Carbon Performance Assessment of International Shipping:
Methodology Note

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CONTENTS

1. INTRODUCTION

The purpose of this note is to provide an overview of the methodology being followed by the Transition Pathway Initiative (TPI) in its assessment of the Carbon Performance of international shipping companies.

TPI is a global initiative led by asset owners and supported by asset managers. Established in January 2017, TPI is now supported by more than 50 investors globally with more than $15 trillion in Assets Under Management and Advice.[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 remainder of this note is structured as follows. Section 2 below provides an overview of the Sectoral Decarbonization Approach (SDA), which forms the basis of TPI's Carbon Performance assessment. Section 3 sets out how TPI applies the SDA to assess the Carbon Performance of companies generically across all sectors, while section 4 explains how it is applied to the shipping sector specifically. A discussion of the issues relating to the Carbon Performance assessment of shipping companies is provided in section 5.

[1] As of 7th October 2019.

2. THE BASIS FOR TPI'S CARBON PERFORMANCE ASSESSMENT: THE 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 Paris Agreement to the UN Framework Convention on Climate Change (UNFCCC)) into appropriate 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 maritime transport) 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 decarbonization pathway to all sectors, regardless of these differences.[2]

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

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 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.
- 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.

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[2] The Sectoral Decarbonization approach (SDA) was created by CDP, WWF and WRI in 2015 (https://sciencebasedtargets.org/wp-content/uploads/2015/05/Sectoral-Decarbonization-Approach-Report.pdf). See also [1].

this assumes companies exactly 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, 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

This section provides an overview of the generic methodology used by TPI to assess the Carbon Performance of companies.

3.1. Deriving benchmark pathways

TPI evaluates companies against benchmark paths, which quantify the implications of the Paris Agreement goals at the sectoral level. For each sector benchmark path, the key inputs are:

- A time path for economy-wide carbon emissions;
- A breakdown of this economy-wide emissions path into emissions from key sectors (the numerator of sectoral emissions intensity), including the sector in focus;
- Consistent estimates of the time path of physical production from, or economic activity in, the sector in focus (the denominator of sectoral emissions intensity).

There are various models available that provide sector-specific emissions paths and estimates of sectoral activity, under various scenarios[4]. These emissions paths can be divided by activity to derive sectoral pathways for emissions intensity. In the case of shipping, TPI draws on the modelling work of:

- the International Energy Agency (IEA), which has established expertise in modelling the cost of achieving international emissions targets; and
- the International Transport Forum (ITF), which provides detailed, integrated modelling of emissions and activity data across all modes of transport, including shipping.

Section 4 describes in more detail how TPI uses the outputs from these two sources to derive benchmark pathways for shipping.

3.2. Calculating company emissions intensities

TPI is based on public disclosures by companies. In any given sector, disclosures that are useful to TPI's Carbon Performance assessment tend to come in one of three forms:

1. 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. Some companies disclose their recent and current emissions on an absolute (i.e. un-normalised) basis. Provided emissions are appropriately measured, and an

[4] 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).

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. 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 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 same model that is used to derive the benchmark paths, in order to be consistent. While companies' market shares are unlikely to remain constant, there is no obvious alternative assumption that can be made, which treats all companies consistently.

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

3.3. Emissions reporting boundaries

Company emissions disclosures vary in terms of the organisation boundary that a company sets. There are two high-level approaches: the equity share 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 organisation 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 organisation boundary would severely restrict the breadth of companies TPI can assess.

When companies report historical emissions or emissions intensity under *both* the equity share and control approaches, as is sometimes the case, TPI chooses the reporting boundary that seems most appropriate, based on the criteria of consistency with the reporting of activity, consistency with the target, and the length of the available time series of disclosures.

3.4. Data sources and validation

All company data in TPI come from 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.
- 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 company's preliminary performance assessment has been made based on the principles and procedures described above, it is subject to the following quality assurance:

- *Internal findings review*: the preliminary assessment is reviewed by analysts who were not originally involved in making it.
- *Company review*: once the initial findings review is complete, TPI writes to companies with their assessment and requests companies to review it and confirm the accuracy of the company disclosures being used. The company review includes all companies, i.e. it also includes those who provide unsuitable or insufficiently detailed disclosures.
- *Final assessment*: company assessments are reviewed and, if it is considered appropriate, revised.

