80**	**4.56**	**3.73**
Below 2°C scenario				
TTW CO_2 emissions (Mt)	812	763	516	364
Tonne-kilometres (t-km) (billion)	124,272	147,948	196,295	279,885
Carbon intensity (gCO_2 / t-km)	**6.54**	**5.16**	**2.63**	**1.30**
1.5°C scenario				
TTW CO_2 emissions (Mt)	812	660	298	106
Tonne-kilometres (t-km) (billion)	124,272	145,087	188,756	265,253
Carbon intensity (gCO_2 / t-km)	**6.54**	**4.55**	**1.58**	**0.40**

3. Carbon Performance assessment of international shipping companies

3.1. Calculating company emissions intensities

The 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 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 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 (see below).
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 intensity can be calculated by the TPI Centre.
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 International 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 and 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.
- 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 and the company is informed.
- If it is concluded that the company's challenge has merit, the assessment is updated.
- 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 in the assessment of shipping companies

4.1. Measure of emissions intensity

In applying the SDA to the international shipping sector, a key consideration is that the vast majority of lifecycle emissions stem from the fuel combustion in the companies' vessels engines, i.e. burning fossil fuels to move cargo ships. Therefore, the scope of a company assessment should include emissions from fuel combustion of its vessel fleet.

Hence, in the international shipping sector, the specific measure of emissions intensity is:

- Tank-to-wheel CO_2 greenhouse gas emissions in grams per tonne-kilometre of the transported cargo.

The calculation of emissions intensity benchmarks for shipping companies requires suitable measures of both marine CO_2 emissions and freight transport activity. A standard metric of transport activity (or 'transport work') used in the shipping industry is 'tonne-kilometres', which is the total number of tonnes transported multiplied by the distance transported.[8] The TPI Centre uses this activity measure as the IEA's models provide projected tonne-kilometres data for international shipping for several scenarios.

Emissions boundaries

'Tank-to-wheel' (TTW) (or sometimes, in the case of shipping, 'tank-to-propeller') emissions refer to the greenhouse gas emissions released during the operation of a vessel (cargo ship). Currently, these represent around 87% of total lifecycle (or well-to-wheel) fuel emissions, the remainder coming from upstream (well-to-tank) emissions occurring during fossil fuel extraction, refining and distribution [14]. This percentage will change in the future as the fuel mix for shipping changes and advanced biofuels, ammonia and hydrogen are introduced. Shipping's fuel mix is not likely to change significantly up to 2030, but evolve rapidly from 2030 to 2050, with a share of low-carbon fuel of over 50% projected by IEA in 2050 [14]. TPI Centre uses TTW emissions, as the shipping industry primarily reports emissions on that basis. In addition, our focus on TTW emissions is consistent with the way IEA presents international shipping emissions data (that is, excluding upstream fuel emissions, emissions from land-based operations and electricity used in the international shipping sector). We are consistently monitoring developments in company reporting and emission scenarios and will review this issue during the next research cycle.

Emissions from fuel combustion are reported by shipping companies under Scope 1 and are sometimes referred to as 'vessel emissions'. Other emissions reported by shipping companies in Scope 1 relate to land-based operations (e.g. at ports), but these are generally minimal (around 1-2% of total Scope 1 emissions). Shipping companies' Scope 2 emissions, which include emissions from purchased electricity, are also generally small for those companies focused on shipping transport (less than 1% of total Scope 1+2 emissions).

TPI Centre's Carbon Performance assessment of shipping companies does not take account of non-CO_2 emissions. Generally, these are small; greenhouse gases such as methane and nitrous oxide are estimated to represent around 2% of total greenhouse gas emissions from international shipping [3].

[8] The IMO also uses this metric for transport work in its Energy Efficiency Operational Indicator (EEOI) guidance for shipping companies [15].

However, one non-CO_2 pollutant, black carbon, is estimated to have a bigger impact. ICCT calculates that black carbon, which is short-lived, represents 7% of all greenhouse gas emissions in terms of CO_2 equivalent on a 100-year timescale (and 21% on a 20-year timescale) [2].[9] The IMO considered action to address the issue of black carbon separately from its Initial Strategy [16]. The MEPC 76 agreed to prohibit ships from using heavy fuel oil in the Arctic starting from 1 July 2024 [6]. Currently, however, black carbon emissions are not included in company disclosures or in the IEA data, so the TPI Centre does not include black carbon in the benchmarks. If the climate impacts of black carbon were to be taken into account, the CO_2 benchmark pathways would be lower to reflect the sector's full contribution to climate change.

