

Carbon Performance Assessment of Airlines Methodology Note

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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 airlines.

TPI is a global initiative led by asset owners and supported by asset managers. Established in January 2017, TPI is now supported by 91 investors globally with over \$23 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 airline sector specifically. A discussion of the issues relating to the Carbon Performance assessment of airline companies is provided in section 5.

¹ As of December 14th, 2020.

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 air 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:

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

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].

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. 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

3.1. Deriving the 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 the airline sector, TPI draws on the modelling work of the International Energy Agency (IEA), via its *Energy Technology Perspectives* report.[3] The IEA has established expertise in modelling the cost of achieving international emissions targets. It also provides easy access to the modelling inputs and outputs in a form suitable for applying the SDA.

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

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

Section 4 describes in more detail how TPI uses the IEA model outputs to derive benchmark pathways for airlines.

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).

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 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 in the TPI is to assume company activity increases at the same rate as the sector as a whole (i.e. this amounts to an assumption of constant market share), using sectoral growth rates from the IEA in order to be consistent with the benchmark paths. While companies' market shares are unlikely to remain constant, there is no obvious alternative assumption that can be made, which treats all companies consistently. Sectoral growth rates from the IEA's baseline scenario are used.

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 that 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 is done for all companies, including 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.
- If it is concluded that there are insufficient grounds to change the assessment, TPI publishes its original assessment.
- If the company requests an explanation regarding its feedback after the publication of its assessment, TPI explains the decisions taken.
- If a company requests an update of its assessment based on data publicly disclosed after the research cut-off date communicated to the company, TPI can note the new disclosure on the company's profile on the TPI website.
- If a company chooses to further contest the assessment and reverts to legal means to do so, the company's assessment is withheld from the TPI website and the company is identified as having challenged its assessment.

3.6. Presentation of assessment on TPI website

The results of the Carbon Performance assessment will be posted on the TPI website, within the TPI tool (<http://www.lse.ac.uk/GranthamInstitute/tpi/the-toolkit/>). On each company page, its emissions intensity path will be plotted on the same chart as the benchmark paths 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. ASSESSMENT OF AIRLINES' CARBON PERFORMANCE

4.1. Deriving airline sector benchmark pathways

The focus of TPI's Carbon Performance assessment is the airline sector as a whole, that is, including international and domestic aviation, and both passenger and freight transport.

TPI uses inputs from the IEA's economy-energy model to derive benchmark emissions intensity pathways for the airline sector. The IEA model includes a specific module for the transport sector, the Mobility Model (MoMo).^[3] This provides projections of energy demand, carbon emissions and transport activity for each mode of transport, including air transport, under various scenarios.

4.1.1 Choice of scenarios

The IEA's work can be used to derive three benchmark emissions intensity paths, against which airline companies are evaluated by TPI. These benchmarks differ from those in use in most other sectors analysed by TPI, for two reasons. First, carbon emissions from *international* aviation are governed in a unique way, outside the process of setting Nationally Determined Contributions or NDCs to the Paris Agreement. Second, a critical uncertainty in benchmarking airlines' emissions is the possible future role of shifting between modes of transport in reducing emissions (similar to the automobile manufacturing sector). It is important to use the scenarios to account for this uncertainty.

The three benchmarks employed for the airline sector are:

- An **International Pledges** scenario;
- A **2 Degrees (Shift-Improve)** scenario;
- A **2 Degrees (High Efficiency)** scenario.

The **International Pledges** scenario corresponds to the Paris Pledges scenario in other TPI sectors and is based on the IEA Reference Technology Scenario. Unlike other sectors, emissions from international aviation are not included in National Inventories under the UNFCCC, nor are emissions targets covering international aviation included in the Paris NDCs. Instead, responsibility for emissions reductions from international aviation lies with the UN's International Civil Aviation Organisation (ICAO).⁵ The International Pledges scenario takes account of existing commitments made by ICAO to reduce international aviation emissions, in addition to the NDCs, which include individual countries' *domestic* aviation emissions reduction commitments. Thus this scenario reflects the world's current emissions reduction commitments, which are known to be insufficient to put the world on a

⁵ Similarly, emissions from international shipping are excluded from NDCs and are instead regulated by the International Maritime Organisation.

path to limit warming to 2°C or below, even if they will constitute a departure from a business-as-usual trend.[4]–[6]

The **2 Degrees (Shift-Improve)** scenario, based on the IEA’s 2 Degrees scenario, 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.[6] This scenario assumes that emissions reductions associated with air transport are achieved by a mixture of measures, including improved fuel efficiency, increased use of low-carbon alternative fuels⁶, and a shift in air passenger activity to more energy-efficient modes of travel, such as high-speed rail. Under this scenario, fuel efficiency improves by an average of 3.2% per year between 2014 and 2030 and by an average of 4.8% per year between 2030 and 2050. In the 2 Degrees (Shift-Improve) scenario, air passenger traffic in 2030 is 13% lower than in the International Pledges scenario and in 2050 it is 20% lower.

