WHY DEMAND MANAGEMENT IS NECESSARY IF AVIATION IS TO ACHIEVE THE PARIS AGREEMENT EMISSIONS REDUCTION IMPERATIVES….. AND HOW TO GO ABOUT IT

Chris Lyle 2023

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There is increasing evidence that aviation emissions mitigation measures, as presently propounded, will be substantially inadequate to achieve the sector's requisite contribution to the Paris Agreement targets and that demand management needs to be added to the mitigation package - at an early date. This commentary accounts for the necessity of fiscal instruments or capacity constraints and is aimed at provoking thought and research on ways forward.

Current emissions mitigation measures

The scientific consensus is that aviation's global CO2 emissions would have to peak by 2025, be reduced by 2030 to about half of 2019 levels and by 2050 to zero (not any "net" zero which includes out-of-sector carbon offsetting, capture and storage). As discussed below many airline and regulatory authorities have an "aspirational" goal of "net zero" CO2 in 2050 but with limited attention to intermediate targets (the European Union being an exception, with binding requirements for meeting both short- and long-term targets).

With the exception of application of the EU *Emissions Trading System* within Europe from 2025, there is yet to be any substantive action regarding aviation's non-CO2 emissions and contrails, despite increasing - if not yet entirely definitive - evidence that these also contribute to climate change, possibly even to a greater extent than CO2 (see for example Definitions and implications of climate-neutral aviation | Nature Climate Change and The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018 - ScienceDirect).

Drawing board concepts such as open rotor engines and blended wing body and truss braced wing aircraft may ultimately contribute significant reductions, but the key for all aircraft to reduce emissions will be changes in the power source away from fossil fuels. In this regard there are now numerous projects on the table or under development. However, with the exception of electric (battery and fuel cell) for smaller aircraft at short- to medium-haul, none of these is expected to have a significant impact at the global level before mid-century. In the meantime, aircraft with current technology and a long lifespan (beyond 2050) continue to be brought into the market.

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Thus, towards achieving "net zero" commitments industry and governments are relying heavily, particularly in the short to medium term, on measures external to the air transport sector rather than emissions reduction directly by air carriers: essentially carbon offsetting and/or emissions trading. In the longer term the in-sector contribution of Sustainable Aviation Fuels (SAF) and another external measure, carbon capture and storage, are expected to play the substantial role.

In its most ambitious of three scenarios, an ICAO report for international aviation in 2022 (REPORT ON THE FEASIBILITY OF A LONG-TERM ASPIRATIONAL GOAL_en.pdf (icao.int)) showed a CO2 emissions reduction through in-sector measures for 2050 over 2019 of 87%, broken down into 21% from aircraft technologies, 11% from operations and 55% from fuels. The report did not cover out-of-sector measures such as carbon offsetting and even in this most ambitious scenario, residual CO2 emissions were anticipated to reach approximately 200 MtCO2 in 2050 (a third of the 2019 CO2 emissions level). The report did not consider cryogenic hydrogen to be a factor prior to 2050. At its subsequent Assembly last year, ICAO adopted a global "Long Term Aspirational Goal" of "net zero carbon emissions" for 2050, with heavy reliance on SAF and the Organization's *Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*; but intermediate targets will only be set at its next Assembly in 2025 - the year of necessary CO2 peaking.

For the consensual long term target date of 2050 industry body IATA produced estimates from emissions abatement measures in 2021 in a *FlyNetZero* programme (IATA - Fly Net Zero) and elaborated on these in June 2023 in a series of *Net Zero Roadmaps* (IATA - Net Zero Roadmaps). Currently these suggest global emissions abatement in 2050 of 62% from Sustainable Aviation Fuels, 25% from carbon capture and offsetting (19% in the 2021 estimates - 11% from carbon capture and 8% from offsetting), with 5% from hydrogen (down from 13% in 2021) and 8% from infrastructure and operational efficiencies (up from 3% in 2021). These estimates are acknowledged as challenging and conjectural; more revealing were intermediate targets in which carbon offsetting played the predominant part, one estimate being 93% in 2030 (along with 5% from SAF), and in particular reliance on ICAO's CORSIA.

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The ICAO and IATA goals have no binding commitments and are not aimed at emission reductions but rather at "Carbon Neutral Growth". The EU is proposing binding legislation to reduce net greenhouse gas emissions from aviation by at least 55% over 1990 by 2030 and achieve "carbon neutrality" by 2050 (ReFuelEU Aviation). Under the mandate's rules, aviation fuel suppliers must provide all flights departing from an EU airport from 2025 with fuel containing a minimum share of 2% SAF, rising to 6% in 2030 and gradually to 70% by 2050. As a market-based measure the EU prefers emissions trading to offsetting, since this has been shown to be a more effective tool for aviation but has yielded to application only of ICAO's CORSIA for flights beyond its territories.