4.2. Company inclusion criteria

The overall objective of TPI Centre's Carbon Performance assessment is to compare emissions intensity pathways of shipping companies to benchmark pathways. Those benchmarks are based on emissions and activity in the international marine freight sector. To ensure that the companies being assessed are comparable with the benchmarks, we use the following criteria to determine the inclusion of companies:

- The company is publicly listed, with a Primary Industry Classification Benchmark (ICB) of *Marine Transportation*, under FTSE Russell's standard categorisation system.
- The company is primarily engaged in ***international shipping*** operations. Thus, companies engaged solely in domestic operations (e.g. in domestic inland waterway transportation using barges) are excluded from the assessment. Some companies have a mix of international and domestic shipping operations. TPI Centre includes companies whose CO_2 emissions from international operations represent at least 70% of total vessel CO_2 emissions.[10] (In such cases, we use the company's reported carbon intensity figure across all shipping vessels, if separate intensities are not provided for international and domestic operations. The implicit assumption we are required to make here is that the company's international and domestic operations have similar emissions intensity profiles).
- The company is primarily engaged in ***freight transport***, with only a small percentage of transport activities being non-freight, such as passenger ferries and cruise ships (less than 5% of vessels emissions or vessels).
- The company ***operates*** shipping vessels. Thus, logistics companies such as freight forwarders that do not operate their own fleet of vessels are excluded. Similarly, companies that own but do not operate vessels are excluded (e.g. leasing companies). In contrast, companies that do not own the vessels that they operate, but instead charter them, on a time charter basis (a practice that is particularly common in the container shipping sub-sector), are included in the assessment.[11]
- The company has a ***minimum level of absolute vessel emissions*** (at least 0.5Mt per year). This excludes companies engaged in a number of Marine Transportation sub-sectors, whose primary operations are non-freight transport, such as those companies primarily involved in port management, storage, support of offshore installations or engineering. In cases where vessel emissions are greater than 0.5Mt, but they still represent a small proportion of total company emissions, then these are included in our assessment, provided a suitable vessel-only intensity metric can be calculated and we can clearly establish what proportion of Scope 1 emissions are covered by our assessment.

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[9] Black carbon emissions contribute to climate change in a number of ways: both directly, by absorbing and scattering sunlight, and less directly, by causing cloud formation. In addition, deposits of black carbon on snow and ice reduce reflectivity (i.e. albedo), which affects melting, causing further warming [17]. Thus, black carbon emissions from shipping in the Arctic region are particularly problematic. While black carbon is not strictly a greenhouse gas (but is instead a particulate), for simplicity ICCT includes it as a gas in its analysis.

[10] In the absence of data showing the breakdown of emissions between domestic and international shipping operations, TPI estimates this using other available data, such as revenue by source or fleet composition by domestic and international vessels.

[11] Generally, shipping companies include emissions from charter vessels in Scope 1, with the exception of emissions from 'voyage' (or 'spot') chartered vessels, where a vessel is chartered to transport a given cargo for an agreed fee. In this case, as the ship owner maintains both technical and commercial control of the vessel, the emissions form part of the charterer's Scope 3 emissions as they relate to purchased ocean services.

Ultimately TPI makes a judgement on whether its estimate of a company's emissions intensity is likely to be biased, and sufficiently so for the company to be excluded from the Carbon Performance assessment, in line with the principles set out in Section 3.3 above.

4.3. Calculating shipping companies' historical emissions intensities

In other sectors, the TPI Centre has sought to verify the carbon intensities reported by companies by using their stand-alone disclosures of emissions and activity. However, this is not possible for many shipping companies as they do not disclose activity metrics, such as tonne-kilometre data. This is due to the fact that such data is often considered to be market-sensitive information [18]. Therefore stated intensities for shipping companies are taken at face value, as long as there is enough confidence that they have been calculated on the same basis as TPI's benchmarks, or can be converted into intensities that are comparable with the benchmarks.[12]

Most shipping companies' reported CO_2 emissions intensities are based on vessel emissions only. A small number include other Scope 1 emissions (e.g. from land operations) or Scope 2 emissions. In these cases, in the absence of further information and given that emissions from ships' fuel combustion generally make up over 98% of all Scope 1 and 2 emissions, we take the reported intensity figure as a proxy for the vessel emissions intensity.

