Journal of Air Transport Management 63 (2017) 71–83

Contents lists available at ScienceDirect

Journal of Air Transport Management

journal homepage: www.elsevier.com/locate/jairtraman

What role for offsetting aviation greenhouse gas emissions in a deep-cut carbon world?

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A R T I C L E I N F O

Article history:
Received 29 June 2016
Received in revised form
29 May 2017
Accepted 29 May 2017

Keywords:
Carbon offset
Emissions pathway
Carbon budget
Atmospheric carbon dioxide concentrations
Airlines
Targets

A B S T R A C T

The long-term goal of containing average warming below the 2 °C limit requires deep cuts in emissions from all sectors. The fast growing global aviation industry has committed to reduce carbon emissions. Carbon offsetting is an integral element of the sector's strategy. Already, airlines offer voluntary carbon offsetting to those customers who wish to mitigate the impact of their travel. To ensure carbon offsetting can make a meaningful and credible contribution, this paper first discusses the science behind ‘carbon offsetting’, followed by the associated policy perspective. Then, against the context of different aviation emissions pathways, the paper provides empirical evidence of current airline practices in relation to offsetting mechanisms and communication. Building on these insights, the challenges of reducing aviation emissions and using carbon credits to compensate for ongoing growth are discussed. The paper concludes by proposing five principles of best practice for carbon offsetting that airlines can use as a basis to develop credible emissions strategies, and that could inform the sectoral framework currently being developed by leading aviation organisations.

1. Introduction

The “Paris Agreement”, the key outcome of the 21st meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), sets out an ambitious emissions reduction path. The long-term goal of containing average warming well below the 2°C limit demands substantial reductions in anthropogenic greenhouse gases (GHG) by mid-Century. The IPCC (2013) estimated a range of global carbon budgets (i.e., the maximum permissible total GHG emissions) for the period 2011–2100 consistent with this global warming goal. Including estimates of 2012–2016 emissions (Global Carbon Project, 2015), the global budget to have greater than 66% probability of limiting warming to below 2° as of 2016 is around 840 Gt carbon dioxide (CO_2). Current annual global emissions are more than 36 Gt CO_2, which leaves only 24 years of emissions, assuming emissions do not increase post-2016. Given these tight scientific estimates, state Parties agreed to aim to reach global peaking of GHG emissions as soon as possible, and to undertake rapid reductions thereafter, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHG in the second half of this century (UNFCCC, 2015).

Sixty-two percent of aviation emissions are in international air space, and as a result they are currently not attributable to the national GHG accounts of any given state (Cames et al., 2015). Thus, international aviation is not covered under the Paris Agreement. Since the industry's emissions are significant in the order of at least 2–3% of global emissions (Global Carbon Project, 2015), a global aviation mitigation scheme is essential. A suite of measures are being explored to reduce emissions (Cames et al., 2015; Peeters et al., 2016; Schäfer et al., 2015), and considerable progress has been made in increasing fuel efficiency of aircraft. The improvement rate in fuel burn had been estimated to be around 55% between 1960 and 1979 (Peeters et al., 2005). Slightly more conservatively, and based on data from 26,331 aircraft, Rutherford and Zeinali (2009) estimated that efficiency increases in fuel burn were about 51% between 1960 and 2008.

The key challenge of aviation is less the exact levels of efficiency gains, but the continuous growth in demand. Over the last 20 years, aircraft capacity measured in available seat-kilometres has grown by more than 25%, and demand is forecast to continue to grow at around 5% per annum (Cames et al., 2015). The global fleet is

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http://dx.doi.org/10.1016/j.jairtraman.2017.05.009
0969-6997/

expected to grow by 20,930 airplanes to reach about 40,000 in 2032 (Peeters et al., 2016). Considering both growth and efficiency gains, it has been estimated that fuel demand from aviation will increase by between 1.9% (Chèze et al., 2011) and 2.6% (IEA, 2012) per annum until 2025. Projected growth in the aviation industry, in the absence of additional, significant mitigation action, could see its share of global CO_2 emissions increase to 22% by 2050 (Cames et al., 2015). Whilst the most effective measure of reducing aviation emissions is to decrease growth, this does not feature in the 'basket of measures' (ICAO, 2017, p. 1) promoted by the industry. Reducing travel also seems unlikely from a consumer perspective (Becken and Bobes, 2016).

The global travel and tourism sector is pursuing substantial global growth, and at the same time has to respond to the ambitious global emission contraction pathway outlined in the Paris Agreement. Several sector agreements are noteworthy (even though they still fall short of the Paris Agreement targets). IEA, 2016, the World Travel and Tourism Council reiterated its 2009 target of halving sector emissions by 2035, relative to 2005, and flagged that these will have to be revised following the Paris Climate Summit (WTTC, 2016). Similarly, the 2007 four-pillar strategy by the International Air Transport Association (IATA, 2009) adopted a set of steps and targets. A constraint on aviation CO_2 emissions from 2020 ("carbon-neutral growth") was to be followed by a reduction in emissions of 50% by 2050, relative to 2005 levels. This was going to be achieved by, among others, an average improvement in fuel efficiency of 1.5% per year, the use of market-based instruments and biofuels.

Most recently in September 2016, in its 38th Assembly the International Civil Aviation Organisation (ICAO) agreed on the principles of a Market-Based-Mechanism (MBM); the Carbon Offset and Reduction Scheme for International Aviation (CORSIA). The idea of CORSIA is to complement measures of efficiency and biofuels, essentially by purchasing carbon credits to achieve the agreed goal of "carbon-neutral growth" from 2020 onwards (ICAO, 2017). Details on emission measurement, the types of carbon credits that are eligible, and how the aviation scheme is linked into national Governments and global frameworks are currently being worked on.

The aviation industry is cognizant that given limits to improving fuel efficiency (Peeters et al., 2016) and the social licence evident in support of international travel particularly for tourism and trade, their mitigation targets can only be achieved through schemes that provide for the purchase of carbon credits such that GHG emissions are reduced elsewhere but the benefits accredited to aviation. Already, some airlines are participating in carbon markets, for example in the European Union and New Zealand where Emissions Trading Schemes are in place. In addition, airlines engage in voluntary carbon offsetting, either at the corporate level or by offering offsetting opportunities to their customers. However, substantial progress has been hampered by different national-level policy environments, inconsistent approaches to measuring and reporting emissions, lack of commitment and uncertainty around consumer demand for more sustainable aviation.

Regardless, amongst existing initiatives, carbon offsetting plays a major role, with IATA (2016b) suggesting that "*carbon offsetting is simply a way for individuals or organizations, in this case airline passengers and corporate customers, to 'neutralize' their proportion of an aircraft's carbon emissions on a particular journey by investing in carbon reduction projects*." Definitions for carbon offsetting differ, and may use the terms 'compensating' or 'neutralising' emissions, referring to "*an activity that prevents, reduces or removes greenhouse gas emissions from being released into the atmosphere to compensate for emissions occurring elsewhere*" (Carbon Neutral, 2016). Whilst credible programs discuss the need for permanent and additional reductions, the language around whether emissions are avoided, reduced or removed is loose (Ecobusiness, 2016).

The scientific basis to carbon offsetting is often misunderstood, leading to the potential for perverse outcomes, including a failure of projects to reduce atmospheric concentrations of GHG, the primary purpose of mitigation activities (Mackey et al., 2013). Given the projected increase in air travel, we can anticipate a likely increase in uptake of offsetting for air travel. It is important, therefore, to clarify the issues surrounding offsets so that the sector, their customers, and the international community, can all be confident in what is or is not being achieved in terms of addressing the deep emission cuts needed to meet the Paris Agreement targets. This paper has three objectives: First, to discuss the science behind 'carbon offsetting'. Second, to assess future aviation emission pathways in order to clarify the depth of the aviation emission challenge. Third, to provide empirical evidence of how offsetting is currently offered by airlines, including ways it is communicated, level of detail provided, and offset projects supported. We conclude by discussing points of contention, and provide good practice principles that can assist in making appropriate use of carbon offsetting schemes in ways that are consistent with the best available science.

2. Carbon offsetting perspectives

The key to assessing the aviation sector's carbon offsetting schemes is to appreciate the difference between scientific and policy perspectives. The former is based on the accumulated knowledge from research published in peer reviewed journal articles. The state of knowledge is evaluated and synthesised every seven years by the Intergovernmental Panel on Climate Change (IPCC), which is the primary source of scientific information used to inform state parties under the UNFCCC. The policy perspective, on the other hand, reflects the norms of international negotiations under the United Nations treaty system, the inevitable tensions that arise among the state parties between national self-interest and international cooperation, and their resolution through bargaining and deal-making (Depledge, 2013), together with how these in turn influence national policies and private sector responses.

2.1. The scientific perspective

The benefits and limitations of carbon offsetting schemes can only be understood in the context of the global carbon cycle and the major stocks, flows, and natural processes which regulate, among other things, the atmospheric concentration of CO_2. Carbon is stored in four major stocks: the atmosphere (as a gas); the ocean (mainly dissolved carbonate ions); terrestrial ecosystems (especially forest biomass carbon and soil carbon); and fossil fuel in the geosphere (oil, coal and gas). Carbon naturally flows between the land and the atmosphere, and the ocean and the atmosphere. However, fossil fuel stocks do not naturally de-gas into the atmosphere in the absence of humans burning them for energy. Furthermore, the natural exchange of carbon between the land and the atmosphere is being greatly accelerated by the release of CO_2 from deforestation and degradation. We therefore have two sources of anthropogenic CO_2 emissions: (1) burning fossil fuel stocks and (2) depleting biomass carbon stocks.

Of the 36 Gt CO_2 emitted into the atmosphere globally from human sources in 2015, around 90%[1] were from fossil fuel and cement production, while 10% came from the land sector (Global Carbon Budget, see Le Quéré et al., 2016). Land carbon emissions, however, account for about 36% of the anthropogenic CO_2 emitted

[1] Coal burning was responsible for 41% of total emissions, oil 34%, gas 19%, cement 6%, and gas flaring 1%.