3.5. Responding to companies

Allowing companies the opportunity to review and, if necessary, correct their assessments is an integral part of TPI's quality assurance process. We send each company its draft TPI assessment and the data that underpin 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, this decision is explained to the company.
- 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 will be posted on the TPI website.

4. ASSESSMENT OF SHIPPING COMPANIES' CARBON PERFORMANCE

4.1. Introduction

The focus of TPI's Carbon Performance assessment is the ***international shipping sector***, which is estimated to account for around 90% of total shipping emissions. [3] The balance comes from domestic shipping, which includes coastal shipping between ports in the same country and inland waterway transport. In addition, TPI'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. [4]

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).[5] 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.[6] [5] To date, the IMO has implemented only limited measures to meet these targets, principally the Energy Efficiency Design Index (or EEDI, an efficiency standard for new ships).[7] These measures alone are deemed to be insufficient to meet the IMO targets. [7] Other measures to reduce carbon emissions, such as slow-steaming, which is effective in reducing emissions particularly in the short term, have been discussed but not yet been agreed.[8] IMO's Final Strategy is due in 2023.

4.2. Deriving international shipping sector benchmark pathways

4.1.2 Data sources used

Various models have been developed that forecast future transport activity in the international shipping sector and the related CO_2 emissions. These models may be used to derive benchmark emissions pathways. Ideally, the benchmarks are calculated using activity and emissions inputs from the same model. However, in the case of international shipping, no individual model provided complete data to allow us to derive all the benchmarks. Therefore, for this sector, TPI combines data from the ITF and IEA.

The ITF data is drawn from its International Freight Model, which provides projections to 2050 for freight transport activity across various modes, including international shipping, and the

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[5] Similarly, greenhouse gas emissions from international aviation are regulated by the International Civil Aviation Organisation (ICAO).

[6] Unlike the ICAO targets for aviation, the IMO shipping targets are based on cutting emissions within the shipping sector and do not include the use of carbon offsetting.

[7] The IMO has 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.[6]

[8] It is estimated that slow steaming can reduce carbon emissions by between 13% and 34% depending on vessel and conditions. [8]

associated CO_2 emissions. [9] The most recent version of the ITF model (2019) includes a baseline 'Current Ambition' scenario, together with a number of other scenarios. However, the ITF notes that none of the scenarios provided are compatible with the Paris climate targets. [9]

TPI uses IEA data to supplement the ITF data in order to derive suitable low-carbon benchmarks. IEA data are drawn from its economy-energy model. [10] 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.[9] However, it does not provide projections of shipping activity.[10]

4.1.2 Emissions intensity metric

The calculation of emissions intensity benchmarks for shipping companies requires suitable measures of both marine freight transport activity and CO_2 emissions. 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.[11] TPI uses this activity measure as the ITF's International Freight Transport Model provides projected tonne-kilometres for international shipping for several scenarios.[12]

An appropriate measure of carbon emissions varies by sector and depends on where emissions occur in the value chain. In the international shipping sector, the majority of lifecycle emissions arise from fuel combustion. These so-called ***'Tank-to-Wheel'*** (or sometimes, in the case of shipping, 'Tank-to-Propeller') emissions currently represent around 87% of total lifecycle (or Well-to-Wheel) fuel emissions, the balance being upstream (Well-to-Tank) emissions occurring during fossil fuel extraction, refining and distribution.[13] [15] 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

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[9] The version of MoMo provided in the IEA's Energy Technology Perspectives 2017 includes emissions for all shipping. [10] More recent IEA publications provide data for ***international*** shipping only. [11]

[10] While the IEA does not publish shipping activity data, recent publications state that activity inputs are based on ITF data [12], so it is reasonable to expect the activity data used in the IEA and ITF models to be broadly consistent.

[11] The IMO also uses this metric for transport work in its Energy Efficiency Operational Indicator (EEIO) guidance for shipping companies. [13]

[12] The shipping industry also uses other activity measures based on shipping supply (i.e. vessel capacity), distance travelled, or tonnes carried. These metrics may be used as proxies for transport work, if necessary, but tonne-kilometres are considered to be the most accurate representation of activity. [14]

[13] This percentage will change in the future as the fuel mix for shipping changes and advanced biofuels, ammonia and hydrogen are introduced. However, the fuel mix is not likely to change significantly up to 2030, which is the timeframe for TPI's analysis. IEA estimates that low carbon fuels will represent only 7% of total fuels at that date. [7]

(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).[14]

TPI does not include Scope 2 emissions in its benchmarks. Instead, we focus only on fuel combustion emissions from vessels to measure the Carbon Performance in this sector, as these emissions represent the majority of emissions within the scope of influence of shipping companies' sustainability policies.[15] In addition, our focus on Tank-to-Wheel emissions is consistent with the way ITF and IEA (in its more recent publications) present international shipping emissions data (that is, excluding upstream fuel emissions, emissions from land-based operations and electricity used in the international shipping sector).

Thus the measure of emissions intensity that TPI uses to derive benchmark pathways in the international shipping sector is the ***Tank-to-Wheel CO_2 emissions in grams per tonne-kilometre***.

TPI'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. [4] 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 CO_2 equivalent greenhouse gas emissions on a 100-year timescale (and 21% on a 20-year timescale).[16] [3] The IMO is considering action to address the issue of black carbon separately from its Initial Strategy. [16] Currently, however, black carbon emissions are not included in company disclosures or in the ITF and IEA data, so TPI 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.

4.1.3 Choice of scenarios

The three benchmarks employed for the international shipping sector are:

- An **International Pledges** scenario, which corresponds with the Paris Pledges scenario in other TPI sectors, and reflects the world's current emissions reduction commitments for international shipping through the IMO. These commitments, when combined with aggregate NDCs and ICAO commitments to reduce international aviation emissions, are known to be insufficient to put the world on a path to limit

[14] Scope 2 emissions may represent a larger proportion of total Scope 1 and 2 emissions for shipping companies that also have terminal, storage or engineering operations.

[15] TPI also excludes Scope 3 (supply chain) emissions from its analysis. For shipping companies, Scope 3 includes shipbuilding and ship recycling emissions, in addition to the upstream fuel emissions noted above. Such emissions are generally not under the control of shipping companies or reported by them.

[16] 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. [25] 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.

warming to 2°C or below, even if they will constitute a departure from a business-as-usual trend.[17]–[19]

- A **2 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", albeit at the low end of the range of ambition.[19]
- A **Below 2 Degrees** scenario, which is also consistent with the overall aim of the Paris Agreement, but is more ambitious than the 2 Degrees scenario above. The IMO targets to reduce emissions by at least 50% by 2050 and emissions intensity by 40% by 2030 are consistent with this scenario, based on the input provided by IEA in 2017 to the IMO's Initial Strategy. [7][11]

TPI's **International Pledges** scenario is based on the ITF's Current Ambition scenario set out in its Transport Outlook 2019. [9] This scenario provides projected activity and emissions data for international sea freight for 2030 and 2050, based on two assumptions:

1. There are moderate efficiency improvements in international shipping, in line with the existing policy commitments made by the IMO. Thus, the International Pledges take account of the EEDI, which applies to new vessels, and is estimated to have an equivalent efficiency improvement across the global fleet of 1% per year between 2015 and 2025. [7] This scenario does not reflect the IMO's target to reduce emissions by 50% by 2050 from 2008 because, aside from the EEDI, there are no firm policies either in place or announced to meet the target.[17] [7]
2. There are moderate reductions in oil and coal trade volumes between 2015 and 2030, as other sectors of the economy move towards decarbonisation. Currently, crude oil and coal are the two largest commodities transported by sea, but as other sectors decarbonise, demand for fossil fuel transportation will decline. [9]

The **Below 2 Degrees scenario and the 2 Degrees scenario** are derived using both ITF and IEA data. The 2 Degrees scenario is derived directly from the Below 2 Degrees scenario, so the latter is described first.