Some shipping companies report emissions intensities that include other greenhouse gases, in addition to CO_2. For shipping companies, non-CO_2 emissions (such as methane and nitrous oxide) are small, typically less than 2% of shipping companies' total greenhouse gas emissions, so the TPI Centre allows the comparison of emissions intensities, expressed in terms of all greenhouse gases, with the TPI Centre's CO_2-only benchmark intensities [3]. As noted above, black carbon is generally not disclosed by shipping companies and is excluded from our analysis.

The most common intensity metric reported by shipping companies is carbon emissions per tonne-kilometre. This is also the metric we use to derive sector benchmarks. However, many container shipping companies use an alternative intensity metric: carbon emissions per TEU-kilometre (or TEU-nautical mile), that is, emissions per filled Twenty-foot Equivalent Unit container (which is a standard-sized shipping container) transported one kilometre (or one nautical mile).[13] As this is a volume rather than a mass metric there is no direct conversion to tonne-kilometres. In the absence of other information, TPI uses an industry rule of thumb, established by the Clean Cargo Working Group initiative, to convert TEUs to tonnes. This assumes that one TEU carries cargo with a net mass of ten tonnes [19]. Clearly, this approach has some limitations, as in practice, the tonnes of cargo per container will depend on the type of goods being transported, which will vary between shipping companies and within the same company, over time, as the cargo mix changes.

Most shipping companies provide an average carbon or greenhouse gas emissions intensity figure across their fleet. However, some companies that operate mixed fleets provide separate intensity data by vessel type. In such cases, to allow comparison with the benchmarks, we estimate a weighted average fleet intensity for the company, provided there is sufficient data available about the composition of the fleet and the proportion of the fleet's total transport work performed by each vessel type.

4.4. Estimating shipping companies' future emissions intensities

Many of the shipping companies that provide emissions targets present them as a percentage reduction in vessel emissions intensity for their fleet. This is consistent with the way the IMO expresses the sector's medium-term intensity target. A small number of companies set an intensity target that applies to Scope 1 and 2 emissions, or to all Scope 1 emissions (i.e. including vessel and land emissions). In such cases, it is

[12] Many shipping companies' emissions data have undergone third-party verification, which increases our confidence in the reported carbon intensity figures.

[13] One nautical mile is 1.852 kilometres.

assumed – in the absence of any other specific information – that the intensity target applies equally across all scopes.

While most shipping companies that provide targets express these as intensity targets, a small number of companies provide targets based on absolute emissions reductions. In such a case, the TPI Centre can estimate the intensity target using the company's current activity data (provided it is available) and the projected growth in shipping activity as assumed in the International Pledges scenario.

4.5. Worked examples[14]

Company A: a simple case

Company A is a global logistics company, primarily engaged in shipping, with 91% of its Scope 1 greenhouse gas emissions derived from shipping and 7% derived from aviation. Company A reports a separate greenhouse gas emissions intensity figure for shipping and we use this figure in our assessment to ensure comparability with the shipping benchmarks. Company A's shipping intensity metric is expressed in terms of CO_2 equivalent emissions from vessels per tonne-kilometre (t-km). While this figure includes other greenhouse gases, the TPI Centre estimates from Company A's disclosures that CO_2 represents around 98% of all Scope 1 greenhouse gases. Thus, we use Company A's greenhouse gas intensity figure as an acceptable proxy for CO_2 emissions per t-km.

