

# *Fasten seat belts: The future of aviation emissions regulation*

*Low Carbon Economy  
Index 2012: Aviation*

*December 2012*



# Summary

Our Low Carbon Economy Index 2012 concluded that to limit global warming to 2°C, countries need to cut the ratio of carbon emissions to GDP by 5.1% every year to 2050. All sectors will play a role, including aviation which currently accounts for around 2% of global energy-related emissions. The aviation industry recognises this challenge. Through the International Air Transport Association, it has set ambitious targets to halve net emissions from the sector by 2050 giving a carbon budget comparable to our Low Carbon Economy Index.

Aviation policy is in a state of flux. Under intense pressure from America, China, Russia and others, the EU has proposed suspending the Emissions Trading Scheme obligation on international flights for 12 months. Despite this, President Obama still signed the EU Emissions Trading Scheme Prohibition Act making it illegal for US airlines to comply with the EU regulation.

This gives the International Civil Aviation Organisation (ICAO) less than a year to agree a global policy to tackle rising aviation emissions. Failure to do so would force US airlines into non-compliance in at least one jurisdiction. It is, at least, encouraging that market-based measures such as emissions trading and carbon offsets are on the negotiating table at ICAO.

Airlines should be able to achieve the 5.1% reductions in carbon intensity without a reduction in absolute emissions through to 2030 because traffic is projected to grow at more than 5% over that period. Improvements in efficiency, use of biofuels and carbon offsets are the three measures that airlines could implement to achieve their target.

Our analysis shows that high jet fuel prices could drive background efficiency improvements (in air traffic management, aircraft design and engine technology etc) accounting for approximately one-third of the airlines' reduction goals. Some incremental efficiency improvements could also come from the imposition of a carbon price.

By 2030 the rest of the reduction target could be met by the use of biofuel. This is provided that the substantial barriers to large-scale biofuel production can be overcome. Given the time required to develop biofuels for aviation and the supporting infrastructure, carbon offsets should be used in the interim. Airlines could therefore be a major new source of demand for credits from the Clean Development Mechanism (CDM) or New Market Mechanisms. Airlines could require over €1bn of carbon offsets annually to help achieve their emissions reduction goals.

Industry cannot achieve this alone. Leadership from ICAO and cooperation among governments are needed for rapid decarbonisation of the aviation sector. The next 12 months present an opportunity to forge a global consensus and secure a sustainable future for aviation.

# Introduction

The global economy needs to cut the ratio of carbon emissions to GDP (carbon intensity) by 5.1% every year to 2050 in order to have a good chance of limiting global warming to 2°C. Our Low Carbon Economy Index 2012 showed that progress towards this goal is wanting: over the past 12 months, global carbon intensity decreased by only 0.7% and has averaged only 0.8% per year since the turn of the millennium.

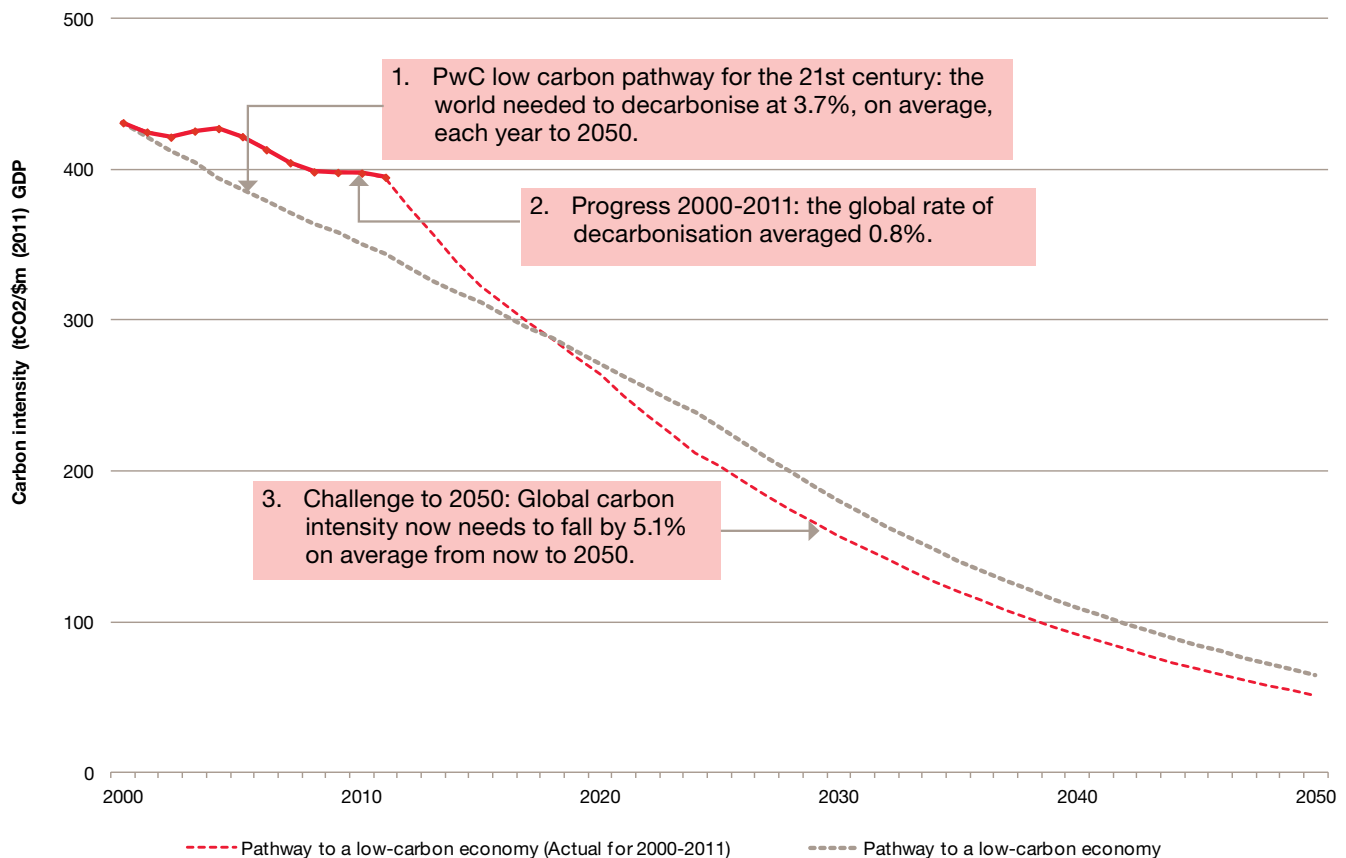
Every sector will have a role to play in meeting this goal, including aviation. Aviation's current share of global carbon emissions is around 2.1%, and rising.