Carbon offsetting is by no means a definitive solution. It shifts the moral responsibility for carbon reduction to someone else, the quality of offset units is heterogeneous and far from guaranteed, and studies have shown that the majority of even those of the highest standards simply do not work. CORSIA in particular will not have any practical effect for a year or two to come and international aviation emissions below 2019 levels (85% of 2019 levels from 2024) will even then continue to be churned out annually without redress. Given also a number of exempted routes, CORSIA will actually apply to less than half of international aviation CO2 emissions between now and 2035. While the first certification of SAF feedstocks (in contrast with out-of-sector offsetting) under CORSIA in June 2023 is a step in the right direction, CORSIA cannot currently be considered as a significant emissions mitigation measure.

SAF is the critical in-sector measure on which hopes are focused. The current volume contribution is very low (less than 0.1% of kerosene) and the price high (varying from some 2.5 to 6 times kerosene). SAF comes in three forms: biobased, waste-based, and synthetic e-fuels. Various biofuels have been proven to be technically viable and ICAO has set global standards for the sustainability of SAF but there remain serious questions as to their full life-cycle benefits, their impact on direct and indirect land-use change, and the potential available volume of supply of raw materials, along with considerable barriers regarding the necessary investment, pricing, and scaling up to a commercial level. Waste-based fuels are a temporary, severely volume constrained, exception. Two recent studies by the United Kingdom's Royal Society (Net zero aviation fuels: resource requirements and environmental impacts | Royal Society) and by Becken, Mackey and Lee

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(Implications of preferential access to land and clean energy for Sustainable Aviation Fuels - ScienceDirect) have cast a dark shadow over the prospects for SAF as a primary contributor to reducing aviation emissions.

An exception may be synthetic e-fuels (also known as "power-to-liquid"), which fall under the SAF umbrella and like biofuels have "drop in" capability, but they do not emit any greenhouse gas emissions at all in operation. Their cost is generally at least three times as high as that of conventional jet fuel - and likely to remain high. For the three technologies of fuel cell aircraft, gas turbine hydrogen jets and particularly e-fuels, hydrogen is a common denominator and there is already strong competition for "green" hydrogen, which requires a considerable volume of renewable energy to produce. Thus, the contribution of e-fuels is expected to be limited, at least through the mid-term (the EU's current proposal is 5% of SAF in 2030 rising to 35% by 2050).

In the light of the inadequate contribution of offsetting and SAF, along with the minimal address of non-CO2 emissions and contrails, even on a precautionary basis, it is becoming increasingly evident that additional mitigation measures need to be taken. A survey by GE Aerospace prior to the Paris Air Show this year showed that even the aviation industry itself was split on whether its net zero 2050 goal was achievable, with under half of the 325 executives surveyed believing the industry will meet its goal (GE Aerospace 2023 Industry Survey | GE Aerospace).

Amongst additional measures, demand management is coming to the fore. In its 2023 report the UK's Climate Change Committee specified its necessity, stating that "Demand management is the most effective way of reducing aviation CO2 and non-CO2 emissions", notably through airport capacity management. Some recent supporting consultancy and NGO views are A Realistic Path to Net-Zero Emissions for Commercial Aviation | Bain & Company and Paris Air Show 2023: Aircraft Sales Boom While the World Burns (safe-land ing.org).

Demand management criteria

The conundrum is to achieve a regulatory approach which addresses climate change in the context of economic and social issues - notably where they relate to tourism and trade - and also take into account the economic regulatory structure for international aviation which is primarily in the form of bilateral air services

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agreements rather than the multilateral regulatory regimes for trade and for climate change.

There are essentially two forms of demand management, fiscal measures and operations capping.

Fiscal measures

International aviation is presently favourably biased, through exemption from fuel, value added and some other taxes. Air transport is also subsidized at many airports through the "single till" approach, whereby some of the profits from non-aeronautical revenues, including duty-free sales, are set against landing charges. Proposals for change have always been heavily torpedoed by industry but should be well worth another look by regulators, with particular regard to potential hypothecation towards aviation emissions reduction.

As for application of mitigation measures directly related to the passenger, options suggested have included a global departure tax and a frequent flyer tax. The vast majority of taxpayers fly rarely or never. But, while the global contribution of aviation to climate change may be considered relatively small at present, the contribution to an individual traveler's total greenhouse gas emissions is very much higher and very often the dominant element. A frequent flyer levy could help implement a global net zero target in an equitable way. Implementation challenges exist, and other forms of such fiscal measures are also worth exploring (see TourismPanelonClimateChangeAviationReport).

Ultimately the most effective and measurably definitive form of demand management is capping or actually reducing operations. One potential scenario is discussed below. This is perhaps a rose-coloured vision from an experienced aviation long-timer, requiring a lot of due diligence on a diverse range of issues well beyond the capabilities of a single analyst, but hopefully a thought provoker towards some serious rethinking and research.

Capping or reducing growth in operations

The need for capping aviation operations is now on the radar. For example a comprehensive research report by the Travel Foundation *et al* (Envision2030_SummaryFINAL.pdf) found only one scenario for travel and tourism to achieve net zero by 2050 and that incorporates slowing the growth in aviation - including capping long-haul flights (over 3 500 km) to 2019 levels. A prime example

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of actual capping policy is the proposal by the Netherlands government to reduce the number of flights at Amsterdam's Schiphol airport (aimed primarily at noise and local air quality rather than emissions reduction *per se*). The proposal does not distinguish between aircraft types or length of haul and hence their relative emissions. A climate-based approach could be to cap not simply the number of flights but rather the volume of emissions from the first leg of departing flights. The necessary data regarding CO2 from international operations, in total and for individual routes, are now available through ICAO's Monitoring, Reporting and Verification system for CORSIA. In cases where data may be incomplete, emissions evaluated from fuel uplifted could be used as a surrogate.

Such an emissions capping approach would favour short-haul flights and smaller aircraft (the converse of application to the number of flights). As required, therefore, the capping could be divided into two or three flight groups according to distance bands, the boundaries being selected according to individual country circumstances and policy. The formula could even be tweaked to accommodate differences in aircraft size or emissions per unit (of ask or atk). As with CORSIA, exemptions could be given for flights to Least Developed Countries (LDCs), Landlocked Developing Countries (LLDCs) and Small Island Developing States (SIDS).

The procedure for application would be, as today, through the airport slot allocation process. While allocation based on emissions generated by a flight rather than simply the flight itself would add a dimension of complexity to the process, this would be well within the bounds of practicability in this era of AI.

Action could be taken nationally, with the level of capping or reduction determined in the context of other emissions mitigation measures in place for the country concerned. Leadership could be shown by one or more countries targeting peak emissions in the year 2025 in the context of current trends.

Such a national approach, if carefully designed and applicable to all carriers at an airport, would not breach the Chicago Convention or air services agreements. But it would of course be beneficial in terms of both effect and comity if a framework, notably regarding competitive impact and slot guidelines, were to be co-ordinated amongst groups of States. Getting a global agreement is almost certainly out of the question but a voluntary "bottom up" approach to commitments by individual countries should be workable (cf the Paris Agreement) and even action by a handful of States would help.

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Potential widespread application of emissions capping for departing flights at airports does raise a number of issues to consider, for example: the potential impact on connectivity; whether application would benefit foreign carriers not constrained at other airports (as has been construed for the effect of existing capacity limitations at major hubs such as LHR, LGW, FRA, and NRT); and the implications for remote destinations such as New Zealand. There is a need to break away from the aviation silo, to take into account the downstream economic and social issues - while encompassing Scope 3 emissions; and generally to tie action more closely to trade and tourism (and to responses to "overtourism" and "degrowth").

As to any consequences for the structure of air operations around the world, that would depend on which countries chose to participate and which did not. For example, potential bias towards short-haul might disproportionately restrict the availability of non-stop longer haul flights with passengers required to transfer (and generate additional emissions). Even the exemptions suggested above could have an effect; for example, Ethiopia (with the largest hub and home to the largest airline in Africa) is an LLDC and Singapore is still classified as a SIDS.

The air transport industry is committed to growth and studiously eschews any contemplation of demand management. But with inadequate contribution of other measures, capping or reducing operations is likely to become necessary sooner rather than later if the Paris Agreement targets are to be met. Early evaluation of options should help to minimise their economic and social impact. And there is evidence that, in air transport as in other sectors, this may come down to a simple issue of supply and demand - constraining capacity can increase both yield and revenues (see for example The impact of airport capacity constraints on air fares - SEO Economisch Onderzoek).

With the need for CO2 peaking now only two years away, re-evaluation of the framework of emissions mitigation measures for aviation and addressing demand management options is critical and well overdue.

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