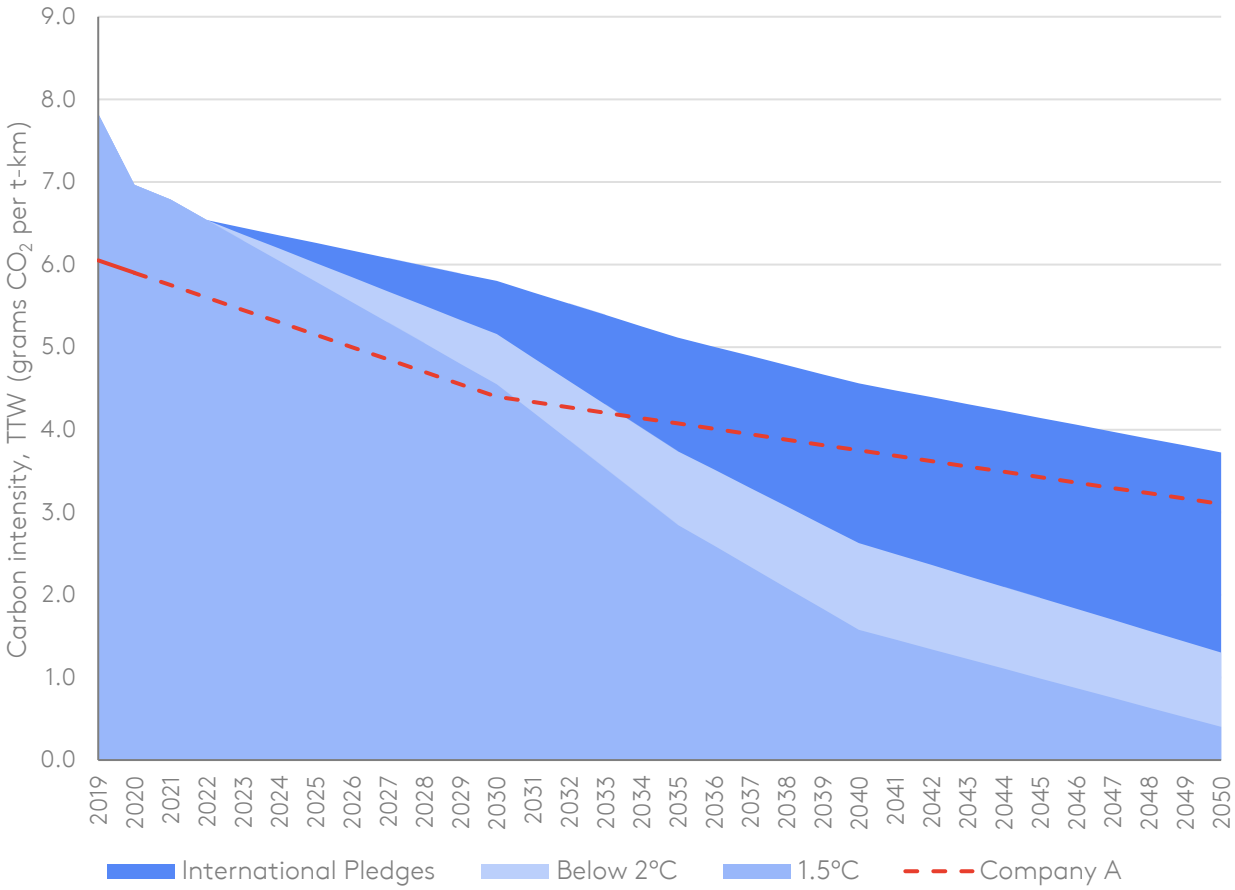
The vast majority of Company A's shipping operations is freight transportation. It operates only one cruise ship, out of a total number of over 750 vessels. Thus, the inclusion of non-freight emissions will not distort the overall shipping emissions intensity metric.

Company A does not provide separate emissions intensity figures for international and domestic shipping operations, but the intensity target it has set applies to all vessels. Therefore, we use the company's overall shipping intensity figure in our assessment. For 2019, the reported shipping emissions intensity was 6.2 gCO_2e/t-km. Company A also discloses separate emissions and tonne-kilometres figures allowing us to independently verify the reported intensity figure, in this case.

Company A has set a target to reduce the intensity of its vessel emissions per t-km by 30% between 2015 and 2030. The company states that by 2019, 5% of this target had been achieved. This implies that the 2019 intensity was (5% x 30%) = 1.5% lower than that in 2015, implying that the 2015 intensity was (6.2/(1 – 1.5%))= 6.3 gCO_2e/t-km. Therefore, the 2030 intensity target for Company A is 6.3 x (1 – 30%) = 4.4 gCO_2e/t-km. The company also set a target to reduce its 2050 emissions intensity per t-km by 50% in 2050, with a 2019 baseline. Therefore, Company A has a 2050 emissions intensity target of 6.2 x (1-50%) = 3.1 gCO_2e/t-km.

[14] In the following examples various numbers are rounded for ease of presentation.