The assumption regarding a shift in air passenger activity to other modes of transport is contentious, however. Thus, TPI also calculates a **2 Degrees (High Efficiency)** scenario, a variant of the 2 Degrees scenario above, in which it is assumed that there is no shift to other modes of transport. That is, air passenger traffic growth is in line with the International Pledges scenario. Under this 2 Degrees (High Efficiency) scenario, emissions reductions in air transport must be delivered by airlines through increased fuel efficiency and higher rates of penetration of sustainable biofuels. This results in an emissions intensity benchmark for the air transport sector which is 13% lower by 2030 and 20% lower by 2050 than that under the 2 Degrees (Shift-Improve) scenario above.

The IEA has also produced a ‘Below 2 Degrees’ scenario, based again on its assumption that decarbonisation is achieved by combining fuel efficiency improvements, fuel switching and a relative reduction in air travel demand in favour of lower-carbon modes of travel. This turns out to produce an emissions intensity benchmark for air transport that is almost identical to TPI’s 2 Degrees (High Efficiency) scenario. Therefore, the two scenarios are equivalent.

⁶ In this paper, the terms ‘sustainable biofuels’ and ‘biofuels’ are used interchangeably and refer to all sustainably produced low-carbon alternatives to petroleum-based fuels, such as conventional biofuels (e.g. crop-based), advanced or second-generation biofuels (e.g. from waste feedstocks) and other low-carbon technologies in development. The equivalent term used by the airline industry is Sustainable Alternative Fuels.

4.1.2 Emissions intensity metric

The calculation of emissions intensity benchmarks for airlines requires suitable measures of both air transport activity and carbon emissions.

The two main metrics for air transport activity used in the airline industry are:

- ‘passenger kilometres’ or ‘revenue passenger kilometres’ (or RPKs), which is the total number of paying passengers multiplied by the distance flown; and
- ‘revenue tonne kilometres’ (or RTKs), which is the total number of revenue-generating tonnes of both passengers and freight multiplied by the distance flown.

The IEA uses RPKs as its activity metric. However, **TPI uses RTKs**, otherwise the Carbon Performance of individual airlines with freight businesses that are significantly larger or smaller than average can be distorted. To include freight in the activity metric we:

- (1) convert the RPKs provided in the IEA model for each scenario (in five yearly intervals) to equivalent RTKs, using a conversion factor of **95 kilograms per passenger**.⁷ This is consistent with the assumptions of the IEA’s 2020 Energy Technology Perspectives, ICAO’s 2018 Annual Report, and the majority of airlines’ own reporting practices;
- (2) use ICAO’s freight (and mail⁸) transport statistics (in RTKs) for 2014 to 2018 [11], to derive freight activity as follows:
 - a. for the International Pledges scenario, applying ICAO’s projected average annual growth rate for freight traffic of 3.5% between 2014 and 2048 (taken as a proxy for 2050); [12]
 - b. for the 2 Degrees (Shift-Improve) scenario, making the assumption that freight traffic is shifted to other lower carbon modes of transport at the same rate as the shift in passenger traffic, which has been assumed in the IEA model (see above);
 - c. for the 2 Degrees (High Efficiency) scenario, making the assumption that there is no such shift in freight traffic (which is consistent with the assumption used for passenger traffic for this scenario).
- (3) summing the passenger RTKs and freight RTKs calculated in (1) and (2) above to obtain an activity metric for the airline sector of equivalent RTKs.

⁷ In our previous aviation methodology note, published in October 2019, we used the conversion of 150kg per passenger. This conversion factor takes account of the mass of passengers and their luggage (estimated to be 100kg, on average) plus an additional 50kg, to include the mass of infrastructure required to transport passengers (such as seats, the galley, toilet facilities, etc.).

⁸ Mail tonne kilometres accounted for less than 3% of total freight and mail tonne kilometres in 2014 [11], so we use the term freight to include mail in the remainder of this paper.

In addition to an activity metric, the calculation of emissions intensity benchmarks requires an appropriate measure of carbon emissions. This varies by sector and depends on where emissions occur in the value chain. In the airline sector, the majority of lifecycle emissions arise from jet fuel combustion. These so-called 'Tank-to-Wheel' (TTW) emissions represent around 84% of total lifecycle (or Well-to-Wheel (WTW)) fuel emissions, the balance being upstream (Well-to-Tank) emissions occurring during fossil fuel extraction, refining and distribution.[13] Emissions from jet fuel combustion are reported by airlines under Scope 1 and are sometimes referred to as 'flight-only' or 'aircraft' emissions. Other emissions reported by airlines in Scope 1 relate to ground operations, but these are generally minimal (around 1% of total Scope 1 emissions). Airlines' Scope 2 emissions, which include emissions from purchased electricity, are also minimal (generally less than 1% of total Scope 1+2 emissions). Thus, jet fuel *TTW or flight-only emissions* are an appropriate measure of Carbon Performance in this sector, as they represent the majority of emissions within the scope of influence of airlines' sustainability policies. This is also consistent with IEA data, which exclude emissions from ground vehicles and electricity used in the air transport sector.