In an increasingly globalised world, the connectivity benefits that the sector provides underpin economic growth. Furthermore, technological options to reduce carbon may be limited compared to other sectors such as energy. Well-designed aviation regulation is therefore key to the success of the global economy – overly strict aviation targets pose threats to other industries too.

The sector's existing emissions goals, as announced by the International Air Transport Association (IATA) - to cap emissions at 2020 levels and then reduce 2050 emissions by 50% on 2005 levels - are broadly consistent with the sector making a fair contribution towards meeting the 2°C goal up to 2050.

This vision is to be congratulated. Given expected traffic growth of more than 5% though, meeting these targets will be tough. Historical efficiency improvement since 2000 has been around 1.7% per year. Strong regulatory support and international action are likely to be needed to reach the 5.1% decarbonisation goals.

**Figure 1:** The Low Carbon Challenge\* (2012)



Source: PwC's analysis, data from World Bank (2012) and BP Statistical Review (2012).

\* We use the carbon intensity for countries as a measure of progress towards a low carbon economy. The carbon intensity of an economy is the emissions per unit of GDP and is affected by a country's fuel mix, its energy efficiency and the composition of the economy (i.e. extent of activity in carbon-intensive sectors).

The European Commission's recent proposal to suspend for 12 months EU Emissions Trading Scheme (ETS) enforcement on the extra-EU aviation sector presents an opportunity to build a global consensus on aviation emissions regulation. As aviation is fundamentally a cross-border activity, a global solution is needed. Unilateral efforts to regulate have provoked diplomatic spats between the EU and other major emerging and developed economies – only this week President Obama signed a bill to prohibit American airlines from complying with the EU ETS legislation, even while it is on hold.

Failure to adopt a convincing global framework at the International Civil Aviation Organisation's (ICAO) next triennial assembly in October 2013 will lead to a resumption of European Union enforcement. This risks re-igniting wider trade tensions, not just with the US, over the EU ETS and undermining meaningful efforts to reduce aviation carbon emissions globally.

Pricing emissions will invigorate the pace of aviation emissions reduction, taking the sector closer to the 5.1% target. However, such action is not enough by itself. ICAO will need to offer a convincing carbon offset framework that addresses concerns about the future of the CER market and provides a role for the New Market Mechanisms. ICAO will

also need to be sensitive to Common But Differentiated Responsibility principle (that less developed nations should have less strict emissions targets), which is often seen as inconsistent with the Chicago Convention (that aircraft regulation should not reflect nationality). Diplomatic sharing of any regulatory revenue raised may be one way to overcome this obstacle.

Furthermore, national governments will need to support ICAO by providing a broader enabling environment, including:

- Coordinating on cross-border issues such as international Air Traffic Management (ATM).
- Investing in public goods such as infrastructure upgrades.
- Supporting the scale-up of global biofuel production.

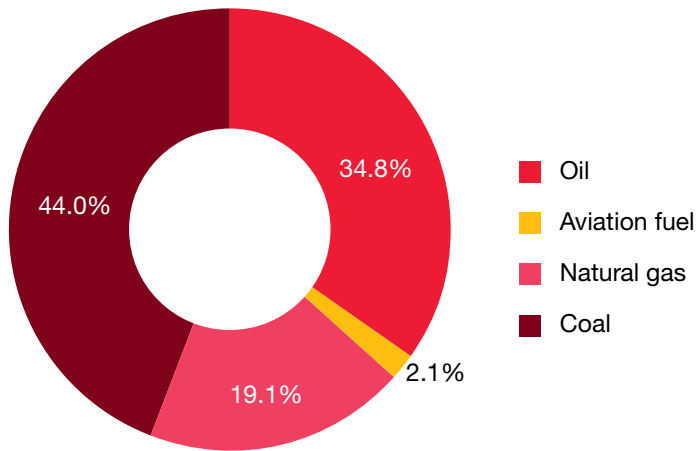
Lastly, governments will need to consider financial stresses faced by the industry. Reinvesting any revenue raised from new regulation in the industry will help. However, the short-term yield environment is challenging in many countries. Matching new regulatory burdens with new incentives – for example, increased capital allowances for investment in fuel-efficient aircraft – may help rally industry support for a new global deal.



# Emissions in the aviation sector

The aviation sector is a small but significant contributor to global GHG emissions. Based on IATA data, we estimate that on a consistent basis with our Low Carbon Economy Index model, domestic and international aviation together account for around 2.1% of global energy-related carbon emissions, excluding airport emissions (see Figure 2)<sup>1</sup>.