Figure 4.1. Company A's emissions-intensity pathway compared to international shipping sector benchmarks



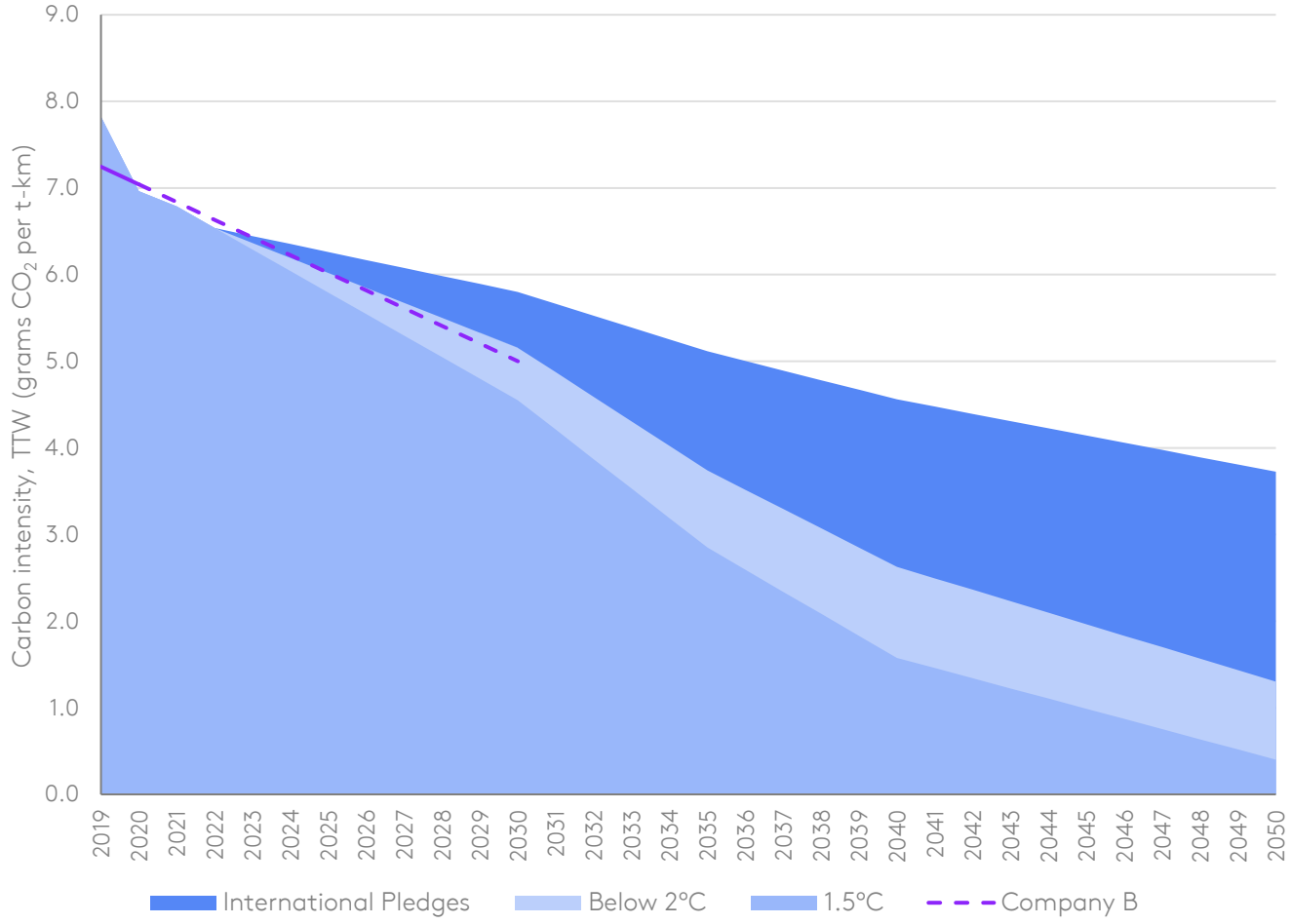
Company B: deriving a carbon intensity target for a container shipping company using fuel efficiency data

Company B is a container shipping company. Around 97% of its Scope 1 emissions come from marine vessels. Company B does not disclose a carbon intensity metric in a suitable form, but it does provide a figure for bunker (i.e. vessel) fuel efficiency expressed in terms of grams of bunker fuel per Twenty Foot Equivalent Unit container (TEU) transported one nautical mile (nm). For 2019 this figure is 44.2g fuel/TEU-nm. This equates to 23.9g fuel/TEU-km (using a conversion factor of 1.852 kms per nm). Company B discloses details of its vessel fuel consumption for 2018. From this we calculate that 94% of marine vessel fuel was Heavy Fuel Oil (HFO) and 6% was Marine Fuel Oil (MFO). Using the IMO standard fuel combustion emissions factors15 for HFO of 3.114 and MFO of 3.206, TPI Centre calculates the weighted average marine fuel combustion emissions factor for Company B of (94% x 3.114) + (6% x 3.206) = 3.119g CO_2 per gram of fuel. Assuming that the fuel mix is unchanged between 2018 and 2019, we calculate that the carbon intensity of Company B's shipping operations in 2019 is (23.9 x 3.119) = 74.5 g CO_2/TEU-km. Company B does not provide suitable activity data, so we uses the industry rule of thumb to convert TEUs to tonne-kilometres. This assumes that one TEU is approximately equivalent to 10 tonnes of net cargo. Thus, the estimated carbon intensity for 2018 is (74.5/10) = 7.45g CO_2/t-km.