For each of its scenarios, the IEA model provides total WTW emissions projections for the air transport sector. The figures include full lifecycle emissions from conventional jet fuel, in addition to those from sustainable biofuels. Biofuels' share of total air transport energy demand is currently very small (around 0.1%), but it is projected to grow significantly in the coming decades. Emissions from combustion of biofuels (i.e. TTW emissions) are similar to those from conventional jet fuel combustion, but airlines apply a CO₂ emissions factor of zero for the combustion of biofuels. This is in line with the UNFCCC reporting guidelines, which recommend that biofuel emissions at the point of use are reported as zero in the energy sector. The assumption here is that negative emissions during the growing stage of the biofuel offset the emissions from combustion. It should be noted, however, that additional emissions occur in the feedstock production, processing and distribution stages, resulting in net positive lifecycle emissions from biofuels.[13] Nevertheless, for comparability with emissions data currently reported by airlines, TPI assumes TTW emissions from biofuels are zero⁹.

Thus, the measure of emissions intensity that TPI uses to derive benchmark pathways in the airline sector is the *Tank-to-Wheel (TTW) CO₂ emissions (from conventional jet fuel only) in grams per revenue tonne kilometre (RPK)*.

In order to obtain this measure using output from the IEA model, the following conversions and assumptions are necessary:

⁹ In the future, airlines' reporting of biofuel emissions will be subject to change. For example, under the rules of the new ICAO agreement, Carbon Offset and Reduction Scheme for International Aviation (CORSIA), the emissions factor to be applied to biofuel combustion reflects the reduction in lifecycle emissions compared with conventional jet fuel and is therefore likely to be greater than zero.

- The IEA projections of final energy consumption from conventional jet fuel are multiplied by a standard combustion emissions factor for jet kerosene, as set out by the Intergovernmental Panel on Climate Change [14], to derive the TTW emissions from conventional jet fuel.
- Emissions from biofuels are omitted, which in effect applies an emissions factor on combustion of biofuels of zero, to obtain Tank-to-Wheel emissions from biofuel in line with those reported by airlines.

Figure 1 shows the benchmark emissions intensity paths for the airline sector, while Table 1 provides the underlying data on emissions and air traffic, expressed as RTKs. For example, under the International Pledges scenario in 2025, total global TTW emissions from the airline sector (including both domestic and international aviation) are projected to be 970 million metric tonnes or megatonnes of CO₂. Under the same scenario in 2025, total RTKs (for both passenger and freight transport) are projected to be 1,193 billion (assuming each passenger is equivalent to 95 kg). Therefore, the average carbon intensity of an airline aligned with the International Pledges path is $970 / 1,193 = 0.814$ megatonnes of CO₂ per RTKs. This equates to 814 grams of CO₂ per RTK.