TPI derives a **Below 2 Degrees scenario** (B2DS) using the following assumptions:

1. 2030 emissions may be estimated by taking the 2015 emissions from the International Pledges scenario above and applying the growth rate in international shipping emissions between 2015 and 2030 implied by the IEA's Sustainable Development Scenario (SDS).[18] [7] That scenario shows international shipping emissions need to be almost flat between 2015 and 2030, so TPI's B2DS assumes that

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[17] The efficiency improvements in this scenario are consistent with those used by the IEA in its New Policies Scenario (NPS). The NPS is the IEA's new baseline scenario, used in its more recent analyses (such as the World Energy Outlook 2018 and the Tracking Clean Energy Progress), replacing the Reference Technology Scenario of the Energy Technology Perspective. [11]

[18] The SDS is a broader but comparable scenario to the IEA's Below 2 Degrees Scenario (B2DS), previously produced as part of the Energy Technology Perspectives (ETP) 2017. The SDS is based on the climate goal of limiting the increase in long-term global average temperature to 'well below 2 Degrees', specifically, 1.7-1.8C, above pre-industrial levels. The SDS also includes goals related to universal energy access and reduced air pollution. [11]

emissions stabilise at the 2015 level until 2030. Implicitly, this TPI scenario reflects the assumptions made in IEA's SDS for international shipping that:

i. low carbon fuels (including advanced biofuels, hydrogen and ammonia) account for 7% of international shipping fuel in 2030 [7]

ii. there are greater efficiency improvements than in the International Pledges scenario, as a result of stronger IMO efficiency standards, than those currently in place.

2. A greater reduction in oil and coal transport volumes between 2015 and 2030 than under the International Pledges scenario. This is based on the ITF's activity projection for 2030 under its High Ambitions scenario,[19] which shows a reduction in shipping activity of 5% in 2030 compared with the Current Ambition scenario.[20]

The IEA does not publish a 2 Degrees scenario in its most recent analyses. [7] [11] However, TPI provides a **2 Degrees** scenario for consistency with other sectors assessed. TPI's 2 Degrees scenario is derived directly from the Below 2 Degrees scenario above, using the following assumptions:

1. The level of international shipping emissions in 2030 that is compatible with a 2 Degrees scenario is 8% higher than that for the Below 2 Degrees scenario. This estimate is based on the percentage difference between the 2030 shipping emissions under IEA's 2DS and B2DS scenarios in its ETP 2017.[21] [10]
2. The reduction in oil and coal transport volumes between 2015 and 2030 is the same as that in the TPI Below 2 Degrees scenario above.

As noted above, TPI's Below 2 Degrees benchmark is derived using ITF's 2015 emissions data as a starting point and applying to it a growth rate based on IEA data. ITF's historic emissions figures for international shipping are consistently higher than those used by IEA, due to their different methods of accounting for fuel use.[22] As a result, over the period 2015 to 2030,

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[19] For other modes of transport, the ITF's High Ambition scenario includes more ambitious mitigation measures than those in the Current Ambition scenario, but in the case of international sea freight, the only difference between the two ITF scenarios is in the assumption relating to oil and coal transport demand.

[20] This is broadly consistent with the IEA's modelling of SDS/B2DS, which also takes account of lower oil and coal transport, but assumes that there is no overall reduction in maritime trade volumes. [10] [20]

[21] Note that the ETP 2017 emissions figures include all shipping (domestic and international) and are based on Well-To-Wheel (WTW) rather than Tank-To-Wheel (TTW) emissions, which are used in the TPI scenarios. Applying an 8% percent uplift to TPI's B2DS international shipping TTW emissions to derive a 2 Degree scenario implicitly assumes that (i) the percentage difference in 2030 emissions between the IEA's Below 2 Degrees and 2 Degrees scenarios is the same for both international and domestic shipping emissions and (ii) the fuel mix (and hence the TTW/WTW ratio) is the same in 2030 under the IEA's Below 2 Degrees and 2 Degrees scenarios. Given that IEA's most recent analysis shows low carbon fuels accounting for only 7% of international shipping fuels by 2030 in the SDS [7], TPI's assumption about fuel mix will not have a significant impact on the projected emissions figures for the 2 Degrees scenario.