Company B has a target to improve its carbon intensity from all vessels by 60% by 2030, from a 2008 baseline. The company states that the 2019 carbon intensity was 41% lower than in 2008. This implies that the carbon intensity in 2008 was (7.45/(1 – 41%)) = 12.6g CO_2/t-km and that the carbon intensity target for 2030 is (12.6 x (1 – 60%) = 5.0 CO_2/t-km. As company B does not have a carbon intensity target up to 2050, TPI is unable to analyse its carbon performance alignment on that timescale.

[15] Third IMO GHG Study 2014 [3].

Figure 4.2. Company B's emissions-intensity pathway compared to international shipping sector benchmarks



5. Discussion

This methodology note has described the methodology followed by the TPI Centre in carrying out the Carbon Performance assessment of international shipping companies.

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 primarily uses the modelling of the Mission Possible Project (MPP) to calculate the steel emissions intensity benchmarks. 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. The comparison between companies and the benchmark pathways might then be inaccurate. Models tend to be regularly updated with the aim of improving their accuracy, and the TPI Centre updates its benchmark pathways 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 international shipping

In addition to the general limitations outlined above, there are several specific issues relating to the benchmarks for international shipping.

There is some uncertainty around the figures available for historic emissions for international shipping. The data vary across different transport modelling groups, such as the IEA and the ITF. This is due, at least in part, to the different methods used to account for vessel fuel. TPI has sought to address this issue by using the same data source, the IEA, for all its scenarios. In the future, the quality of emissions data available for the shipping sector is expected to improve, with the introduction of the IMO Data Collection System for Fuel Oil Consumption after 2020.

Another issue in this sector relates to the way TPI has derived the benchmarks based on the average carbon intensity across the global shipping fleet. However, carbon intensity varies significantly by vessel type and size. Therefore, a company's Carbon Performance, when assessed against the benchmarks, may be distorted if its fleet composition is significantly different from that of the sector as a whole. This is an unavoidable limitation in our assessment as there is currently insufficient data available to allow separate benchmarks to be calculated for each sub-sector.

A further issue arises when assessing the Carbon Performance of container shipping companies against TPI's benchmarks. For comparison with the benchmarks, TPI uses an industry-standard factor to convert carbon intensity expressed in terms of TEU-kilometres to equivalent tonne-kilometres, but the actual conversion factor may vary across different container shipping companies and over time.

As noted in Section 4. above, TPI Centre's benchmarks do not take account of the climate impact of black carbon, which has been estimated to represent 7% of all CO_2 equivalent greenhouse gas emissions from shipping, on a 100-year timescale [2]. Black carbon emissions are not currently reported by companies or included in the IEA models and thus the shipping sector's contribution to climate change is likely underestimated to some extent, at present.

One additional source of uncertainty specific to the shipping sector benchmarks relates to the impact on future CO_2 emissions of the new measures introduced by MEPC 76 and potentially further measures which could be agreed on during MEPC 77 in November 2021. As their impact on projected CO_2 emissions becomes clearer, this will be reflected in future updates of the IEA models and our benchmarks.

One final point to note relates to the ownership structure of companies within the shipping sector. The focus of TPI's assessment is publicly listed companies but some of the largest shipping companies are privately owned. Therefore, the coverage of emissions achieved by TPI in this sector is lower than in some other assessed sectors.[16]

[16] It is worth noting however that while private shipping companies may be under less pressure from investors than public companies to reduce emissions, there is still pressure from other sources, including lenders (as evident from the Poseidon Principles initiative launched in June 2019) and shipping customers, many of whom are large industrials seeking to reduce emissions in their supply chain.

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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

Transition Pathway Initiative

Grantham Research Institute on Climate Change and the Environment