Figure 1 Benchmark global carbon intensity paths for the airline sector

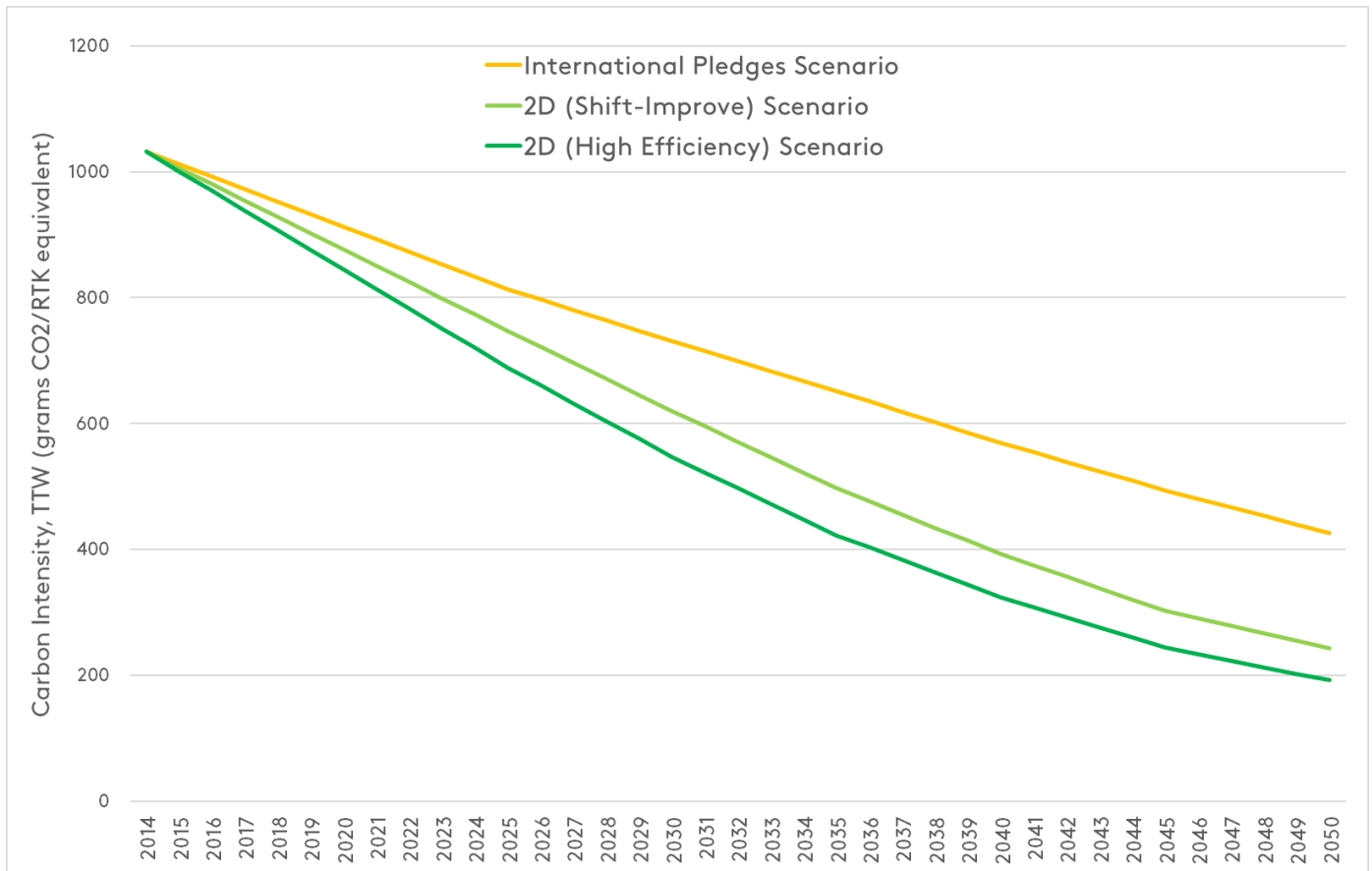


Table 1 Projections of emissions and tonne kilometres (passenger and freight) used to calculate intensity paths (Source: IEA, ICAO and own calculations)

	2014	2025	2030	2035	2040	2045	2050
<i>International Pledges scenario</i>							
TTW CO ₂ emissions (Mt)	813	970	1,055	1,128	1,165	1,179	1,171
Passenger tonne kilometres (billions)	587	890	1,084	1,304	1,538	1,784	2,031
Freight tonne kilometres (billions)	201	303	360	428	508	603	717
Total revenue tonne kilometres (billions)	789	1,193	1,445	1,731	2,046	2,387	2,748
Carbon intensity (gCO ₂ / RTK)	1,032	814	730	652	569	494	426
<i>2 Degrees (Shift-Improve) scenario</i>							
TTW CO ₂ emissions (Mt)	813	822	790	732	664	583	528
Passenger tonne kilometres (billions)	587	813	948	1,100	1,265	1,445	1,620
Freight tonne kilometres (billions)	201	286	327	372	425	484	552
Total revenue tonne kilometres (billions)	788	1,100	1,274	1,472	1,689	1,929	2,172
Carbon intensity (gCO ₂ / RTK)	1,032	747	620	497	393	302	243
<i>2 Degrees (High Efficiency) scenario</i>							
TTW CO ₂ emissions (Mt)	813	822	790	732	664	583	528
Passenger tonne kilometres (billions)	587	890	1,084	1,304	1,538	1,784	2,031
Freight tonne kilometres (billions)	201	303	360	428	508	603	717
Total revenue tonne kilometres (billions)	789	1,193	1,445	1,731	2,046	2,387	2,748
Carbon intensity (gCO ₂ / RTK)	1,032	689	547	423	324	244	192

The benchmark paths above take account of CO₂ emissions only. A critical point to note is that aviation has climate-change impacts that go beyond CO₂ emissions, which result from aircraft flying at high altitude. These impacts include the warming caused by Nitrogen Oxides (NO_x) and water vapour emissions, and by the formation of contrails and increased cirrus cloudiness.[15] There is generally high uncertainty over the Radiative Forcing from non-CO₂ effects, but they are estimated to be significant and may **double** the overall climate change impact of aviation.[15] Furthermore, a recent study found that the radiative forcing effect specifically of contrail cirrus is expected to increase faster in the future than that due to CO₂ emissions. This is because the effects on cirrus cloud formation of growth in air traffic and change in traffic patterns (such as shifts to higher altitudes), will not be offset by the expected small reductions in radiative forcing from contrail cirrus as a result of factors such as reduced soot emissions from alternative fuels [16]. For now, TPI's analysis does not take into account the non-CO₂ impacts of aviation, due to the current uncertainty in quantifying them, but if these impacts were to be taken into account the TPI benchmarks would almost certainly be tighter. This issue is currently under review.