[22] ITF's historic figures for international shipping emissions are consistent with those produced in other research (for example, ICCT's inventory study [3] and IMO's third greenhouse gas report [4]) that use a bottom up approach to estimating emissions, based on fuel usage of vessels. 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

cumulative emissions in TPI's Below 2 Degrees scenario are 21% higher than those in the IEA's SDS. Ideally, TPI's cumulative international shipping emissions should be consistent with the IEA model, which TPI has used to derive equivalent benchmark pathways in other sectors. Doing so would ensure the economy-wide carbon budget is not exceeded once international shipping is included. Despite the fact that cumulative emissions under TPI's Below 2 Degrees scenario for international shipping exceed those in IEA's SDS, it is still reasonable to consider TPI's scenario to be consistent with a Below 2 Degrees economy-wide carbon budget for two reasons. Firstly, international shipping represents only a small proportion of global emissions, particularly to 2030. Secondly, TPI's analysis only runs to 2030, so there is scope for international shipping emissions to be reduced at a faster rate in the period 2030 to 2050, thereby still meeting its own sector carbon budget, in the longer term.

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. [21]

Figure 1 shows the benchmark emissions intensity paths for the international shipping sector, while Table 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 1,127 million metric tonnes or megatonnes of CO_2. Under the same scenario in 2030, tonne-kilometres are projected to be 117,425 billion. Therefore the average carbon intensity of a shipping company aligned with the International Pledges path is 1,127 / 117,425 = 0.0096 megatonnes of CO_2 per billion tonne-kilometres, which is equivalent to 9.6 tonnes per million tonne-kilometres. This equates to 9.6 grams of CO_2 per tonne-kilometre. As the ITF model does not provide projections for 2020 or 2025, the carbon intensities for those years are estimated by linear interpolation of the carbon intensities for 2015 and 2030.

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international shipping emissions is somewhat arbitrary, as one tank of fuel may be used for both international and domestic voyages. [4]

Figure 1 Benchmark carbon intensity paths for international shipping

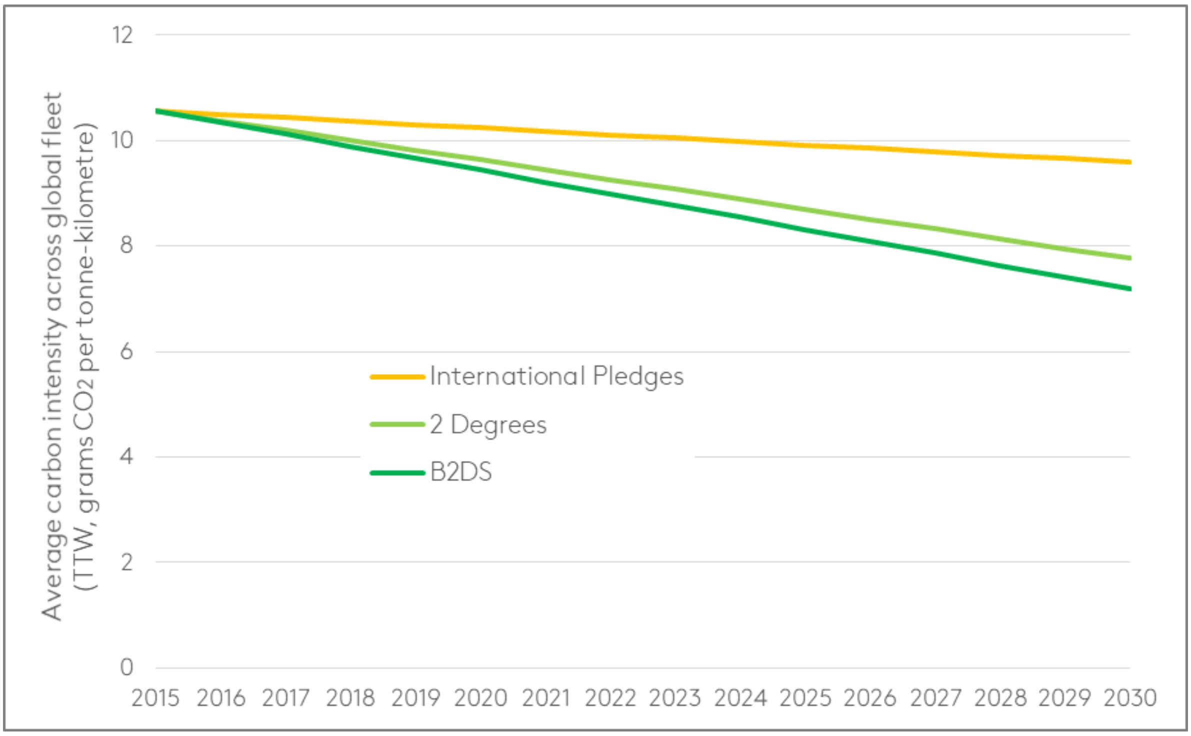

Table 1 Projections of CO_2 emissions and tonne-kilometres used to calculate benchmark intensity paths (Source: ITF, IEA and own calculations)

	2015	2020	2025	2030
International Pledges scenario				
TTW CO_2 emissions (Mt)	800			1,127
Tonne-kilometres (t-km) (billion)	75,698			117,425
Carbon intensity (gCO_2 / t-km)	**10.6**	**10.2**	**9.9**	**9.6**
2 Degrees scenario				
TTW CO_2 emissions (Mt)	800			864
Tonne-kilometres (t-km) (billion)	75,698			111,244
Carbon intensity (gCO_2 / t-km)	**10.6**	**9.6**	**8.7**	**7.8**
Below 2 Degrees scenario				
TTW CO_2 emissions (Mt)	800			800
Tonne-kilometres (t-km) (billion)	75,698			111,244
Carbon intensity (gCO_2 / t-km)	**10.6**	**9.4**	**8.3**	**7.2**

4.3. Criteria for inclusion of companies in Carbon Performance assessment

The overall objective of TPI'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, TPI uses 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 includes companies whose CO_2 emissions from international operations represent at least 70% of total vessel CO_2 emissions[23]. (In such cases, TPI uses 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 operates 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;[24]
- 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

[23] 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.

[24] 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.

calculated and we can clearly establish what proportion of Scope 1 emissions are covered by our assessment.

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.

4.4. Calculating shipping companies' recent and current emissions intensities

In other sectors, TPI 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. [14] 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.[25]

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, TPI takes 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 [4], so TPI allows the comparison of emissions intensities, expressed in terms of all greenhouse gases, with the TPI's CO_2-only benchmark intensities. As noted above, black carbon is generally not disclosed by shipping companies and is excluded from TPI's analysis.

The most common intensity metric reported by shipping companies is carbon emissions per tonne-kilometre. This is also the metric used by TPI 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[26]). 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***. [22] 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

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

[26] One nautical mile is 1.852 kilometres.

separate intensity data by vessel type. In such cases, to allow comparison with the benchmarks, TPI estimates 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.

4.5. 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 assumed – in the absence of any other specific information – that the intensity target applies equally across all scopes. This is in line with TPI practice in other sectors.

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, TPI can estimate the intensity target using the company's current activity data (provided it is available) and the projected growth in shipping activity as implied by the ITF model.

4.6. Worked examples[27]

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, TPI estimates from Company A's disclosures that CO_2 represents around 98% of all Scope 1 greenhouse gases. Thus, TPI uses Company A's greenhouse gas intensity figure as an acceptable proxy for CO_2 emissions per t-km.

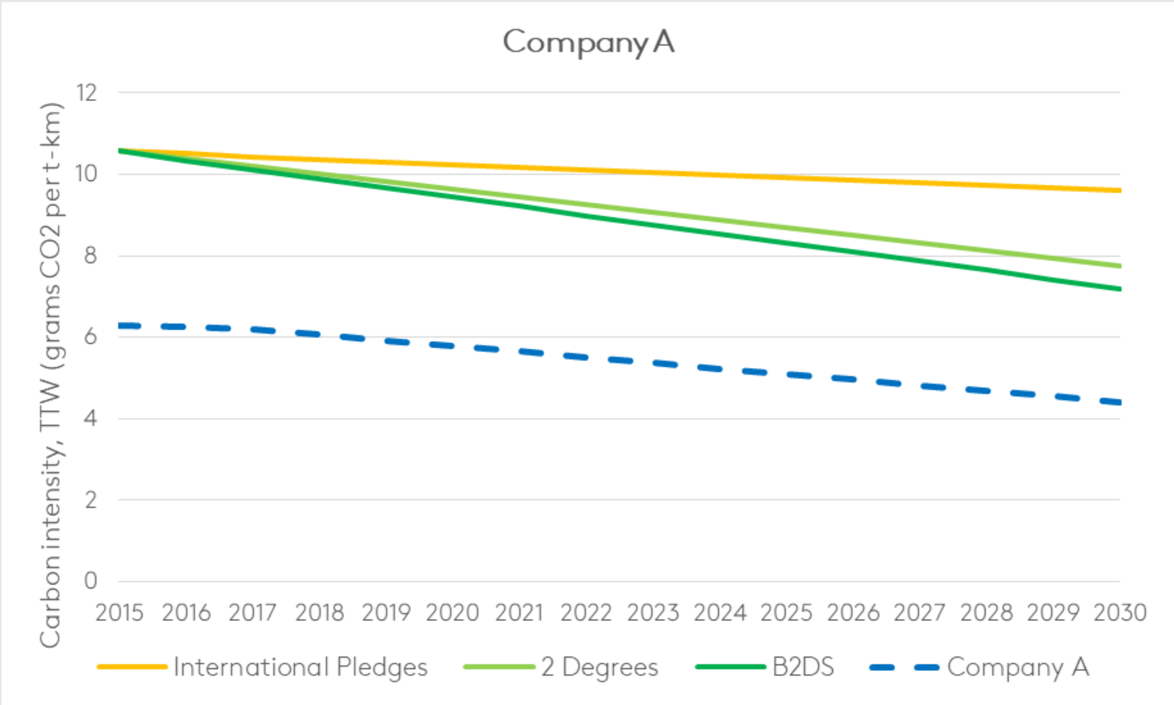
The vast majority of Company A's shipping operations is freight transportation. It operates only one cruise ship, out of a total number of over 750 vessels. Thus, the inclusion of non-freight emissions will not distort the overall shipping emissions intensity metric.

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 2017, 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 2017 5% of this target had been

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

achieved. This implies that the 2017 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 gCO2e/t-km. Therefore, the 2030 intensity target for Company A is 6.3 x (1 – 30%) = 4.4 gCO_2e/t-km.



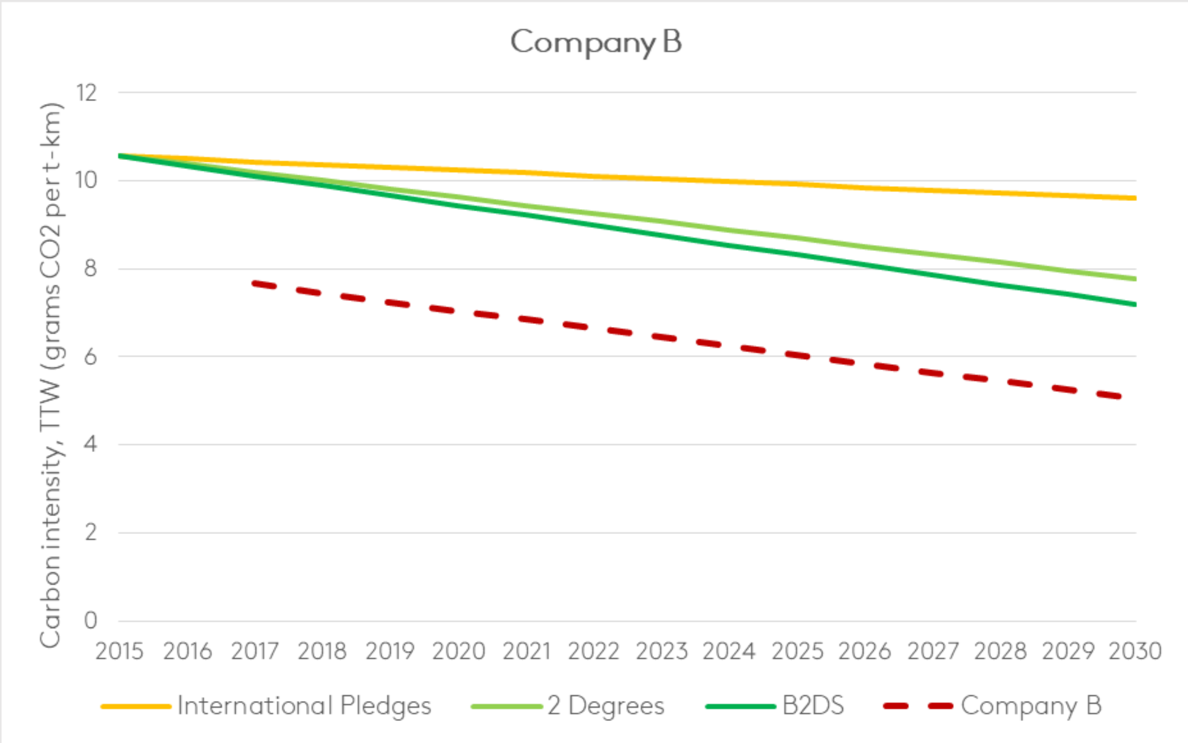
Company B: deriving a carbon intensity target for a container shipping company using fuel efficiency data