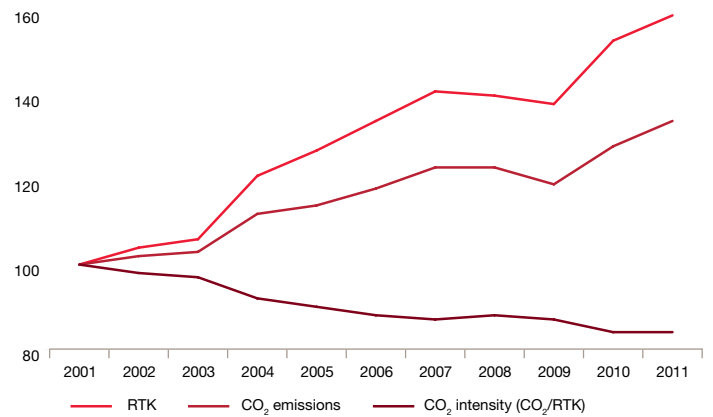
**Figure 2:** Sources of 2011 global energy-related carbon emissions, by fuel type



Source: IATA, PwC analysis.

Aviation emissions have risen over the past decade (see Figure 3) and most business-as-usual projections (i.e. excluding alternative fuels) expect emissions to continue rising through to 2050<sup>2</sup>. Due to increasing efficiency, emissions have not risen as fast as distances flown – the average carbon intensity of global aviation traffic fell from above 1.1 kgCO<sub>2</sub> per Revenue Tonne Kilometre (RTK) to less than 0.95 kgCO<sub>2</sub>/RTK between 2001 and 2011. This is equivalent to a 1.7% annual improvement<sup>3</sup>. This had been made possible by a range of new technologies and operational improvements, but these generally only permeate slowly through the industry due to slow fleet turnover cycles (discussed further in the next section). From a commercial perspective, it is likely that high and volatile oil prices have been the primary driver for these improvements, rather than carbon targets alone.

**Figure 3:** Traffic, emissions and intensity trends in the aviation sector 2001-11



Source: IATA WATS 2011, PwC analysis, 2001 = 100.

<sup>1</sup> The estimate in Figure 2 corresponds to 660 MtCO<sub>2</sub>, as cited in IATA's Airlines International Environment Supplement, May 2011.  
**Note:** In order to analyse carbon intensity, we use IATA's World Air Transport Statistics (WATS) in the remainder of this report, which is the most consistent global data set on RPK and CO<sub>2</sub> emissions. This implies a lower emissions profile of around 530 MtCO<sub>2</sub>, since the data are not exhaustive (e.g. scheduled flights only). Since all analysis and targets in this report are relative to this common baseline, this does not significantly affect our conclusions.

<sup>2</sup> ICAO Environmental Report, 'Aviation and Climate Change', 2010.

<sup>3</sup> This figure covers both passenger and freight transport. Carbon intensity is very similar to carbon efficiency already discussed, except that it also accounts for how much profit can be generated from each kilometre flown. We use the terms interchangeably here since for this analysis we make the simplifying assumption that yields remain broadly constant.

# The 2°C challenge

## The challenge for aviation

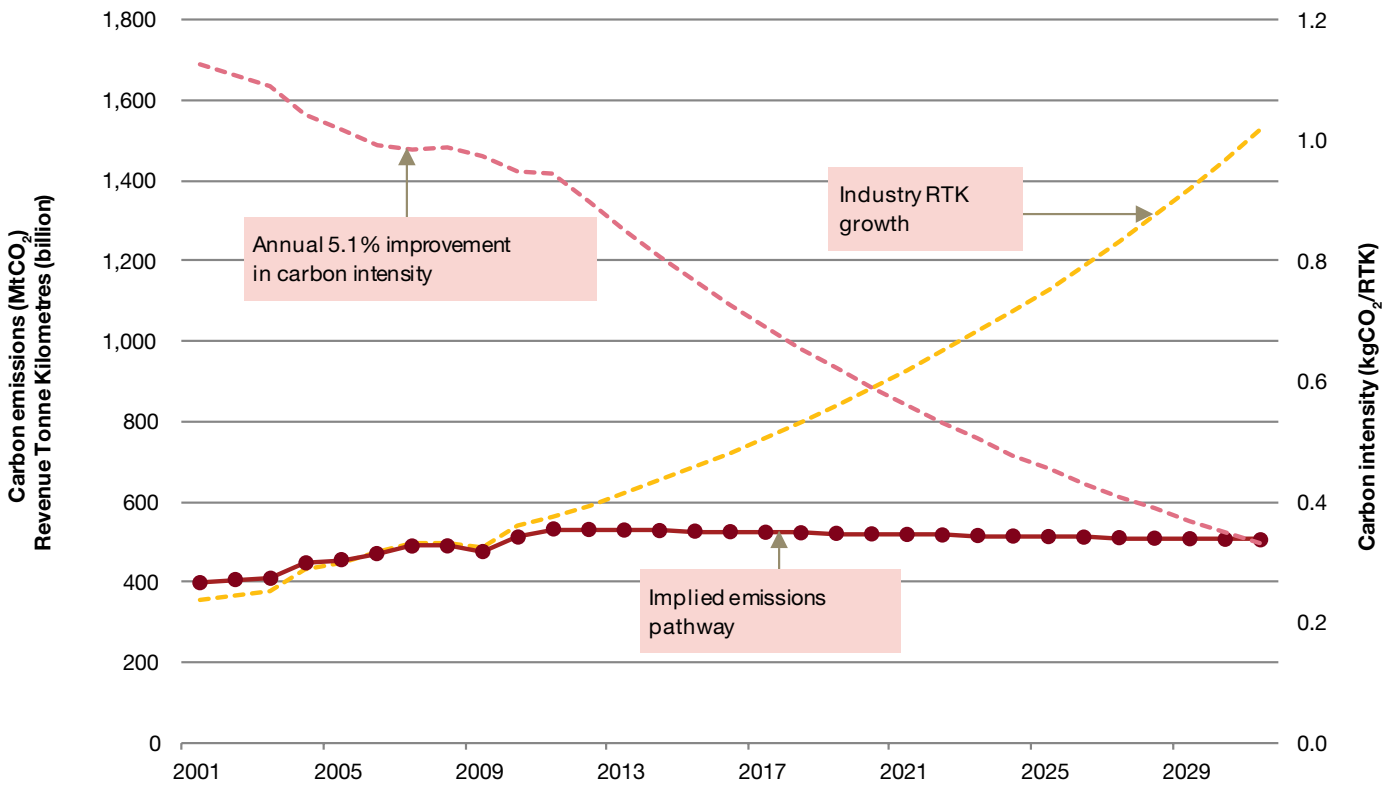
Our Low Carbon Economy Index model considers global emissions trajectories consistent with the 2 degrees goal. Our 2012 results showed that, on average, the global economy needs to decarbonise at 5.1% every year to 2050 to retain a fair chance of limiting global warming to 2 degrees.