4.2. Calculating airlines' historic and current emissions intensities

Airlines report emissions in various ways. While some provide a breakdown of Scope 1 emissions from flight and ground operations, others do not provide this split. A small number of airlines do not provide a breakdown of total emissions between Scope 1 and 2. In these cases, in the absence of further information and given that emissions from jet fuel combustion make up over 98% of all Scope 1 and 2 emissions, TPI takes the total Scope 1 emissions reported (or total Scope 1 and 2 emissions, where applicable) as being all jet fuel emissions.

The greenhouse gas emissions reported by airlines also vary, with some providing CO₂ emissions separately, while others report all greenhouse gas emissions in equivalent tonnes of CO₂. IEA provides an estimate of CO₂ emissions only. The non-CO₂ emissions reported by airlines (such as methane and nitrous oxide) are very small, typically less than 1% of airlines' total greenhouse gas emissions, so TPI allows the comparison of emissions intensities expressed in terms of all greenhouse gases, as reported by some airlines, with the CO₂-only benchmark intensities.

Another variation between airlines relates to the coverage of flight operations included in Scope 1 emissions. Some airlines operate regional services through third-party partners and emissions from those flights are generally reported under Scope 3 as indirect emissions. In several cases, these emissions represent around 10-15% of an airline's total flight emissions. For such airlines, TPI calculates the emissions intensity to ensure consistency with the activity figures reported by the airline. Thus, if the passenger and freight activity data include third-party flights, then the emissions from those operations are also included in the carbon intensity calculation.

Airlines also report their activity in a number of ways. Frequently, an airline's passenger and freight activity are reported separately, in terms of passenger kilometres and freight tonne kilometres, respectively. In such cases, TPI converts the reported passenger kilometre figures to tonne kilometres using the same conversion factor as used for the benchmarks (i.e. assuming each passenger is equivalent to 95 kg). The resulting passenger tonne kilometres are added to the airline's reported freight tonne kilometres, to obtain total RTKs. This is then combined with the reported flight emissions to calculate the airline's carbon intensity.

Some airlines report their activity in terms of total RTKs transported (including passenger and freight activity). In those cases, TPI assumes airlines use a conversion factor of around 90-95kg per passenger and therefore directly uses the reported RTKs to calculate the airline's carbon intensity.

Some airlines, particularly low-cost carriers, report only RPKs, but no freight activity data. In such cases, TPI assumes that the airline has no freight transport business and converts RPKs to RTKs, assuming 95 kg per passenger.

In a small number of cases, airlines report only carbon intensity, expressed in terms of emissions per RPK, but do not disclose the underlying RPK or CO₂ data. While we are unable to verify the carbon intensities in such cases, TPI takes the reported intensities at face value, as long as there is enough confidence that they have been calculated based on flight-only carbon emissions¹⁰ and revenue passenger kilometres. TPI then expresses the reported intensities in terms of RTKs, assuming 95 kg per passenger.

4.3. Estimating airlines' future emissions intensities

Compared with other sectors such as electricity and steel production, there is unusual uniformity in the airline sector in terms of how companies state their emissions targets. This is attributable to the coordinating role of the airline industry body, the International Air Transport Association (IATA). The majority of airlines have adopted an intensity target proposed by IATA to improve fuel efficiency by an average of 1.5% per year between 2009 and 2020. While the IATA target relates to international aviation, most airlines have adopted the targets across their entire operations, both international and domestic. This target is generally expressed in terms of fuel consumption per revenue tonne kilometre. As fuel efficiency improvements translate directly to carbon emissions reductions, TPI applied this target to carbon intensity in previous research cycles. However, in the current research cycle, targets for the year 2020 are not included in company assessments as they are no longer forward-looking.

¹⁰ Or alternatively, Scope 1 or total Scope 1 and 2 emissions, given that flight emissions make up the vast majority of total Scope 1 and 2 emissions.

While most airlines set an intensity target based on jet fuel combustion, several apply the intensity target to all Scope 1 or total Scope 1 and 2 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.

Beyond 2020, many airlines replace their carbon intensity (or fuel efficiency) target above with an absolute emissions reduction target, that is, one based on total CO₂ emissions, rather than emissions per revenue tonne kilometre. This is in line with the target that has been included in the Carbon Offset and Reduction Scheme for International Aviation (CORSIA), which was proposed by IATA and then agreed by ICAO member states in 2016. The target seeks to stabilise CO₂ emissions from international aviation at the 2020 level, through the use of carbon offsetting, whereby airlines fund climate reduction projects in other sectors. Under the scheme, the **gross** absolute emissions from international aviation may grow beyond 2020, but the **net** absolute emissions (i.e. after carbon offsetting) are expected to level off.

In addition to the target derived from CORSIA, some airlines adopt a longer-term target based on IATA's industry goal to reduce **net** absolute emissions from international aviation by 50% by 2050, based on 2005 levels. Again, this target is based on the expectation that net absolute emissions will be reduced, at least in part, through carbon offsetting. There is no equivalent industry target for emissions reductions within the sector, that is, for emissions reductions that could be achieved without the use of offsets.

The IEA model produces a carbon budget for air transport, excluding the use of offsets. Thus, emissions reductions are assumed to be achieved directly within the airline sector rather than in other sectors. This is based on the rationale that the IEA's economy-wide carbon budget is allocated between sectors in a cost-effective way and that emissions reduction in other sectors are already taken into account in the overall carbon budget and hence would not be available for purchase by airlines in the form of offsets.[3] As the emissions intensity benchmark paths derived from the IEA model do not allow for offsets, TPI does not use any airline targets that are based on net absolute emissions reductions.

4.4. Worked examples¹¹

Company A: a simple case

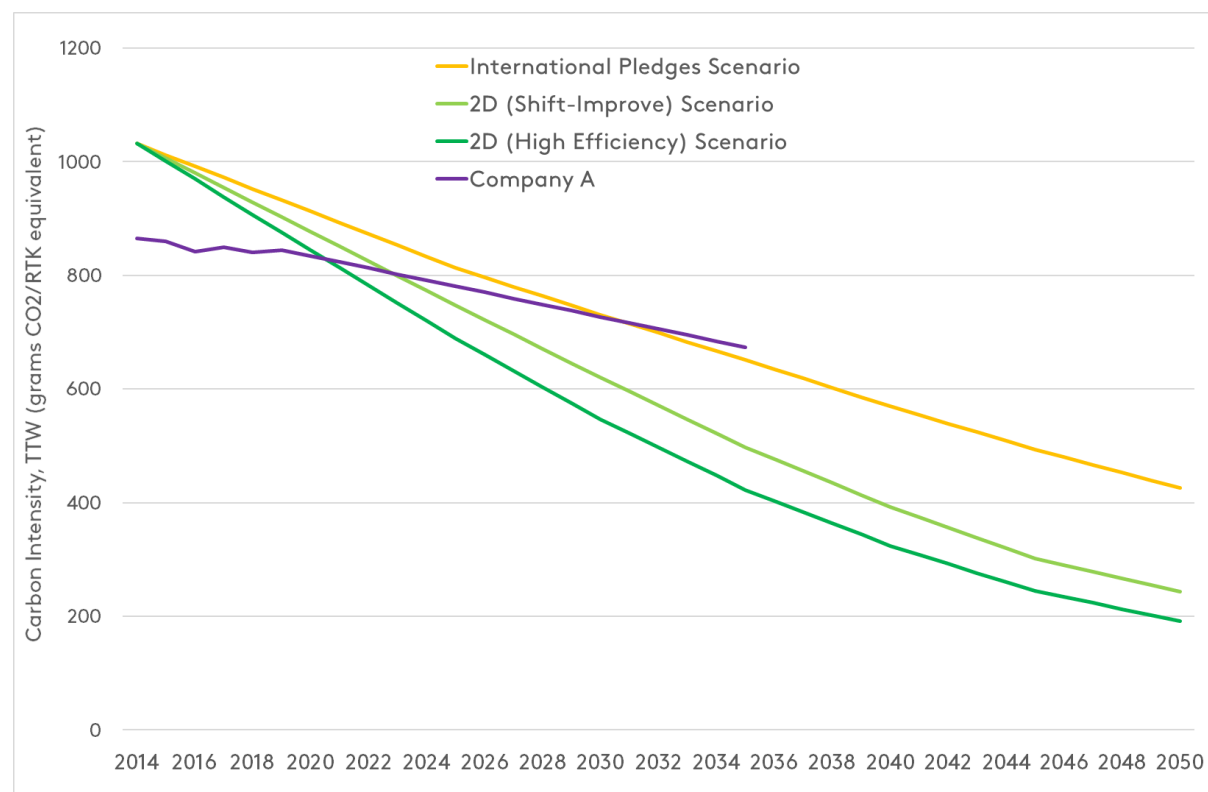
Company A reports its historical emissions intensity in terms of CO₂ emissions from jet fuel combustion per revenue passenger kilometre. For example, in 2016 it was 80 gCO₂/RPK. TPI has been able to independently verify the emissions intensity using separate company disclosures of emissions and passenger kilometres. Company A

¹¹ In the following examples various numbers are rounded for ease of presentation.

does not disclose any data for freight activity, so TPI assumes that Company A has no freight operations. Thus, TPI converts the reported intensity figures to carbon emissions per RTK by assuming that one passenger is equivalent to 95 kg or 0.095 tonnes. Therefore, Company A's carbon intensity for 2016 can be expressed as $80/0.095 \text{ t} = 842 \text{ grams of CO}_2 \text{ per RTK}$.

Company A has also set a target to reduce the intensity of its aircraft carbon emissions per passenger kilometre by 20% from 2016 by 2035. This can be applied to the carbon intensity expressed in RTKs, given that all Company A's operations relate to passenger transport. Therefore the 2035 target is to reduce CO₂ intensity to $842 \times (1 - 0.2) = 674 \text{ gCO}_2/\text{RTK}$.

Figure 2 Carbon Performance of Company A compared with sector benchmarks



Company B: recalculation of carbon intensity using separately disclosed passenger and freight data

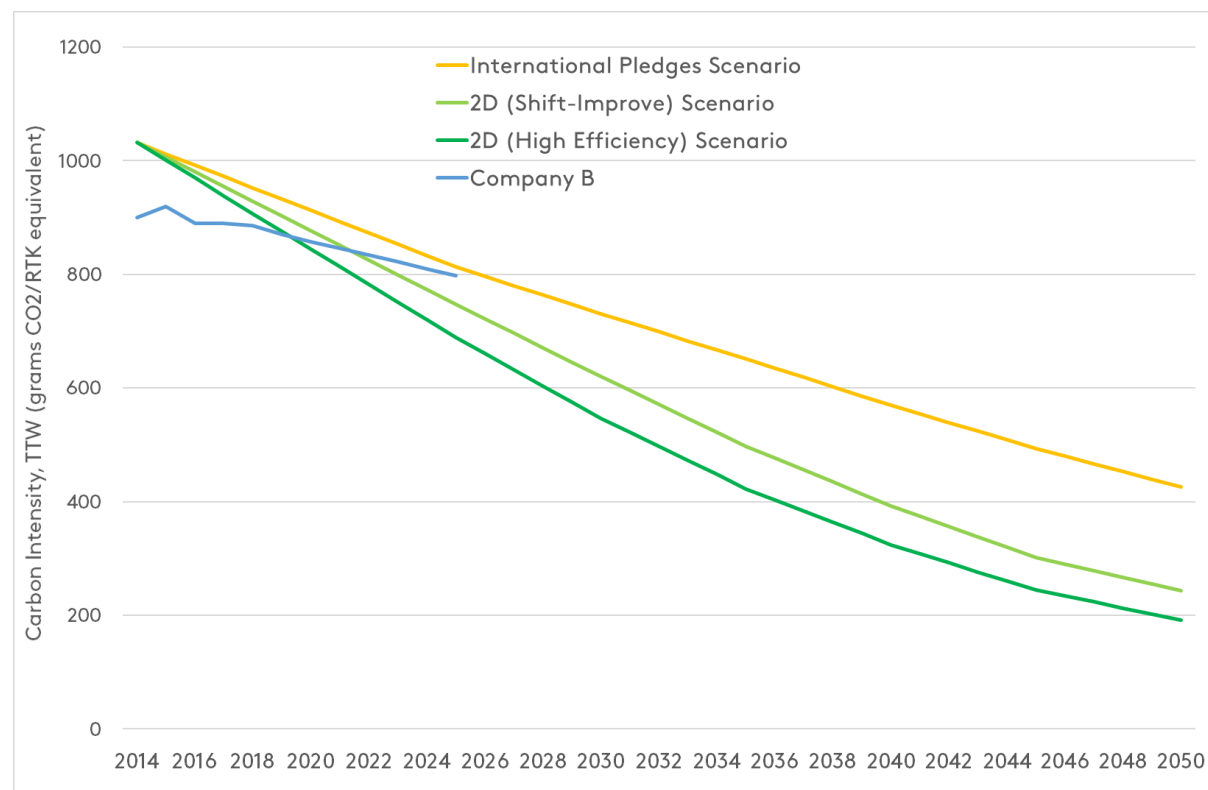
Company B provides separate carbon intensity figures for passenger and freight operations. These are not in a form suitable to use in our assessment. However, Company B also provides separate data for flight emissions, passenger kilometres and freight tonnes kilometres, which can be used by TPI to calculate carbon intensity in terms of RTKs. For example, Company B's total CO₂ emissions from flight operations (excluding those operated by third parties) were 32,301,249 tonnes in 2018, passenger kilometres were 277,462 million RPKs (also excluding third party

flights) and freight tonne kilometres were 10,118 million tonne kilometres (excluding third party flights). Thus, total revenue tonne kilometres for 2018 are calculated as $((277,462 \times 0.095) + 10,118) = 36,478$ million RTKs and the carbon intensity is calculated as $(32,301,249 / 36,478) = 886$ tonnes per million RTKs, equivalent to 886 gCO₂/RTK.

Company B provides a carbon intensity target to reduce CO₂ emissions per RTK by 25% by 2025 compared with 2006 values. Company B also states that by 2018, 67% of the target had been achieved. Thus, Company B's carbon intensity in 2018 was $(67\% \times 25\%) = 16.75\%$ lower than that in 2006, implying the 2006 intensity was $(886 / (1 - 16.75\%)) = 1,064$ gCO₂/RTK and the target for 2025 is $(1,064 \times (1 - 25\%)) = 798$ gCO₂ per RTK.

Company B provides two further emissions targets; a medium-term target to cap net absolute emission at 2020 levels and a longer-term target to reduce net absolute emissions by 50% by 2050, relative to 2005 levels. As noted above, the TPI benchmark does not take account of emissions reductions from carbon offsetting and therefore these targets are not used in assessing the Company B's Carbon Performance.

Figure 3 Carbon Performance of Company B compared with sector benchmarks



5. DISCUSSION

This note has described the methodology followed by TPI in carrying out its Carbon Performance assessment of companies, with a particular focus on airlines.

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 targets (e.g. the sum of International Pledges).

TPI uses IEA modelling to calculate the benchmark paths. The IEA modelling has a number of advantages, but it is also subject to limitations, like all other economy-energy 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. The IEA updates its modelling every two years with the aim of improving the accuracy of its projections and TPI plans to update its benchmark paths accordingly.

TPI uses companies' self-reported emissions and activity 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 pathway.

5.2. Issues specific to airlines

In the context of the SDA, TPI's approach to assessing the Carbon Performance of the airline industry is to focus on the CO₂ emissions from jet fuel combustion, as this is where the majority of the industry's lifecycle emissions are concentrated.

Benchmarking the performance of airlines can be achieved using integrated modelling of the transportation sector. TPI uses the IEA's MoMo model (combined with freight forecasts from ICAO). A significant source of variation between the 2°C-compliant scenarios of different transportation modelling groups is the share of the burden that is placed on avoiding air transportation and shifting modes of

transportation, as opposed to improving fuel efficiency and increasing the use of low-carbon fuels.[17] In view of this uncertainty, TPI has proposed two different 2 Degrees scenarios, capturing the range of assumptions on this issue.

In our first assessment of the Carbon Performance of the airline sector, we used revenue passenger kilometres as the activity metric, because this is the metric provided in the IEA's MoMo transport model. To refine our benchmarks, we now include freight in the activity metric and express carbon intensity in terms of revenue tonne kilometres. We do this by assuming that one passenger is equivalent to 95 kilograms.

TPI benchmarks airlines between now and 2050. The three benchmark pathways do not diverge very much in the next few years due to the specific features of the industry. These include the long life of aircraft, the high cost of infrastructure and the existing cost differential between conventional and alternative low-carbon jet fuels, which together mean that technological developments are slow to be reflected in lower carbon intensities for the industry.

In terms of the emissions targets set by airlines, the role of IATA means that there is remarkable uniformity in the type and level of individual company targets. The majority of airlines set intensity targets up to 2020, which are not included during this research cycle since we are publishing our assessments in late 2020. Beyond that, targets are generally based on absolute net emissions, which rely on airlines purchasing emissions reductions from other sectors through the carbon offset market. However, TPI benchmarks are derived from the IEA's modelling work, which uses the approach of allocating **gross** carbon budgets to each sector in a cost-effective way. IEA projects that, after taking into account emissions reductions from other sectors, airlines will still have to reduce their gross emissions significantly. Although in principle offsetting is a means to reduce emissions cost-effectively, we do not currently take into account airlines' net emissions targets, because it is unclear how much their gross emissions will fall and this is the key piece of information required for benchmarking.

To provide investors with more information about their long-term emissions reduction plans, airlines could augment their net targets with gross targets, or with an alternative, suitably firm indication of what proportion of a net target will be met by own emissions reductions as opposed to offsetting. Nonetheless, in future assessments, TPI will look to establish how airlines' net targets compare with comparable benchmarks. This would provide an additional measure of companies' Carbon Performance. To do this, it would be necessary to convert airlines' targets expressed in terms of absolute CO₂ emissions into carbon intensity targets, expressed in terms of CO₂ per RTK. This would require information, such as:

- Details of what proportion of an airline's net emissions will be capped at 2020 levels under the target. If the target is based on CORSIA then it will relate solely to an airline's international flight emissions. In addition, CORSIA

excludes emissions from certain international routes, to or from countries that have not signed up to participate in CORSIA;

- An estimate of the growth in emissions (beyond 2020) that are not included in the target above (that is, from domestic and excluded international flights);
- An estimate of the growth in passenger and freight activity for each airline beyond 2020.

Currently, much of this information is not publicly available, but with the introduction of CORSIA and its Monitoring, Reporting and Verification requirements, effective from next year, we would expect that information disclosure will improve in the future.

Finally, a distinguishing feature of the airline sector is that its climate-change impact is greater than the effects of its carbon emissions. The non-CO₂ radiative forcing effects of aircraft flying at altitude are substantial and may be of similar magnitude to the CO₂ impacts, although there is uncertainty over the size.[15, 18] As a result, TPI's assessment focuses solely on the Carbon Performance of airlines. ICAO recognises the need for an up-to-date scientific assessment of the full climate effect of aviation. [18] Without this, the airline sector's contribution to climate change is likely underestimated.

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