CARBON NEUTRAL GROWTH FOR AVIATION – AT WHAT PRICE?

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1. INTRODUCTION

Ever since the Kyoto Protocol in 1997 assigned to the International Civil Aviation Organization (ICAO) responsibility for managing greenhouse gas emissions from international aviation,[1] progress in agreeing targets for the sector has been lamentably slow. Only recently has ICAO started to address the issue seriously, partly stimulated by the European Union's unilateral decision to include a portion of these emissions within the EU Emissions Trading System.

In 2010, following a proposal by international airlines to halve their emissions by 2050,[2] ICAO agreed on a number of climate goals for international aviation. The two most significant of these were "aspirational" (i.e., non-binding) goals for improving fuel efficiency 2% per year to 2050, and for stabilizing international aviation's carbon dioxide emissions by the year 2020. The organization also agreed that members would explore the use of market-based measures (MBM) to achieve the stabilization goal. In June 2013, the stabilization goal took a step forward when the International Air Transport Association (IATA) explicitly urged ICAO member states to develop, for adoption by 2016, a single "mandatory" global carbon offsetting scheme as a means of helping operationalize the goal of carbon-neutral growth from 2020 (CNG2020).[3] The spotlight is now on ICAO to deliver the mechanisms to achieve this goal. Further decisions taken at ICAO's 38th Assembly in September this year will play a key role.

This paper assesses potential implications for the international aviation sector of achieving the CNG2020 goal. Specifically it addresses the following questions:

- What is the anticipated size of the emissions gap to be covered by a single global market-based mechanism?
- Where might carbon units come from to offset this gap?
- How much might this cost?
- What are the potential policy implications?

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[1] See Kyoto Protocol on Climate Change (1997) at Article 2.2; and see "A New Flightplan: Getting Climate Measures for Aviation off the Ground," Transport & Environment, Environmental Defense Fund, The International Council on Clean Transportation and the Aviation Environment Federation (2012), text available at http://www.transportenvironment.org/sites/te/files/media/Aviation%20Conference%20Background%20Report.pdf; see also H. Miller, "Civil Aircraft Emissions and International Treaty Law," 63 J. of Air and Commerce 698 (1998).

[2] Halving its emissions by 2050: aviation brings its targets to Copenhagen, http://www.iata.org/pressroom/pr/Pages/2009-12-08-01.aspx

[3] IATA Resolution on the Implementation of the Aviation 'CNG2020' Strategy (3 June 2013), http://www.iata.org/pressroom/pr/Documents/agm69-resolution-cng2020.pdf

2. SIZE OF THE GAP

Any estimate of the size of the emissions gap to be covered by a single offsetting program first requires a projection of international aviation emissions. This in turn depends on a number of factors including: growth in demand for international air travel, the number and type of planes that will be used to meet this demand, technical improvements in the fuel efficiency of new planes, fleet replacement phasing, improvements to air traffic management systems, and changes to the fuel mix, such as the use of biofuels.

Given the uncertainty over these influences, there is a wide range of estimates for emissions to the year 2050. One comprehensive analysis from Manchester Metropolitan University estimates that the cumulative shortfall in emissions for carbon-neutral growth between 2020 and 2050 will be between 6bn tonnes and 17bn tonnes. As shown in Table 1, with modest assumptions on underlying improvements in emission reduction measures, the range is 10bnt to 17bnt, but with more optimistic assumptions the gap is down, at 6bnt to 11bnt. Under a moderate or "central" scenario for growth, the range is 8bnt to 14bnt. A key uncertainty in these figures is the extent to which ICAO's goal of a 2% per annum efficiency improvement is achieved.

Table 1: Estimates of the size of the gap for carbon-neutral growth for international civil aviation, 2020-50 ($MtCO_2$)

Growth scenario:	Low	Central	High
Business as usual	10,080	13,630	17,583
Maximum mitigation potential	6,031	7,954	10,817
Midpoint	**8,056**	**10,792**	**14,200**

Source: Lee D.S., L. L. Lim and B. Owen (2013), "Bridging the aviation CO2 emissions gap: why emissions trading is needed", Dalton Research Institute, Dept. of Environmental And Geographical Sciences, Manchester Metropolitan University, Manchester, UK.

3. SOURCES OF CARBON UNITS TO OFFSET THE GAP

From a macro perspective, the global aviation sector currently accounts for about 2% of world CO_2 emissions, and the growth expected in air travel from 2020 under some scenarios would be enough to double this figure by around 2040.[4] The international aviation component is about two thirds of the world total when domestic operation emissions are excluded. Offsetting this growth however is not expected to pose a problem for the industry.

In theory, emissions could be reduced from any source outside the international aviation sector and used to offset growth in aviation emissions. There are several emissions cap-and-trade programs operating around the world, and units from these could be used to cover the demands of aviation. Other programs are under development in various countries, including Korea, China, and Australia.[5] In

[4] Extrapolated from IATA Economics, 2013, which shows global aviation emissions increasing from 677Mt in 2012 to 1011 in 2030.

[5] See, e.g., http://www.ieta.org/worldscarbonmarkets.

addition, there are over 100 categories of emission-reducing projects recognized by the UN and various other independent bodies for producing carbon credits from sectors where there is no cap on emissions. These projects range from domestic and industrial energy efficiency, from renewable energy to forestry and changes in land use, and many more project types are expected to be accredited eventually. Supplying the aviation industry with carbon units to offset the industry's growth above 2020 levels thus seems eminently feasible.

Environmental integrity

Whilst it is often assumed that all carbon emission allowances or emission reduction credits are equal (i.e. "a tonne is a tonne"), in practice the environmental integrity of units of carbon can vary. In general, units of carbon with the highest environmental integrity and least administrative burden come from programs that place tough caps on a set of emitters, ensure that emissions are accurately reported and have in place strong penalties for non-compliance. Examples of such schemes are the EU and California trading programs.

Units of carbon for which environmental integrity is subject to question and/or involve a greater administrative burden, usually come from programs that lack a cap on emissions. These programs allow entities to earn credits if they reduce emissions below what would have otherwise occurred in the absence of a particular emission reduction project. Proving the environmental integrity of such units is difficult. Regulators, for example, must define baselines to determine whether an emission reduction would not have occurred without the project, and account for "leakage" (i.e. a project in one place may cause emissions to increase elsewhere). These issues have led regulators to restrict the use of such credits in terms of their quantity and the type of projects from which credits can be generated.[6]

The following section looks, in theoretical terms, at potential sources of offset supply if all credit types were available to the international aviation industry. However, maximizing environmental integrity is one of industry's three central criteria for the construction of any offset mechanism.[7] So, while the analysis below examines what might be available in theory, a set of quality and eligibility requirements for credits will need to be adopted so that industry can know what units can be used in an ICAO-based offsetting scheme.

Potential sources of supply

There are four main potential sources of supply that could be used to provide emissions units to meet the aviation industry's emission goals:

1. Emission allowances from national or regional cap and trade programs.
2. Emission allowances created under the Kyoto Protocol at the national level.

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[6] For example, the EU ETS has a maximum import quota of around 11% of allocated emissions over the period 2008 to 2012, and has restricted the use of carbon offsets from projects that destroy certain industrial gases with high global warming potentials (HFCs).

[7] IATA's other criteria are minimizing competitive distortion and administrative complexity. See http://www.iata.org/pressroom/pr/Documents/agm69-resolution-cng2020.pdf

3. Credits from UN registered emission reduction projects.
4. Credits from voluntary offset projects.

There are questions of whether, and to what extent, these sources could be genuinely counted as "supply," given that some were developed in the absence of an emissions cap, and that some are subject to uncertainties about the future regulatory framework under which they might be accepted. The currently available supply sources, and a review of their likely eligibility for an aviation-based cap-and-trade scheme, are summarized below.

1. Emissions allowances from national or regional cap-and-trade programs

Programs currently underway that place caps on total emissions include the European Union's emissions trading system (EU ETS), the New Zealand national cap-and-trade program, the US state of California's cap-and-trade program and the Canadian province of Quebec's provincial program.

The EU ETS is the largest system in operation, and it currently has a large surplus of allowances that could potentially be used by the aviation industry. The EU ETS took effect in 2005, and its current target caps emissions so as to contribute towards the EU's overall goal of a 20% reduction relative to 1990 by the year 2020 and beyond. The EU ETS places caps on greenhouse gas emissions (mostly CO_2 but also N_2O and PFCs) on more than 11,000 power generating and industrial facilities in the 27 countries of the EU, the three EEA-EFTA states (Iceland, Liechtenstein and Norway), and Croatia, which joined the Union this month. In 2012, an expansion of the system took effect covering emissions from aircraft flying domestically within the EU as well as emissions from aircraft flying internationally into and out of EU airports, although in 2012 the EU stopped the clock for one year on the system's coverage of the international flights. In total, the system covers about 50% of EU CO_2 emissions. This ETS, combined with other policies and the economic downturn in Europe, has resulted in emissions being substantially below the cap for the last five years.[8] As a result there is a substantial "bank" of unused allowances.

Analysis by Bloomberg New Energy Finance (BNEF) indicates that withdrawals from the "bank" may begin in 2018, but will still leave a potential pool of banked allowances of about 1.7bnt by the year 2020. These volumes would be available to aviation sector buyers if the EU ETS allowances were deemed eligible in any future aviation MBM. Similarly, allowance volumes from the New Zealand, California, and Quebec programs might also be deemed eligible in any future aviation MBM.

In addition to these systems, a number of countries are currently developing legislation to support new cap-and-trade programs and are conducting pilot initiatives, the allowances from which could provide further supply to an aviation MBM. China for example, recently launched the first of seven pilot emissions trading programs, and South Korea is consulting on design options for its proposed system. Other countries currently considering cap-and-trade programs include Mexico, Kazakhstan, South Africa and Brazil. While it is difficult to estimate the potential of these programs, estimates are

[8] See "The European Union Emissions Trading System: Results and Lessons Learned," Environmental Defense Fund (2012), text available at http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

that one operating in the Brazilian State of Acre will reduce emissions by as much as 164mt during the period 2006-20.[9]

2. Emissions allowances created under the Kyoto Protocol at the national level

The Kyoto Protocol was established under the auspices of the UN Framework Convention on Climate Change (UNFCCC) in 1997. It imposes internationally binding greenhouse gas emission limits on 35-plus industrialized countries for the period 2008 to 2012. Although the US did not participate in the agreement, and Canada withdrew, the targets were accepted by the EU, Japan, New Zealand, Australia, Russia and the Ukraine, among others.

Provisions in the Protocol (i.e. Article 17) establish emissions trading as a primary flexibility mechanism for participating nations, permitting allowances from one industrialized economy to be transferred to another if the countries so choose. The Protocol also allows trading in emission units earned by projects in industrialized countries that reduce emissions, and by projects outside the industrialized countries providing they reduce emissions below some baseline level of emissions.

Many Kyoto Protocol countries have met their targets through a range of domestic measures and trading. Some countries, for which emissions dropped well below their target levels as a result of economic restructuring in the early 1990s, have banked or saved large stocks of allowances. BNEF figures show that Russia has the largest bank of allowances, at 8.8bnt, followed by Ukraine at 2.8bnt, Poland at 0.89bnt, and Romania at 0.78bnt. Other EU countries collectively account for around 1.4bnt of banked allowances. In total, the Kyoto Parties currently hold around 14bnt of banked allowances.

Whether the existing Kyoto allowances will come into future emission trading schemes in a practical sense, is still unclear. Because of this uncertainty, it is prudent to exclude these when calculating the potential supply that could be used to offset aviation emissions.[10]

One pool of Kyoto allowances which may be the exception to this general principle is those allowances that have been registered with the UNFCCC as representing emission reduction units (ERUs) from joint implementation (JI) projects that reduce emissions within the cap as described below.

3. Credits from UN registered emission reduction projects

This source of credits includes emission reductions achieved under the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI) schemes. The CDM was created to allow carbon offsets to be produced from emission-reducing projects in that have no caps on emissions under Kyoto. JI projects refer to offset projects in countries that have caps under the Kyoto Protocol. This includes the EU28, Norway, Switzerland, Australia, New Zealand, Japan, Russia and Ukraine, although the vast majority of JI credits to date have originated from Russia and Ukraine.

[9] http://www.ipam.org.br/download/livro/Subsidio-para-a-Adocao-de-meta-de-reducao-de-desmatamento-no-ambito-do-PPCD-Acre/227

[10] That said, it is important for governments to keep in mind that if jurisdictions with emissions caps under the Kyoto Protocol choose to allow emissions units from their domestic emissions trading programs to be used in an MBM for international aviation, they will need to subtract from their Kyoto allowance accounts an amount of Kyoto allowances equal to the domestic emissions units transferred to the aviation scheme.

Offsets from CDM and JI projects are calculated as the difference between the actual emissions from a project and what would have happened in the absence of the project. CDM projects produce Certified Emission Reductions (CERs) and JI projects yield Emission Reduction Units (ERUs). Projects are subject to a series of validation and verified steps before they can be approved by the UN. While questions have been raised about the environmental integrity of some CDM and JI projects and project types, CERs and ERUs can currently be used by private entities to meet part of their compliance obligations in the current EU Emissions Trading System and in the emerging Australia system. Recent amendments to the EU ETS limit, for new CDM projects, the use of these to CERs generated in least developed countries.' By mid-2013, some 6,750 CDM and 600 JI projects had been registered with the UN. BNEF calculates that together these sources are capable of issuing around 5,500Mt of offset credits between 2008 and 2020. The actual volume will depend on the prevailing price, but 1.3bnt CERs and 730mt of ERUs have already been issued.

Not all of these credits however will be available to the aviation sector. BNEF estimates that, between 2008 and 2020, companies and governments in the EU, Australia and Japan will buy around 3bnt of these credits in order to offset domestic emissions. Taking into account the fact that some types of credits are not permitted for use in the EU and Australia programs (e.g. those from certain industrial processes), this leaves a net surplus of about 2.3bnt of CERs and ERUs up to the year 2020 that could be used by the aviation sector post-2020.

4. Credits from voluntary offset projects

In addition to the compliance-driven markets of the national/regional programs and the Kyoto Protocol, there is also a small voluntary offset sector. These projects, and the offsets they create, are not accredited by the UN[11] but are subject to their own independent quality assurance processes, such as the Verified Carbon Standard, Climate Action Reserve, and the Gold Standard. However, in order to boost environmental integrity and reduce administrative complexity, some of these bodies are moving towards using UN accreditation procedures.

Voluntary credits are bought by companies or individuals on their own initiative to offset emissions, or as pre-compliance instruments with the intention that the credits will eventually be used to offset against future targets in some legally mandated scheme. As with some other emission markets, supply in the voluntary sector is currently running ahead of demand. Based on recent data from BNEF and Forest Trends[12], by the end of 2011 only about a quarter of the 280Mt of voluntary credits accumulated had actually been used to offset emissions in some way. This proportion is however increasing, and in 2011 just under 50% of verified credits had been used.

[11] This could be for a range of reasons including different project types, such as types of land use activities, or because the start dates don't exactly coincide with the requirements of the UN validation processes.

[12] Bloomberg New Energy Finance, Forest Trends, 2012, "Developing Dimension - State of the Voluntary Carbon Markets 2012".

With the supply of these credits growing at about 90Mt a year, coupled with the retirement of an increasing proportion of these credits each year, BNEF estimates that by 2020 there will be around 360Mt of surplus voluntary offsets that could potentially be used by the aviation sector.

Carbon offset summary

The above carbon offset units present a collective source of supply that, if environmental integrity concerns can be addressed, could be used to meet potential offset demand from the growth in aviation emissions. BNEF estimates that, excluding the surplus emission allowances created at the national level under the Kyoto Protocol, the remaining sources total a maximum available supply of up to 4.4bnt by the year 2020.

It is important to note that this supply is only what is likely to be left unused, based on historical and expected credit generation and compliance use in the existing UN, EU ETS, and voluntary markets. It does not include the potentially substantial new supply of carbon units that could be brought to market to meet additional demand.

4. COST CONSIDERATIONS

Based on Table 1**,** the international aviation industry could face a shortfall of between 8.0bnt and 14.2bnt of CO_2 over the 30 years from 2020 to 2050. On the basis of a central estimate of around 10bnt, the *currently identifiable* surpluses of 4.4bnt could meet between 30 and 50% of this demand. Beyond this, additional investment would be needed to reduce emissions from sources outside the international aviation sector.

Ultimately what matters is the price paid for these offsets. Today, different types of carbon allowances and credits have different prices and these are likely to change over time. Currently, allowances in the EU ETS trade at around $6/t, CERs and ERUs are less than $1/t, and voluntary offsets are about $6/t. The range in price for voluntary offsets is wide due to specific project characteristics. Across all of these offset types, prices are likely to rise over time as the surplus of banked allowances is gradually drawn down and more jurisdictions impose emissions caps.

To model costs, Environmental Defense Fund (EDF) prepared conservative estimates of offset "supply" and "demand"; the price at the intersection of those two curves would provide an estimate of the potential cost outlay of airlines. EDF's demand curve assumes that aviation will grow according to the central scenario, rather than the high or low forecasts, and will reduce emissions by a central amount via technology, operations, infrastructure, and alternative fuels (Table 1). Two scenarios are created for the emission reduction requirements for existing and newly formed cap-and-trade programs outside the aviation sector: Scenario 1 assumes these programs require a 50% cut in emissions by 2050 and Scenario 2 a 25% cut. It is also assumed that these programs will limit the use of offsets to some extent and that offsets used in the aviation sector must meet strict environmental integrity criteria. The resulting modeled offset prices for international aviation are shown in Table 2.

Table 2: International civil aviation CNG2020 - unit costs of offsets ($/tCO2, real USD 2010)

	2015	2020	2025	2030	2035	2040	2045	2050
Scenario 1	6	8	10	12	16	20	26	33
Scenario 2	4	6	7	9	12	15	19	25

Source: EDF.

The analysis shows the unit cost of offsets increasing from about $4-6/t in 2015 to around $25-33/t in real terms by the year 2050. Taking the range of shortfall of 8 to 14bnt over this period, the annualized cost of carbon-neutral growth (presented in 2015 prices) through to 2050 would be between $2.4bn and $4.6bn per year under Scenario 1, and $1.8bn to $3.5bn per year under Scenario 2. These figures assume a real discount rate of 5%.

To put this in context, the global aviation industry had sales of around $680bn in 2012.[13] Of this, around 60% is likely to be from international flights, so international revenues in 2012 would be some $408bn. Assuming airline revenue grows broadly in line with emissions, international airline revenue in 2035 - the mid-point to 2050 - would be expected to be around $1.2 trillion in today's prices.[14] The annualized costs of the offsetting scheme of around $5bn over the period would therefore represent less than 0.5% of international aviation revenue.

Stated differently, global airlines collected $27bn in 2012 for checked bags, extra legroom, and snacks.[15] Assuming the same split in revenue between international and domestic travel of 60%, the cost of carbon-neutral growth to the international sector over the period 2020 to 2050 in real terms, would be roughly a quarter to a third of what the airlines bring in solely from charging for these perks.

These costs are clearly small, to the point of being trivial compared to other costs of running airlines. The net effect on the airlines themselves however, will be even less as these additional costs will most likely be covered through higher ticket prices. At the margin, some passengers may be put off by the increase in fares but this effect will be slight. Analysis conducted for IATA in 2007 showed that demand for international air travel when taken as a whole is unresponsive to changes in price.[16] When factors affect all routes globally prices can be increased with little impact on passenger numbers. The net effect on the finance of airlines would therefore only be a small fraction of gross costs described above.

As a broad indication though a simple calculation suggests that on the basis of the carbon prices shown in Table 2, CNG2020 would add between $1.5 and $2 to the price of a one way fare from Paris Charles de Gaulle to New York JFK in 2030, and between $10 and $20 in 2050 in real terms. These

[13] Source: IATA Financial Forecast, June 2013

[14] Emissions growth to 2035 taken from Lee et al central growth scenario (S2 upper scenario)

[15] http://www.cleveland.com/business/index.ssf/2013/06/airlines_worldwide_collected_271_billion_in_2012_for_checked_bags_extra_legroom_seats_and_other_perks.html

[16] Intervistas Consulting, December 2007, *A report for IATA – estimating air travel demand elasticities*. In this report price elasticities of -0.5 are assumed for long haul travel, ie a 10% increase in fares would lead to a 5% reduction in demand.

estimates assume that the cost to the aviation industry of offsetting the global emissions growth beyond 2020 is spread evenly across all routes, existing and new. In practice the distributional effects will depend on how the allocation process is designed but the assumption is reasonable for the purposes of illustrating of the scale of additional costs for a typical route.

By comparison a ticket bought today for a direct journey in 3 months' time on the CDG-JFK route would cost around $1,000 return ($500 each way). Assuming no change in the underlying costs of flying this route, the costs of the CNG2020 in today's prices would therefore represent an increase of between 0.3% and 0.4% on the ticket price in 2030 and between 2% and 4% in 2050.

5. CONCLUSIONS

The goal of carbon-neutral growth for the international aviation industry, beginning in 2020, is certainly achievable. There are already large banks of carbon units available, and, based on current projections, by the year 2020 these sources could provide between 30% and 50% of the aviation industry's carbon offset requirements for the 30 years up to 2050.

Prices of these carbon offsets are currently low, and although they will rise over time, they will remain significantly below the cost of reducing emissions internally within the aviation sector (i.e. over and above efficiency improvements expected as part of business as usual). Even accounting for an increase in offset prices, the net cost to the aviation sector of achieving CNG2020 will be trivial. The international aviation industry should therefore have few concerns about the implications of CNG2020.

Moreover, with relatively low costs and the ability easily to pass through these costs to consumers, the international aviation industry should consider moving beyond its current goals towards those that are better aligned with the world's long-term climate goals. This would for example see significant absolute emission reductions by 2050 – potentially in line with the industry's aspirational goal of a 50% reduction by 2050[17] - rather than mere stabilization at 2020 levels.

[17] Halving its emissions by 2050: Aviation brings its targets to Copenhagen, http://www.iata.org/pressroom/pr/Pages/2009-12-08-01.aspx

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