The distribution of effort across industries towards this target may not be equal. Sectors that are more integral to the global economy or those with limited technological options for abating carbon may consider it fairer to aim for a lower decarbonisation target. Our analysis shows that, if the aviation sector were to adopt the 5.1% target, it could achieve this even by maintaining flat emissions to 2030, given that

traffic growth is expected to be above 5%. In the next section, we highlight that this is in line with IATA's existing announced targets over the long term.

Figure 4 illustrates the pathway implied by our model. Scheduled traffic is expected to grow at around 5.1% a year from around 560 billion RTK in 2011 to 1,500 billion in 2031. Therefore, if the sector follows the required global reductions in carbon intensity of 5.1% suggested by our Low Carbon Economy Index model, traffic growth and intensity improvements 'cancel out' – emissions must implicitly remain constant to hit the target.

**Figure 4:** Global aviation carbon emissions, traffic growth and carbon intensity, 2001-31



Source: Boeing 2012 Traffic forecasts ([http://active.boeing.com/commercial/forecast\\_data/index.cfm](http://active.boeing.com/commercial/forecast_data/index.cfm)), IATA WATS 2011, PwC analysis.

Note: Scheduled services only. RTK assumed to grow at 5.1% per annum; this is a global average of traffic and cargo forecasts of 5% and 5.2% respectively. This analysis does not consider the role of displacement of other forms of travel by aviation traffic growth, which may further increase the sector's implied carbon budget.

## Meeting the challenge: Options

Decoupling the growth in emissions from traffic and revenue growth will require new technologies, new ways of doing business and cooperation with other sectors. These actions fall under five headings:

- **Alternative fuels:** The use of biofuels allows fuel consumption to continue rising even as carbon emissions fall. There are currently some barriers to the widespread use of biofuels, including a lack of available biofuel feedstock, production infrastructure resulting in costs significantly above conventional jet fuel, and major concerns about the impact on food production, biodiversity and total life-cycle emissions. If these can be overcome then some forecasts have suggested that even a worst case scenario is a 40% share of the fuel mix as early as 2035<sup>4</sup>.
- **Technological measures:** Improvements in aerospace manufacturing in areas such as aerodynamics, use of lightweight materials and apparatus, and engine combustion efficiency continue to drive small but significant improvements in fuel efficiency per kilometre flown.
- **Infrastructure/operational measures:** The fuel efficiency of a flight from departure to destination is determined not only by its technological efficiency but also by the geographical route, flying profile and ground emissions. Measures such as Air Traffic Management (ATM), which makes routes more direct and smoothes ascent and descent, and airport measures such as runway taxing using ground-vehicles can significantly decrease the end-to-end emissions profiles for a given journey.
- **Business/operational measures:** The efficiency per passenger can be increased by reaping economies of scale through larger aircraft and ensuring load factors are maximised. Carbon intensity in value-added terms can be further improved by optimising yields and profit margins at the sectoral level<sup>5</sup>.
- **Offsets/carbon credits:** Where a combination of the above measures cannot reduce emissions intensities enough to meet the decarbonisation target, carbon offsets represent a cost-effective way to reduce net emissions further. Offsets have a natural role to play in an emissions market since they are fungible with carbon allowances. However, in other schemes designed to limit emissions, offsets can also be a relevant instrument, whether through direct private sector procurement or private sector contributions to a centralised carbon fund responsible for hitting national net emissions targets.

## Meeting the challenge: combining the options

How might these measures combine to provide a pathway for the industry consistent with the 5.1% target? We outline one illustrative scenario below, based on the following assumptions:

- **Business-as-usual (BAU) fuel efficiency improvements:** Carbon intensity follows historical efficiency gains since 2000 - a 1.7% per year improvement in CO<sub>2</sub>/RTK - driven mostly by commercial incentives to reduce fuel bills. In reality, fuel efficiency gains are 'stepped' rather than smooth, as major changes to the composition of the fleet occur in waves (see page 11).
- **Additional fuel efficiency improvements:** A further 0.3% per year improvement, to bring the total rate of fuel efficiency growth to 2% per year in line with ICAO's aspirational target, might be prompted by measures such as a carbon price or better Air Traffic Management.
- **Increasing biofuel usage:** A rapidly increasing share of low-carbon biofuels in the fuel mix is assumed, with the total share reaching 30% by 2030.
- **Carbon offset purchases:** To make up the difference to the target, it is assumed that remaining emissions are offset against carbon emissions reductions in other sectors. Taking the average long-term price as €10/tCO<sub>2</sub>, this could mean average annual purchases by the aviation sector of €1.1 billion yearly between 2012 and 2031.

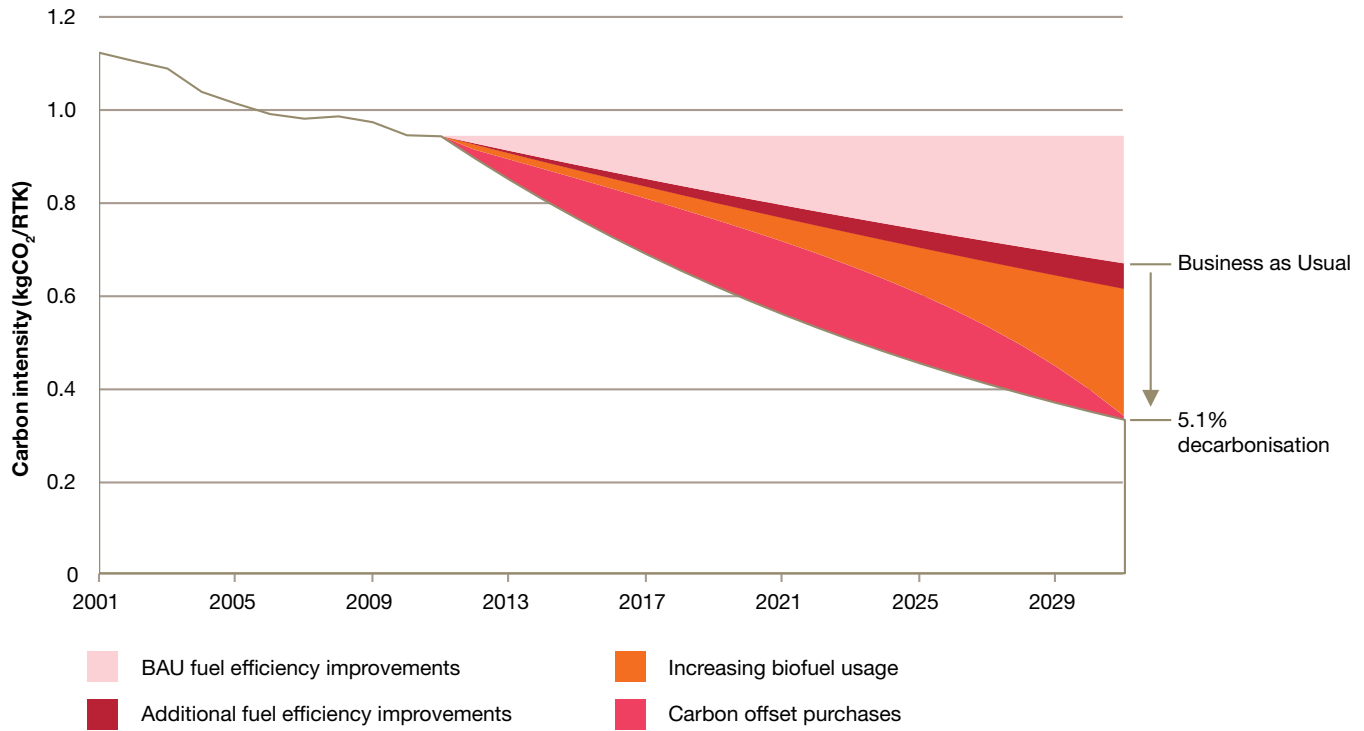
These measures appear broadly technically feasible, but they may not be commercially attractive. Clearly, reacting to ongoing social, technological and economic developments in the biofuel industry will be a key requirement of any aviation regulation.

Well-designed regulation, which appropriately alters market prices, and targeted public investment in the right technologies and infrastructure, can change these commercial dynamics and guide industry along the 5.1% decarbonisation pathway.

<sup>4</sup> CAPA Centre for Aviation, 'IATA predicts biofuel use within three to five years', June 2010.

<sup>5</sup> Yields are excluded from this analysis due to uncertainties associated with forecasting long-run profitability.

**Figure 5:** Potential measures for reducing emissions intensity of aviation, 2001-31



Source: IATA WATS 2011, PwC analysis. Scheduled services only.





# Implications: Regulating emissions

*The implications of the previous section – a 5.1% decarbonisation target consistent with the 2°C goal is not likely under business-as-usual alone – provide a clear rationale for regulators to step in. Here, we summarise historical efforts to regulate, before outlining our view on the future of international aviation emissions regulation.*

## Regulation to date

Historically, international aviation was solely the responsibility of the UN body, ICAO, which was delegated regulatory authority under the Kyoto Protocol. As in the case of global shipping, this recognised the difficulties in regulating an international activity on a sovereign basis. However, efficiency gains since the agreement in 1997 (see Figure 3) did not prove enough to limit emissions, given growth in traffic.

Frustrated with the lack of progress at the international level, the European Commission moved unilaterally in 2009 to include aviation emissions in the EU Emissions Trading Scheme from 2012. This meant that most flights in and out of the EU would have been obliged to surrender carbon credits equal to the amount of emissions released. Since 2009 though, international opposition to this move has built up.

Twenty-six nations (including the USA, China, India and Russia) formed what was dubbed the ‘coalition of the unwilling’ to discuss potential retaliatory measures to, what they saw as, breaches of sovereign rights to regulate. The freezing of up to \$14 billion of Airbus orders by China was widely perceived as one example of such a retaliatory measure. Ratcheting up the pressure still further, on 22 September 2012 the US Senate passed the European Union Emissions Trading Scheme Prohibition Act of 2011. This Act, which prohibits ‘an operator of a civil aircraft in the United States from participating’ in the EU ETS, was signed into law by President Obama on 28 November 2012<sup>6</sup>.

Faced with this overwhelming international pressure, on 12 November 2012, the European Commission proposed a suspension of the EU ETS on international flights for 12 months, pending regulation at the international level.

There are still other schemes under consideration in other countries. For example, the Chinese Government were earlier this year reported to be considering using revenue raised from international passenger taxes to fund a Civil Aviation Development Foundation, in turn investing in emissions reductions measures<sup>7</sup>. However, all eyes are now on ICAO for a single, global solution.

## The future of international regulation

The industry has already made significant strides towards regulating emissions. First of all, ICAO has defined an aspirational industry goal of 2% per annum improvement in fuel efficiency, and carbon-neutral growth after 2020. Secondly, the industry’s global representative, IATA, has adopted a target to halve net GHG emissions by 2050 relative to 2005 levels. Mapping these against our decarbonisation analysis from the previous section shows that over the long term industry goals are broadly in line with the 5.1% goal. We re-iterate that our analysis does not explicitly account for yields – in fact, if the industry were able to improve their share of value-added in revenue<sup>8</sup>, IATA’s ambitions might represent a higher rate of decarbonisation than 5.1%.

As Figure 6 shows, there is some ‘overshoot’ on a BAU path to 2020, but this is fully compensated for following IATA’s proposed long-run path to 2050. The peak in 2020 also reflects the practicalities of aerospace manufacturing. The decade starting in 2020 is likely to witness large step improvements in fuel efficiency as a series of new aircraft come online. The backlog of Airbus A330/340/350 orders already stands at 889, the Airbus A380 backlog at 168, and the Boeing 787 Dreamliner backlog at 805<sup>9</sup>. This latter aircraft is expected to be around 15-20% more fuel efficient than the aircraft it was designed to replace<sup>10</sup>; the Boeing 767. This trend is likely to be more marked than previous generations of fleet replacements, due to the increased tendency of emerging market carriers to buy new, rather than second-hand, developed-market aircraft.

<sup>6</sup> S.1956.ENR. Public Law No: 112-200.

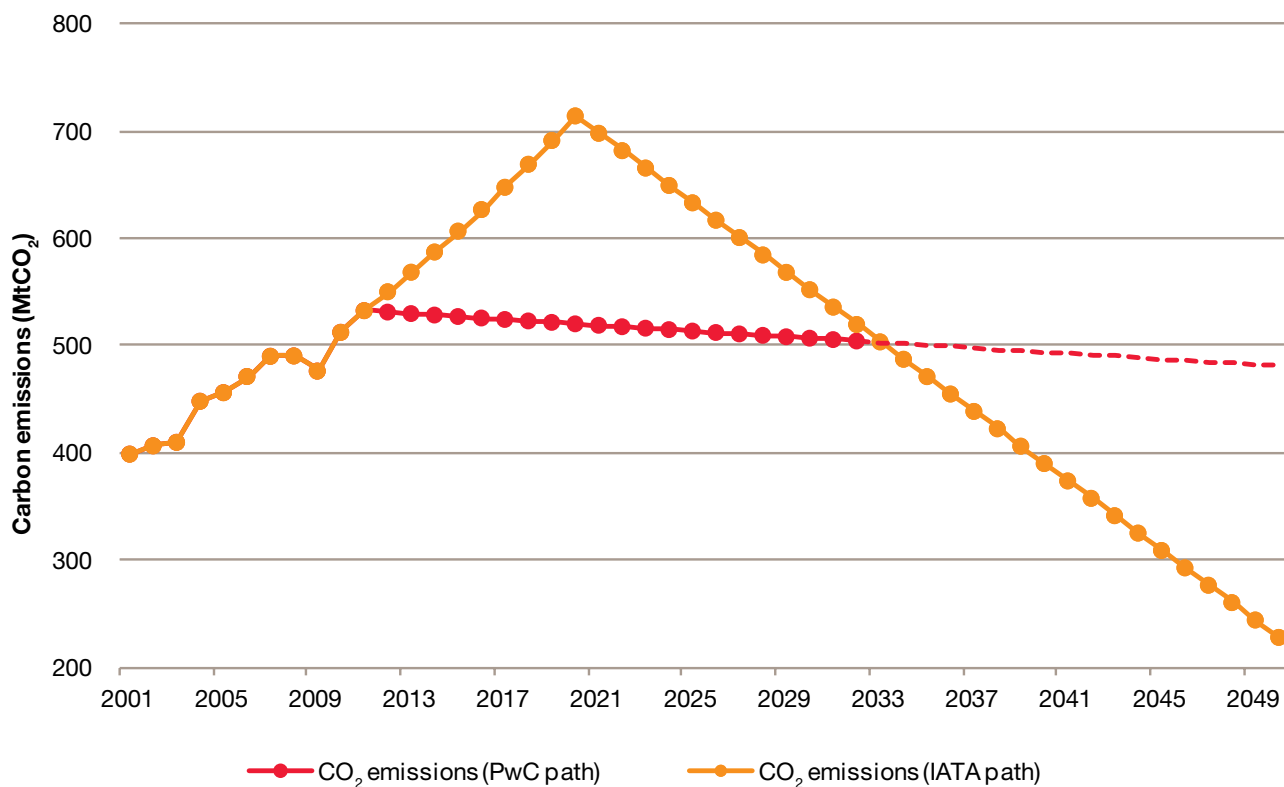
<sup>7</sup> Business Green, ‘EU investigating Chinese aviation emissions plan’, 20 April 2012.

<sup>8</sup> i.e., Improving the joint share of profits and wages in total revenue.

<sup>9</sup> Source: Boeing and Airbus websites accessed 23/11/12 (<http://active.boeing.com/commercial/orders/displaystandardreport.cfm?cboCurrentModel=787&optReportType=AllModels&cboAllModel=787&ViewReportF=View+Report> and <http://www.airbus.com/tools/airbusfor/analysts/>). Figures current as of October 2012.

<sup>10</sup> Aviation Week ANA, ‘JAL Boeing 787 Fuel Burn Performance Beating Expectations’, 26 June 2012.

**Figure 6:** Comparing IATA's announced emissions targets with the Low Carbon Economy Index 2012 pathway



Source: IATA WATS 2011, PwC analysis.

Note: Scheduled services only. Our analysis does not explicitly consider the period after 2030 – the dashed line represents a linear extrapolation. IATA does not explicitly provide a pathway from 2012-20 – this is a business-as-usual path based on industry growth forecasts and the 1.7% annual improvement in carbon intensity observed from 2001-11.

To reach these targets, ICAO is currently considering four market-based measures:

- Global mandatory offsetting.
- Global mandatory offsetting, including a revenue-raising mechanism.
- Emissions Trading Scheme.
- Emissions Trading Scheme, based on efficiency benchmarking.

As outlined in our 2009 paper ‘Carbon Taxes vs Carbon Trading: Pros, cons and the case for a hybrid approach<sup>11</sup>, we are broadly in favour of any market-based measures ahead of emissions regulation, as they are generally more cost-effective than command-and-control measures (such as enforcing technology standards). We therefore welcome all four of ICAO’s proposals.

There are in practice though a range of issues around risk and implementation that differentiate the four proposals. In Figure 7 below we outline some of these issues.

<sup>11</sup>. PwC, Carbon Taxes vs Carbon Trading: Pros, cons and the case for a hybrid approach 2009.

**Figure 7:** Strengths and drawbacks of ICAO’s four proposed market-based measures

	<b>Strengths</b>	<b>Potential drawbacks</b>
<b>Global mandatory offsetting</b>	<ul style="list-style-type: none"> <li>• Offsets are a potentially cost-effective way of tackling emissions growth (current CER prices are less than €1/tCO<sub>2</sub> versus double or triple-figure abatement costs in-sector<sup>12</sup>).</li> <li>• Simple to administer compared to ETS.</li> </ul>	<ul style="list-style-type: none"> <li>• Risk of price volatility in external offset markets.</li> <li>• Reduced incentive for in-sector abatement, which might jeopardise technological breakthroughs such as biofuels.</li> <li>• A range of commentators have called into questions the future of key compliance-grade credit markets, such as the Clean Development Mechanism.</li> <li>• NGO allegations that some offsets have questionable environmental integrity.</li> </ul>
<b>Global mandatory offsetting, including a revenue-raising mechanism</b>	<p><b>As above, plus:</b></p> <ul style="list-style-type: none"> <li>• Revenue raised can be re-invested in low-carbon R&amp;D and infrastructure improvements such as ATM (see next section).</li> </ul>	<p><b>As above, plus:</b></p> <ul style="list-style-type: none"> <li>• Revenue raising across jurisdictions may not gain political traction.</li> <li>• The extra cost to the private sector may undermine a global deal being reached in 2013.</li> </ul>
<b>Emissions Trading Scheme</b>	<ul style="list-style-type: none"> <li>• Flexibility to use offsets as above, but allows increased focus on in-sector abatement.</li> <li>• Flexibility on cost to airlines of allowances (proportion of auctioned allowances variable).</li> </ul>	<ul style="list-style-type: none"> <li>• More costly to establish and administer compared to offsetting.</li> </ul>
<b>Emissions Trading Scheme, based on efficiency benchmarking</b>	<p><b>As above, plus:</b></p> <ul style="list-style-type: none"> <li>• Easy to align with global carbon intensity targets as outlined in this paper.</li> <li>• Drives technological change even in absence of industry growth.</li> </ul>	<p><b>As above, plus:</b></p> <ul style="list-style-type: none"> <li>• Environmental outcome (absolute emissions) uncertain if industry forecasts underestimate growth.</li> <li>• Requires verification metric independent from tonne-km data (e.g. fuel consumption).</li> </ul>

<sup>12</sup> UK Department for Transport, ‘A Marginal Abatement Cost Curve for the UK Aviation Sector’, 2011.

Whichever the chosen scheme, we would expect some role for out-of-sector offsets: as outlined in our scenario, they form a key bridge between today and the time when large-scale biofuel production is feasible. The choice of schemes is therefore not a dilemma between ‘offsets or not’. Rather, it is a question of how best the industry can use offsets to keep compliance costs to a minimum, and at the same time address legitimate concerns and risks around offsets. At a minimum, any global aviation emissions regulation blueprint would need to provide convincing answers to the following questions:

- Which offset types will be eligible in the proposed scheme? Will these be compliance-grade or voluntary credits?
- How would the proposals account for fundamental concerns about the largest compliance-grade market<sup>13</sup> (CDM) and plan for a likely long-term transition to New Market Mechanisms that are economically and structurally different?

- How will the industry respond to NGO concerns around the environmental integrity of some offset types?<sup>14</sup>

Further, implementing any of these schemes is likely to be a complex undertaking at a global level. We emphasise that institutional design and administrative efficiency are likely to be just as important to success as the economic parameters.

We welcome a robust debate over such questions in the coming months, and encourage a pragmatic and consensus-building solution for consideration in 2013.

<sup>13</sup>. See e.g. International Emissions Trading Association, ‘Annual GHG Sentiment Survey’ 2012.

<sup>14</sup>. For example, the European Commission has rendered ineligible industrial-gas CERs in the EU ETS, as of 31 December 2012, inter alia because of perceived concerns about their environmental integrity.



# Supporting ICAO: Government enablers

Putting a price on carbon emissions is unlikely to drive the required emissions reductions by itself, at least while maintaining profitability and growth at the same time. Governments need to offer airlines a practical way of growing their business while freezing further emissions growth. There are two key ‘win-win’ solutions in this area that governments will need to support if international regulation is to be a long run success both for businesses and the environment:

## 1. Support alternative fuels

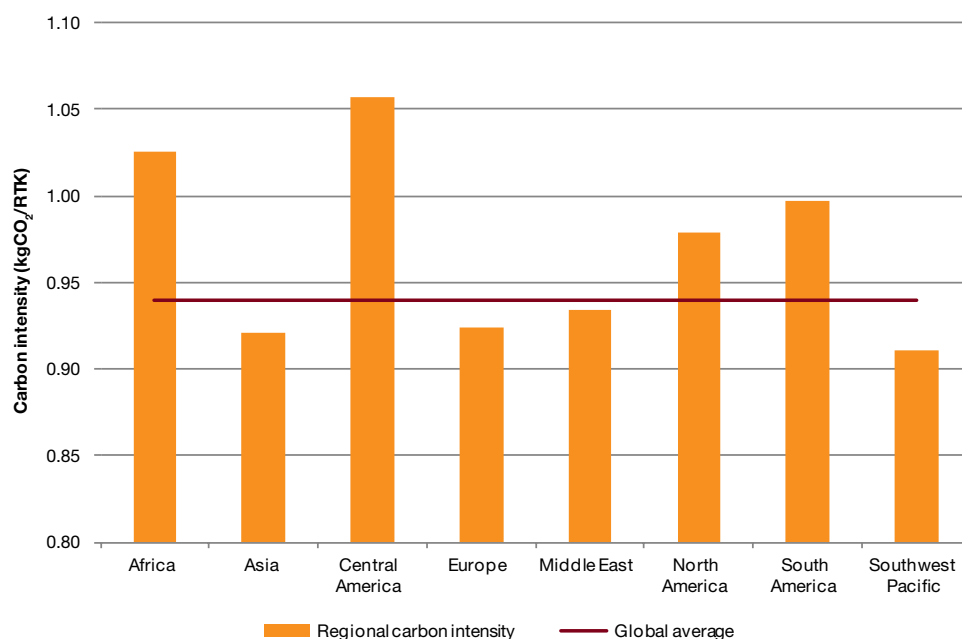
- Biofuels will be an integral part of emissions reductions efforts in the aviation sector, and will probably be cost-effective compared to squeezing ever more fuel efficiencies out of aircraft. In a study commissioned by the UK government, mandatory biofuel use was estimated to cost around £24/tCO<sub>2</sub> (€29), as compared to an average cost for ‘operational measures’ of around £40/tCO<sub>2</sub> (€48)<sup>15,16</sup>.
- Governments should look to support the scale-up of this relatively immature technology to reduce its cost further still.
- However, this will require addressing: fundamental issues such as striking international agreements on the balance between food production and fuel production, and protecting biodiversity; financial issues such as providing funding for demonstration projects for next-generation biofuels derived from organic waste (rather than purpose-grown crops); and administrative issues such as clarifying carbon accounting treatment of biofuels (what are their emissions content, including indirect land-use change?)

## 2. Invest in public goods

- Measures such as ATM are difficult for airlines to bring about by themselves, and the up-front costs may prohibit any individual airline from funding these. However, the long term return from measures such as ATM can be positive if participants can be brought together, or the investment can be funded or financed by government. In the same study as mentioned above, ATM improvements were shown to be highly cost-effective, with a *negative* net cost of £77/tCO<sub>2</sub> (€92).
- The NextGen programme in the United States, which upgrades American infrastructure from an inefficient ground-based network to a GPS-guided system, is a very welcome example of such move. Increasing route precision and consequently reducing delays is will save 14 MtCO<sub>2</sub> and \$23 billion in costs to the industry, the Federal Aviation Administration (FAA) and the travelling public by 2018<sup>17</sup>.

Domestic government action and cooperation on cross-jurisdictional issues, such as international Air Traffic Management, will both be needed to facilitate large-scale emissions reductions without needlessly jeopardising industry profitability. Such initiatives will be particularly important in regions where carbon intensity is already above the global average (see Figure 8).

**Figure 8:** Carbon intensity by region, 2011



Source: IATA WATS 2011.

<sup>15</sup> Average net economic cost.

<sup>16</sup> UK Department for Transport, ‘A Marginal Abatement Cost Curve for the UK Aviation Sector’ 2011.

<sup>17</sup> Federal Aviation Administration, ‘NextGen Implementation Plan’ 2011.



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