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 2018 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 2017. From this TPI calculates 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 factors[28] for HFO of 3.114 and MFO of 3.206, TPI 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 2017 and 2018, we calculate that the carbon intensity of Company B's shipping operations in 2018 is (23.9 x 3.119) = 74.5 g CO_2/TEU-km. Company B does not provide suitable activity data so TPI 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 2018 carbon intensity was 41% lower than in

[28] Third IMO GHG Study 2014 [4].

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.



5. DISCUSSION

This note describes the methodology followed by TPI in carrying out its Carbon Performance assessment of companies, with a particular focus on international shipping.

TPI's Carbon Performance assessment is designed to be easy to understand and use, while robust. 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 to understand these.

5.1. General issues

The assessment follows the Sectoral Decarbonization Approach (SDA), which involves comparing companies' emissions intensity with sector-specific benchmark emissions intensities that are consistent with international climate targets.

TPI uses ITF and IEA modelling to calculate the benchmark paths. This modelling has a number of advantages, but it is also subject to limitations, like all other economy-energy or sector-specific modelling. In particular, model projections often turn out to be wrong. The comparison between companies and the benchmark paths might then be inaccurate. However, there is no way to escape the need to make a projection of the future in forward-looking exercises like this. ITF and IEA update their modelling regularly with the aim of improving the accuracy of their projections and TPI plans to update its benchmark paths accordingly.

TPI uses companies' self-reported data to derive emissions intensity paths. Therefore companies' paths are only as accurate as the underlying disclosures.

Estimating the recent, current 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 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 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 ITF, for both historic emissions and tonne-kilometres, and then estimating future emissions for the 2DS and B2DS by applying growth rates in emissions derived from the IEA model to the ITF emissions data. 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 in 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'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. [3] Black carbon emissions are not currently reported by companies or included in the IEA and ITF 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 IMO regulation (known as IMO 2020) to limit the sulphur content of shipping fuels. Some of the options available to shipping companies to reduce their sulphur emissions will also reduce their CO_2 emissions, while others will have little or no effect. For example, switching to Liquefied Natural Gas (LNG) may reduce life-cycle CO_2 emissions by up to 20% [23], but the installation of scrubbers would have no effect on CO_2. As the impact of IMO 2020 on projected CO_2 emissions becomes clearer, this will be reflected in future updates of the IEA and ITF models and our benchmarks.

TPI benchmarks shipping companies from now until 2030. The three pathways do not diverge very much in the next few years. This is due to the specific features of the industry. These include the long life of vessels (around 20 years [24]), the high cost of new fuel infrastructure (e.g. for LNG), and the existing cost differential between conventional and alternative low-carbon fuels, which together mean that technological developments are slow to be reflected in lower carbon intensities for the industry. TPI identified a similar pattern in the benchmarks for the airline sector, which experiences some of the same decarbonisation challenges. Unlike the airline sector, however, shipping has the short-term option of slow-steaming available.

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 sectors that have been assessed.[29]

[29] 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 recently launched Poseidon Principles initiative) and shipping customers, many of whom are large industrials seeking to reduce emissions in their supply chain.

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