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Flight from reality: sustainable aviation, Jet Zero, and the technofix

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ABSTRACT

This paper argues that rising aviation emissions, which are disproportionally driven by the wealthy, pose a serious threat to climate goals. Using the UK's Jet Zero strategy as a case study, it explores how policymakers and industry promote speculative technologies—efficiency gains, electric and hydrogen aircraft, sustainable aviation fuels, carbon capture, and offsetting—to justify continued aviation growth. We critically assess these claims: electric aircraft are limited to short routes; hydrogen faces major storage and infrastructure barriers, and green hydrogen remains scarce. SAFs, often derived from land-intensive crops, risk deforestation, biodiversity loss, and higher net emissions. Second generation SAFs, such as used cooking oil, are scarce, and power-to-liquid is speculative and prohibitively expensive. Carbon capture is unproven at scale, and offsetting enables airlines to claim reductions without cutting actual emissions. These "solutions" align with a political agenda that prioritises economic growth and airport expansion. We argue that this techno-optimism delays real action. Rather than gambling on future breakthroughs that may never materialise, policymakers should pursue immediate demand-reduction strategies and support a just transition—ending frequent-flyer incentives, shifting short-haul flights to rail, removing aviation fuel subsidies, and retraining workers for low-carbon sectors.

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Introduction: aviation and the climate crisis

It is no longer necessary to watch a Hollywood movie to imagine what a climate disaster might look like; glancing at the newsfeed will often suffice.[1] 2024 was the hottest year on record, and the first to exceed 1.5°C warming above pre-industrial levels. It brought catastrophic flooding to West Africa and Valencia, and drought to southern Africa. In southern California, where a perfect tinderbox had been created by extreme wet-then-dry conditions known as hydroclimatic whiplash, the start of the new year saw wildfires wreak havoc (Kolbert, 2025). 2025 also saw destructive floods in Pakistan, Colombia,

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Venezuela, northern China and Texas, while in Britain many crops failed due to drought. Climate breakdown is proceeding more quickly than previously anticipated (Hansen et al., 2025). We are, warns UN secretary-general António Guterres, on the 'highway to climate hell' (United Nations, 2024). And climate is only one among many vectors of environmental breakdown. 'Planetary boundaries' are being crossed at a rate of knots – seven out of nine at the latest count (Gayle, 2024).

Against this backdrop, the need to rapidly decarbonise could not be more pressing. Britain is currently off track to meet its target of 'net zero' by 2050 (CCC, 2024), and three quarters of its primary energy still comes from fossil fuels (Energy Institute, 2025). Nowhere is the scale of the deficiency clearer than in aviation. According to the 7th Carbon Budget of the Climate Change Committee (CCC), an advisory body to the British government, in 2023 UK aviation emissions were 69% higher than in 1990; they account for 8% of UK emissions, with international flights the principal driver of expansion (CCC, 2025, p. 222).

In this paper, we scrutinise aviation decarbonisation strategies, with Britain's Jet Zero plan as the case study. We read Jet Zero as a gamble predicated on a series of technologies and policies that are highly unlikely to achieve their goals. We assess the prospects for electric and hydrogen aviation, efficiency savings, carbon capture and storage, offsets, and sustainable aviation fuel. We then tease out the implications for policy.

Our focus is on Britain, due in part to its historic responsibility for the climate crisis. In cumulative CO_2 emissions Britain ranks eighth in the world, but if we factor in its empire (ruled from London) the position is higher, and it reflects Britain's pivotal role in the dissemination of fossil-fuel use worldwide (Evans & Rydén, 2005; Ritchie & Roser, 2020). Against this fossil-imperial backdrop, Britain's Nationally Defined Contribution (NDC) to reducing emissions falls short of an equitable share (Civil Society Equity Review, 2023; Gabbatiss, 2023). In part, too, our focus on Britain relates to its legal commitment to a target of 'net zero' by 2050, following a law passed in 2008 when Labour's Ed Miliband was Secretary of State for Energy and Climate Change. Ever since, it has positioned itself as a 'climate leader' (DESNZ & Miliband 2024). The increasing climate-impacting significance of aviation and the role the sector plays in the government's vision for making Britain 'the world's best-connected place to do business' makes its 'Jet Zero' programme an exemplary lens through which to study the friction between 'growth' and sustainability (Stewart, 2025b).

Jet Zero was set up under Boris Johnson's premiership, the declared aim being to steer the aviation industry toward 'sustainability'. With particular clarity that programme manifests the 'technological solutionism' and 'technofixes' that dominate policymaking on decarbonisation, and above all on aviation. Technofixes refer to questionable claims regarding what technology can achieve in order to reduce the pressure to address social and ecological problems in other ways. There are obvious reasons that governments succumb to this way of thinking (e.g. line of least resistance regarding potentially unpopular behavioural change) and obvious attractions for corporations in propagating it (the camouflage it offers for prioritising profits over the habitability of Earth).

Technological solutionism, similarly, recasts 'complex social situations either as neatly defined problems with definite, computable solutions or as transparent and self-evident processes that can be easily optimised (Morozov, 2013, p. 5). Examples of technological solutionism abound in UK government pronouncements and policies today, be it the

programme for 'a digital health service powered by cutting-edge technology' as a solution to an ailing NHS, or the quest to make Britain 'the world leader' in AI in order to 'turbocharge growth' (Department for Science, Innovation & Technology et al., 2025; Streeting, 2024). Jet Zero is cut from the same cloth. It seeks to sidestep politically difficult questions pertaining to the social purposes of transport, leisure and work, instead reaching for technological trump cards.

Those techno-fixes range from the unproven to the unrealistic to the downright harmful. It is important that we strip back the futurist veneer of the promises and policies of sustainable aviation, debunk the obfuscatory language deployed, and carefully scrutinise the claims made.

We submit that 'sustainable aviation' represents a reckless gamble on new technologies, some of which are unproven and many of which are likely to be unscalable. It melds flimsy promises from the aviation industry, in its attempt to pre-empt government intervention, with empty bluster from governments keen to placate a climate-concerned electorate. Ultimately, its function, if not the motivation, is to provide a smokescreen, one that lingers until the current government is out of office, leaving its successors – not to mention human society and other fauna and flora – to face the heat. In short, in Britain, as is largely the case elsewhere, techno-utopian fantasy is writing the official script. The result is a diversion of attention from the practical changes needed, which we shall summarise in the final section.

Jet Zero and aviation emissions

Consultation for Jet Zero began in July 2021 under Boris Johnson's premiership. It built upon the previous 'Net Zero Strategy' and 'Transport decarbonisation plan' to chart a course for aviation to reach net zero by 2050 (Department for Transport, 2021; HM Government, 2021a). With the aim of helping the aviation sector decarbonise, the consultation centred on a Jet Zero Council – 'a forum bringing together government, industry and academia to speed up change' (Department for Transport, 2022b, p. 4). In July 2022, the Jet Zero strategy document was published. It was constructed chiefly of assumptions and promises borrowed – naïvely, as we show below – from the aviation sector, in particular from the industry organisation Sustainable Aviation, mediated through government-industry partnership bodies (Department for Transport, 2022a, 2024a). Largely frozen out were climate scientists and the environmental groups and NGOs that seek to protect the interests of Earth and its inhabitants.

A key assumption that the Jet Zero strategy reproduces is that in its emissions calculations and scenarios CO_2 emissions are foregrounded. This risks obscuring aviation's true climate impact. As much as two-thirds of aviation's global-heating impact stems from non-CO_2 emissions and cloud formation. The actual impact of aviation on global heating may be tripled once these non-CO_2 emissions are factored in (EUASA, 2020; Lee et al., 2021). To put this in perspective, a return flight from London to New York, generating one tonne of CO_2 per passenger on average, has an actual impact equivalent to around three tonnes (Kommenda, 2019). According to the CCC (2020), three tonnes is the *total* annual level of per capita emissions to which Britain must be restricted by the mid-2030s, if the 1.5C target is to remain even possible.[2] We should also consider military aviation. Aviation makes up a third of the Ministry of Defence's (MOD) self-reported CO_2

footprint, and the MOD accounts for 50% of UK government emissions (Defence Science and Technology Laboratory, 2024).[3] If we factor in the non-CO_2 effects, military aviation alone could account for as much as a third of total UK government emissions. Military aviation emissions are forecast to rise, as Britain increases its military spending in line with the NATO-wide target of 3.5% of GDP. This target, if met, would lead to extra emissions across NATO member states estimated at 1320 million tCO_2e over the next ten years – the equivalent of the annual emissions of Brazil (Parkinson, 2025).

Rather than exercise caution in a situation where underestimating impacts will generate real effects that cannot simply be 'taken back', the government's response to the question of non-CO_2 effects has been 'wait and see'.[4] It promises to channel some funds into research in the area, while refusing to incorporate any of the existing research into its calculations on the climate impact of aviation (HM Government, 2024a). This is short-sighted and self-serving: it frames uncertainty as a reason for current lack of action and misrepresents what the 'uncertainty' is telling us. Consider by contrast the International Civil Aviation Organisation (ICAO). Although it has been widely criticised for its capture by the aviation industry (Carrington, 2025), even it takes care to point out the significant impact of non-CO2 aviation emissions on global heating. Its research shows that non-CO_2 emissions' effects increase alongside the projected growth in CO_2 emissions (Lee et al., 2023). In other words, these obscured contributions of aviation to climate breakdown will only grow in significance unless the sector's overall CO_2 emissions are reduced.

As noted in the introduction, Jet Zero's projections point to significant growth in numbers of passengers, flights and distances flown. For example, a 2020 government report projected that by 2050, passenger miles flown will be twice the 2017 figure and six times the 1990 figure (Department for Transport, 2020a). The picture is similar in Europe, with the latest figures suggesting that EU air traffic could reach more than 2.3 times the 2019 level by 2050 (T&E, 2025). Aviation, by the government's own admission, is set to comprise fully a quarter of Britain's GHG emissions by 2050, and will be the industry with the greatest carbon emissions (HM Government, 2018; Sustainable Aviation, 2020). This means that even if the proposed techno-fixes were to work as promised, in 2050 the sector could be burning as much fossil kerosene as in 2023 (T&E, 2025).

Jet Zero and its technofixes: efficiencies, batteries, hydrogen

The Jet Zero report set 2019 as the peak year for aviation CO_2 emissions, following which they would decline to 21 million tonnes (Mt) in 2050. At that point, aviation will be 'net zero' – assuming that those 21 Mt are captured and stored, or offset. Before we examine the proposals for reaching that goal, it is worth pointing out that airline emissions are *already* on track to exceed the 2019 peak (Topham, 2024). That the plan is already faltering is an early warning of its inadequacy. We predict that it will not get back on track. A key reason is that the strategy assumes that technology can be relied upon to solve the problem. This emulates the strategy of transition to electric vehicles in the road transport sector, but without the proven technologies that that sector can point to.

One prominent techno-fix is efficiency improvements. These, Jet Zero predicts, will account for a major share of aviation carbon savings by 2050. Such forecasts, however,

are based on wishful thinking; the empirical evidence leans strongly against them. According to the International Council on Clean Transport (ICCT) the real-world fuel efficiency of aircrafts – otherwise known as block fuel – increased by 1.3% per annum (pa) between 1960 and 2024 (Hameed & Rutherford, 2025; see also Kharina & Rutherford, 2015; Zheng & Rutherford, 2020). Over the same time period, the metric value[5] – which measures how efficient an aircraft is technically designed to be – increased by even less: only 1% pa.[6] Almost all of the scenarios developed by major international aviation organisations in the last few years forecast efficiency savings at less than 1% pa (IATA, 2024). The 1.4% pa efficiency gain on which Jet Zero relies, Finlay Asher, a former aircraft engine designer at Rolls Royce, told us, is 'wildly optimistic'. There are 'no large step-changes in efficiency around the corner and it takes 10–15 years to certify a significant new aircraft and engine design. So, anything we do see in 2035 – e.g. new designs entering service – will not be the predominant aircraft in service in 2050, due to the 20–30 year lifetime of aircraft'.

A deeper problem with efficiency gains are their rebound effects (York et al., 2022). Improvements reduce costs which spur demand, leading to more miles flown. According to the CCC (2020), if demand is not constrained, Britain's aviation industry will grow at an average rate of over 2% pa over the coming decades. While there are different scenarios, there is a shared expectation that numbers of passengers, flights and distances flown will grow (Leggett, 2025). Globally, the sector is set to double by 2040, with growth at an average 3.5% pa (IATA, 2023). Needless to say, Earth's systems care little that less kerosene is required per passenger if more in total is being burnt due to air travel's overall growth (Dobruszkes & Ibrahim, 2022).

Other techno-fixes look to alternative fuels. At the inception of the Jet Zero plan, Grant Shapps, the transport secretary, identified 'biofuels and electric aircraft' as a key focus (Department for Transport, 2020b). The model is similar to the electric vehicles (EVs) strategy for road transport: a 'business as usual' approach that assumes ever-growing sales, little or no demand management, and a high-stakes gamble on technology. In road transport, the strategy is fraught with problems, not least the emissions from extraction and manufacturing processes, and the capacity of renewable energy production: replacing all vehicles with EVs risks exceeding the global carbon budget (Morgan, 2020). But while decarbonising road transport is deeply problematic, it is technically feasible. Adopting a similar strategy for aviation is not simply problematic; it is, at least for the foreseeable future, delusional. Jet Zero's promotion of electric planes is exemplary in this regard. Shapps' claim that they offer 'boundless possibilities' (Department for Transport, 2019) is questionable, given the well-documented challenges they face. Due to the weight of batteries – which, unlike fuel, don't burn off as you fly and are much less energy dense – electric flights will only be viable for short journeys with few passengers (Walker, 2019). The maximum range of the tiny nine-seater prototype 'commuter plane' developed by leading firm Eviation is 460 km – about the distance from London to Newcastle (Weitering, 2024). These aircraft remain a long way from commercial operation and the past five years for the sector has been a story of delays and tempered expectations (Kaminski-Morrow, 2020; Sampson, 2025), if not outright insolvency, as in the case of German electric aerospace company Lilium (Westerheide, 2025). The industry consensus is that for flights of 1,500 km or longer – which make up 80% of aviation emissions – battery-powered flight is unfeasible (Air Transport Action Group, 2021; Pfeifer, 2019; Schwab et al., 2021).

In other words, electric planes are a substitute less for jet planes than for buses and trains: an airborne taxi service for well-heeled travellers seeking to avoid congested roads and trains.

Another technofix promoted by the Jet Zero consultation is hydrogen flight (HM Government, 2021b). Hydrogen doesn't suffer from the problematically low energy density by mass of lithium batteries, but because its energy density by volume is far lower than jet fuel it requires much bigger and heavier onboard storage tanks. Hydrogen planes would also require very extensive modifications to airport infrastructure. The source of hydrogen is another concern. Only one percent is currently 'green' – i.e. produced with renewable energy. It is over thrice the price of 'grey' hydrogen, which itself is four times as expensive as kerosene (Henderson, 2021). Grey hydrogen is produced from fossil fuels, with CO_2 released as a waste gas – around 830 million tonnes each year (Pirani, 2020). If those emissions are captured and sequestered, the hydrogen is known as 'blue'. Recent studies warn that blue hydrogen could be worse for the climate even than burning fossil gas, due to methane loss during its production plus the high energy inputs – still, typically, from fossil fuels (Howarth & Jacobson, 2021; Schlissel & Juhn, 2023).

It is also worth noting that there are corporate and geopolitical pressures behind the push for some technologies over others (Balanyá et al., 2020). In Britain, oil companies have strategically misrepresented the costs of blue hydrogen whilst asking the taxpayer for billions of pounds in subsidies (Ambrose, 2021). The myth of a green transition to hydrogen-powered aviation serves the interests of states rich in oil and gas deposits and of the fossil-fuel companies that extract them, fearful that their assets will become stranded (Noussan et al., 2021). We are not using the word 'myth' lightly. Willie Walsh, Director-General of the International Air Transport Association, admits that no long-haul hydrogen flights will be possible until 'beyond 2050' (Topham, 2021). Airbus has 'suspended' its plans to develop hydrogen-powered commercial aircraft, citing 'slower than expected developments in technology' (Hepher, 2025). Boeing, likewise, sees little potential in hydrogen-powered flight before 2050 (Raymond, 2023), and other industry experts forecast the most optimistic date for its long-haul viability as the 2050s or 2060s (Transport Select Committee, 2022). