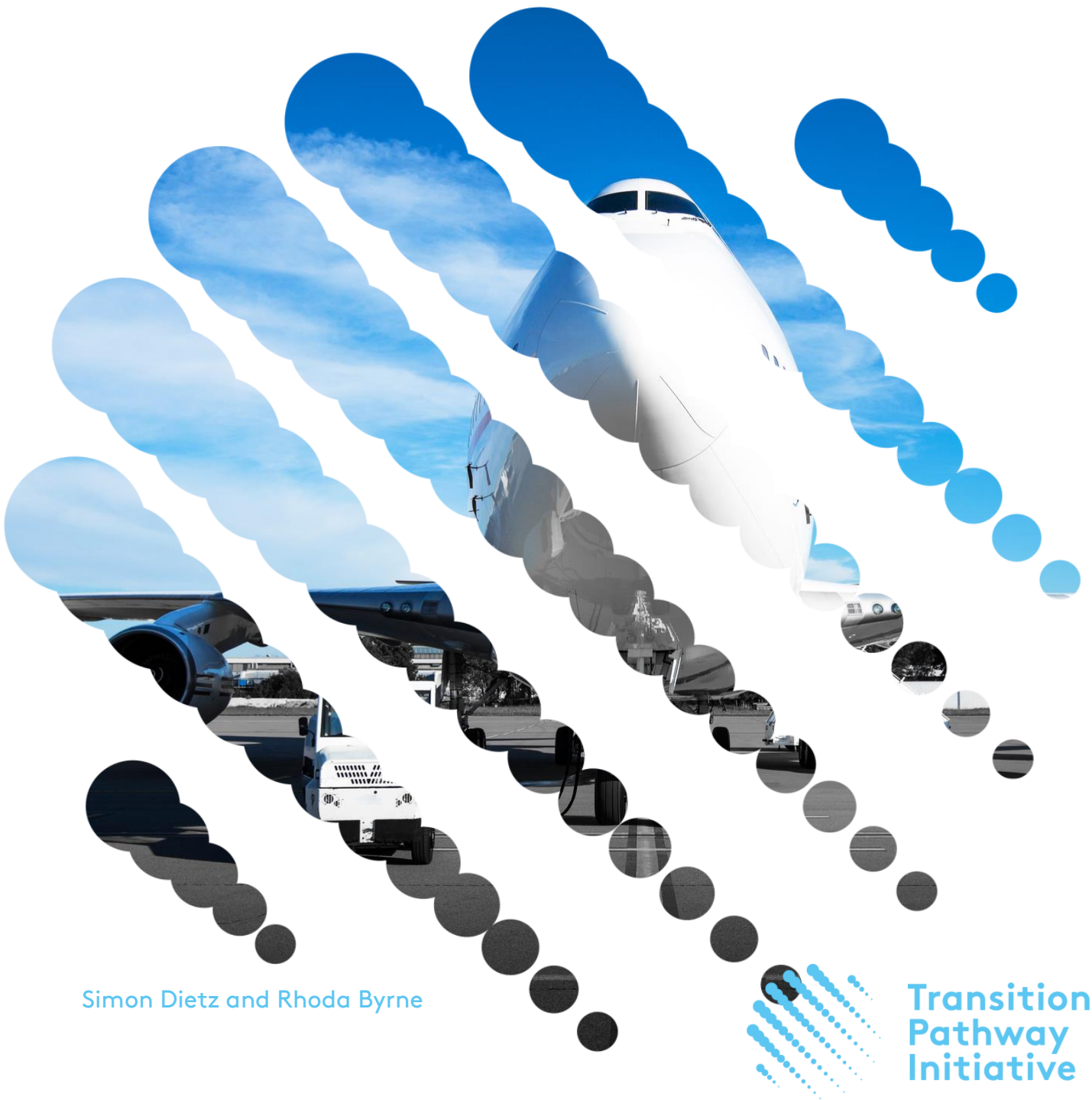


Carbon performance assessment of airlines: note on methodology

March 2019



Simon Dietz and Rhoda Byrne



**Transition
Pathway
Initiative**

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1. INTRODUCTION

The Transition Pathway Initiative (TPI) is a global initiative led by asset owners and supported by asset managers. Established in January 2017, TPI investors now collectively represent over £10.3/\$13.3 trillion of assets under management.¹

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

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

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

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

The purpose of this note is to provide an overview of the methodology being followed by TPI in its assessment of the carbon performance of airlines.

¹ As of 15th February 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).[1] 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.²

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:

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

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

² Another initiative that is also using the SDA is the Science Based Targets Initiative (<http://sciencebasedtargets.org/>).

- 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

The key inputs to calculating the benchmark pathways are:

- A time path for carbon emissions, which is consistent with the delivery of a particular climate target (e.g. limiting global warming to 2°C). Consistency requires that cumulative carbon emissions are within the associated carbon budget.
- A breakdown of this economy-wide emissions path into emissions from key sectors (the numerator of sectoral emissions intensity).
- Consistent estimates of the time path of physical production from, or economic activity in, these key sectors (the denominator of sectoral emissions intensity).

For the airline sector, TPI obtains all three of these inputs from the International Energy Agency (IEA), via its biennial *Energy Technology Perspectives* report.[3] The IEA has established expertise in modelling the cost of achieving international emissions targets. It also provides unprecedented access to the modelling inputs and outputs in a form suitable for applying the SDA.

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

In 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.

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 emissions since 2014, 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, 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

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 with 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)⁴. 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 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

⁴ Similarly, emissions from international shipping are excluded from NDCs and are instead regulated by the International Maritime Organisation.

emissions reductions associated with air transport are achieved by a mixture of measures, including improved fuel efficiency, increased use of low-carbon alternative fuels, 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 2.5% per year between 2014 and 2030, sustainable biofuels meet 8% of air transport energy demand by 2030 and air passenger traffic is 13% lower than in the International Pledges scenario in the same year⁵.

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 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 than that under the 2 Degrees (Shift-Improve) scenario above.

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 a similar – in fact slightly higher (i.e. less ambitious) – emissions intensity benchmark for air transport than TPI's 2 Degrees (High Efficiency) scenario. Therefore we prefer to use the 2 Degrees (High Efficiency) scenario as our most ambitious benchmark.

4.1.2 Emissions intensity metric

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

A standard metric of air transport activity used in the airline industry is 'passenger kilometres' or 'revenue passenger kilometres', which is the total number of paying passengers multiplied by the distance flown. The IEA transport model provides projected air passenger kilometres for each scenario, at five year intervals.

An appropriate measure of carbon emissions 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' emissions represent around 84% 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.[7] 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).

⁵ 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.

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 Tank-to-Wheel 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 Well-to-Wheel emissions projections for the air transport sector. The figures include full lifecycle emissions for conventional jet fuel, in addition to those for 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. Tank-to-Wheel emissions) are similar to those for 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 for biofuels. [7] Nevertheless, for comparability with emissions data currently reported by airlines, TPI assumes Tank-to-Wheel emissions from biofuels are zero⁶.

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

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

- 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 [8], to derive the Tank-to-Wheel 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 passenger traffic. For example, under the International Pledges scenario in 2025, total global Tank-to-Wheel 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, air passenger kilometres are projected to be 9,365 billion.

⁶ 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.

Therefore the average carbon intensity of an airline aligned with the International Pledges path is $970 / 9,365 = 0.104$ megatonnes of CO₂ per billion passenger kilometres, which is equivalent to 104,000 tonnes per billion passenger kilometres, or 104 tonnes per million passenger kilometres. This equates to 104 grams of CO₂ per passenger kilometre. As the IEA model does not provide projections for 2020, the carbon intensities for that year are estimated by interpolating the carbon intensities for 2014 and 2025.

Figure 1 Benchmark global carbon intensity paths for the airline sector

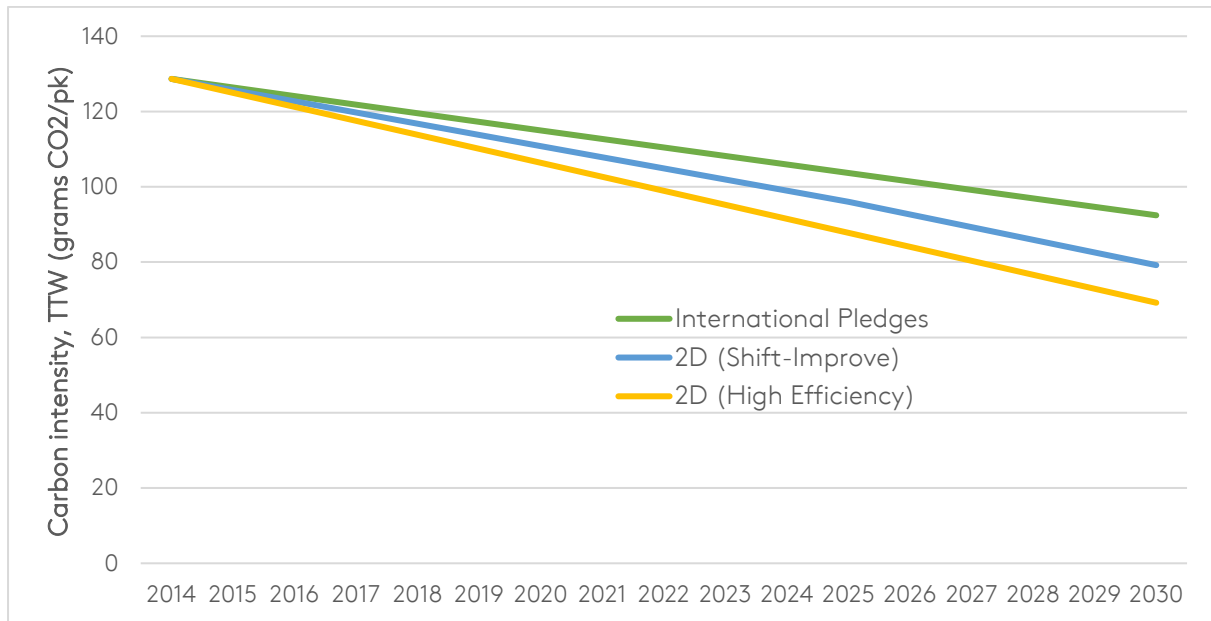


Table 1 Projections of emissions and passenger kilometres used to calculate intensity paths (Source: IEA and own calculations)

	2014	2020	2025	2030
International Pledges scenario				
TTW CO ₂ emissions (Mt)	814		970	1,055
Passenger kilometres (pk) (billion)	6,323		9,365	11,416
Carbon intensity (gCO ₂ / pk)	129	115	104	92
2 Degrees (Shift-Improve) scenario				
TTW CO ₂ emissions (Mt)	814		822	790
Passenger kilometres (pk) (billion)	6,323		8,562	9,976
Carbon intensity (gCO ₂ / pk)	129	111	96	79
2 Degrees (High Efficiency) scenario				
TTW CO ₂ emissions (Mt)	814		822	790
Passenger kilometres (pk) (billion)	6,323		9,365	11,416
Carbon intensity (gCO ₂ / pk)	129	106	88	69

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.[9] Non-CO₂ effects still occur even when biofuels replace conventional jet fuel.[10] 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.[9] Due to the current uncertainty in quantifying non-CO₂ impacts we have not taken them into account in our analysis.

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.

The TPI benchmarks use passenger kilometres as a measure of airline activity. Many airlines have operations that include both passenger and freight transport. The transport of passengers represents the majority of airline activity and is estimated to contribute around 90% of total air transport emissions.[11,12] Freight may be carried in passenger aircraft (as 'belly freight') or in dedicated cargo aircraft. Airlines frequently report their activity in terms of both passenger kilometres and tonne kilometres, which is based on the total number of tonnes transported (or 'payload'), including tonnage associated with passengers, their baggage and any freight transported. An airline may express its carbon intensity in terms of emissions per passenger kilometre or per tonne kilometre. Some airlines allocate their carbon emissions between passengers and freight to calculate separate carbon intensity measures for each operation. The IEA model, which underpins the TPI benchmarks, provides data for passenger kilometres only and does not split jet fuel demand or emissions between passenger and freight transport. Therefore, for comparability with the benchmarks, TPI calculates airlines' emissions intensity using total emissions from jet fuel combustion and total passenger kilometres, which in effect allocates an airline's total carbon emissions to passenger operations.

A small number of airlines provide activity metrics in terms of aircraft capacity or 'Available Seat Kilometres' (or miles), rather than passenger kilometres actually

flown. In those cases, TPI estimates the passenger kilometres actually flown, using metrics provided by the airline on passenger load factors, multiplied by the available seat kilometres.

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 passenger kilometre figures reported by the airline. Thus, if the passenger kilometre data include third-party flights, then the emissions from those operations are also included in the carbon intensity calculation.

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 tonne kilometre. As fuel efficiency improvements translate directly to carbon emissions reductions, TPI applies this target to carbon intensity. In addition, TPI assumes that the carbon intensity target can be expressed in terms of passenger kilometres rather than tonne kilometres. This effectively assumes that the 1.5% carbon intensity improvement target applies uniformly across passenger and freight operations.

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 emissions intensity target above with an absolute emissions reduction target, that is, one based on total CO₂ emissions, rather than emissions per passenger 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 absolute 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.

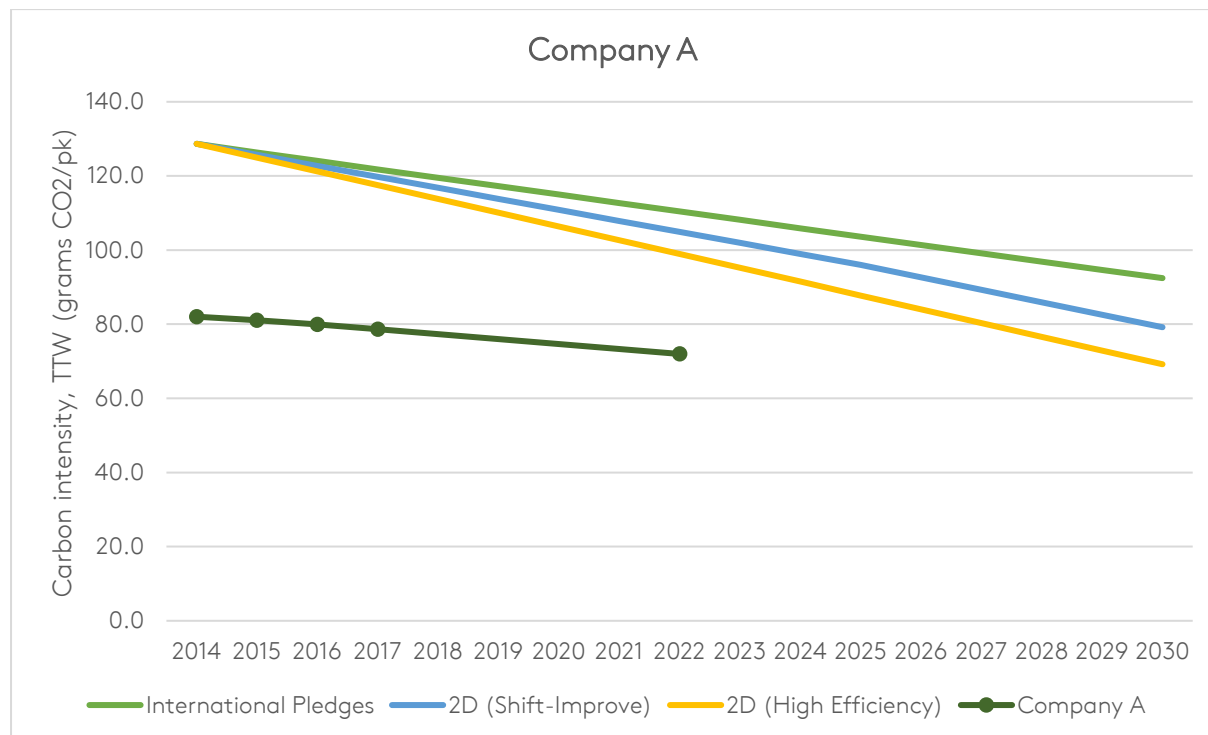
The IEA model produces a carbon budget for air transport, excluding the use of offsets. Thus, emissions reductions are assumed to be achieved directly within the airline sector rather than from other sectors. This is based on the rationale that the IEA’s economy-wide carbon budget is allocated between 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] Therefore, 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 examples⁷

Company A: a simple case

Company A reports its historical emissions intensity and it does so in the required metric, i.e. CO₂ emissions from jet fuel combustion per passenger kilometre. For example, in 2016 it was 80 gCO₂/pk. After independently verifying the estimates using separate company disclosures of emissions and passenger kilometres, these figures are used directly without adjustment.

Company A has also set a target to reduce the intensity of its aircraft carbon emissions per passenger kilometre by 10% from 2016 by 2022. Therefore the 2022 target is to reduce CO₂ intensity to $80 \times (1 - 0.1) = 72 \text{ gCO}_2/\text{pk}$.

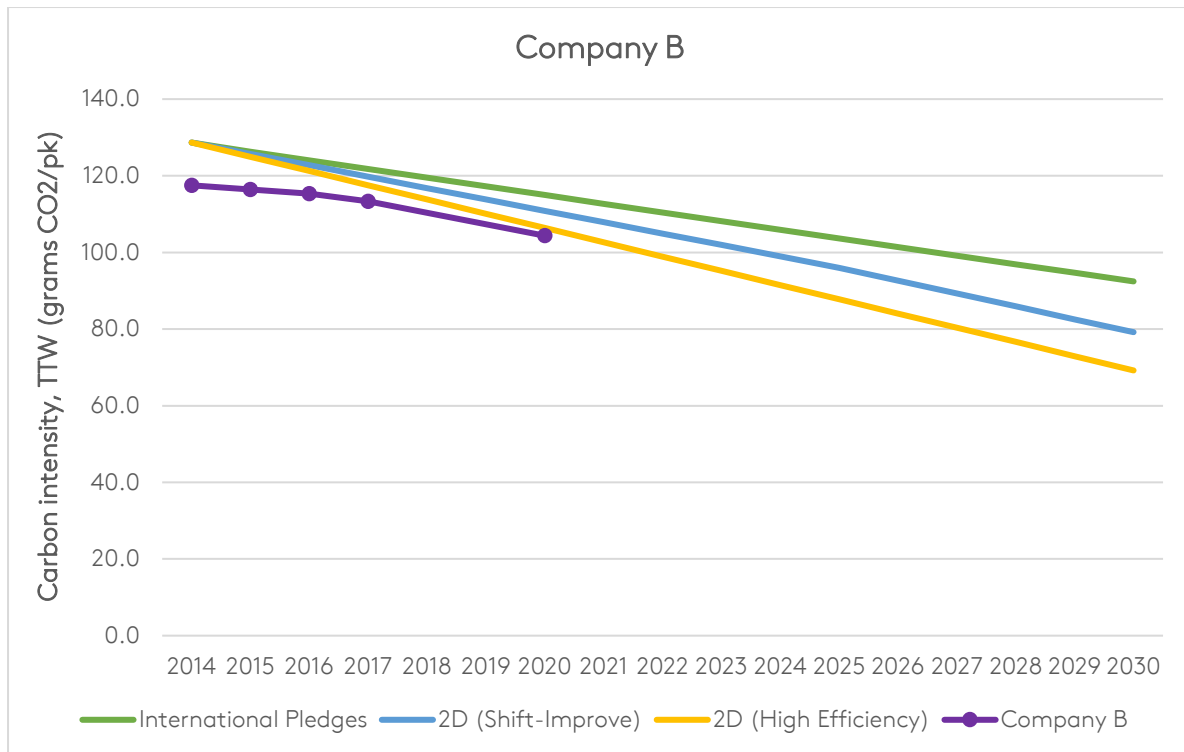


⁷ In the following examples various numbers are rounded for ease of presentation.

Company B: intensity target based on efficiency improvements per tonne kilometre

Company B provides historic fuel efficiency figures, expressed as gallons of jet fuel per 100 Revenue Ton Miles (RTMs). This is not in a format that is comparable with the TPI benchmarks, but Company B provides sufficient information to allow such a carbon intensity figure to be calculated. Company B discloses emissions in metric tonnes of CO₂e from jet fuel used in mainline operations and wholly owned subsidiaries in Scope 1 and reports jet fuel emissions from non-wholly owned regional partners in Scope 3. For example, in 2017 this was 35,591,053 metric tonnes of CO₂e for the former and 4,129,530 for the latter, resulting in total flight emissions of 39,720,583 metric tonnes. This figure includes other greenhouse gases, but, as noted above, TPI uses this figure as an acceptable proxy for CO₂ emissions. The company also discloses passenger traffic from all flights (including from regional partners) for 2017 of 217,712 million revenue passenger miles. This can be converted to 350,373 million passenger kilometres using a conversion factor of 1.60934. Thus the carbon intensity in 2017 may be calculated as (39,720,583 metric tonnes of CO₂ / 350,373 million passenger kilometres) = 113 metric tonnes of CO₂ per million passenger kilometres, which is equivalent to 113 grams of CO₂ per passenger kilometre.

Company B has a target to improve its fuel efficiency from all flight operations (including regional partners) by an average of 1.5% per year from 2009 to 2020, based on Revenue Ton Miles. TPI assumes this target applies equally across the company's passenger and freight businesses. Thus, the target can be expressed as a 1.5% average annual reduction in carbon intensity, based on passenger kilometres flown from all operations (mainline, wholly owned subsidiaries and non-wholly owned regional partners). The airline reports an 8% improvement in fuel efficiency between 2009 and 2017. Based on the calculation of carbon intensity per passenger kilometre for 2017 shown above, this would imply a carbon intensity figure for 2009 of (113/(1 - 0.08)) = 123 gCO₂/pk. Applying an average carbon intensity improvement of 1.5% per year between 2009 and 2020 gives a target of 104 gCO₂/pk for 2020 (i.e. 123 x (1 - 0.015)¹¹).

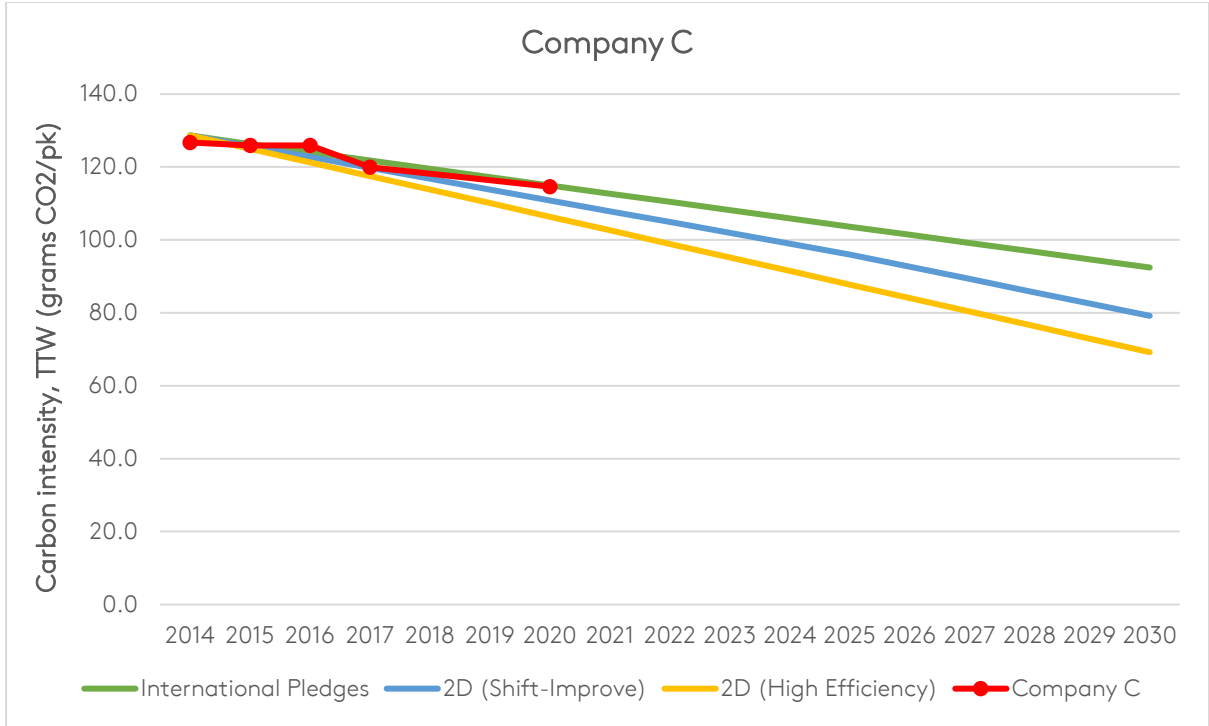


Company B provides two further emissions targets; a medium-term target to cap net absolute emission at 2020 levels and a longer-term target to reduce net absolute emissions by 50% by 2050, relative to 2005 levels. As noted above, the TPI benchmark does not take account of emissions reductions from carbon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

Company C: separate intensity targets for passenger and freight operations

Company C provides a 'passenger specific' carbon intensity figure, expressed as kilograms of CO₂ per 100 passenger kilometres. This metric excludes emissions from freight transportation. As noted above, the TPI benchmark includes all CO₂ flight emissions, from both passenger and freight operations, and thus Company C's carbon intensity figure is not comparable with the benchmark. However, Company C provides data for emissions and passenger kilometres separately, so comparable carbon intensity figures can be calculated. For example, Company C's total CO₂ emissions from flight operations (excluding those operated by third parties) were 30,296,998 tonnes in 2017 and passenger kilometres were 252,660 million passenger kilometres (also excluding third party flights). Thus, the carbon intensity for 2017 can be calculated as 120 tonnes per million passenger kilometres, equivalent to 120 gCO₂/pk.

Company C provides a carbon intensity target in line with the industry target of improving fuel efficiency by 1.5% per year until 2020. In contrast to Company B, Company C interprets this target as a year-on-year improvement rather than an annual average improvement of 1.5% between 2009 and 2020. Thus, for Company C, the flight-only carbon intensity target for 2020 is $(120 \times (1 - 0.015)^3) = 115 \text{ gCO}_2/\text{pk}$.



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. 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 path.

5.2. Issues specific to airlines

Within 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 (which underlies its *Energy Technology Perspectives* report). 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 travel and shifting modes of transportation, as opposed to improving fuel efficiency and increasing the use of low-carbon fuels.[13] In view of this uncertainty, TPI has proposed two different 2 Degrees scenarios, capturing the range of assumptions on this issue.

TPI benchmarks airlines between now and 2030. 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. 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. The TPI benchmarks are derived from the IEA's modelling work, which uses the approach of allocating carbon budgets to each sector in a cost-effective way and therefore assumes carbon offsets will not be available for purchase from other sectors. As a result, in its assessment of the carbon performance of airlines, TPI does not include airline targets based on net emissions.

While most airlines set carbon intensity targets to 2020, there is some variation in how they are presented, some using passenger kilometres as the measure of activity, while others use tonne kilometres based on total payload (passengers and freight). For consistency with the IEA modelling, TPI uses passenger kilometres as the activity metric and recalculates carbon intensity targets that are reported on a tonne kilometre basis, using emissions and passenger kilometre data disclosed by airlines. While it is necessary to choose one activity metric for comparison of carbon performance across the sector, this leads to some distortion depending on differences between the business models of airlines, such as the share of operations represented by freight or premium class passenger transport.

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.[9,14] 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.[14] Without this, the airline sector's contribution to climate change is likely underestimated.

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The Transition Pathway Initiative (TPI)

c/o UNPRI PRI Association
5th Floor, 25 Camperdown St
London, E1 8DZ, UK

T +44 (0)20 3714 3141

E tpi@unpri.org

transitionpathwayinitiative.org

[@tp_initiative](https://twitter.com/tp_initiative)

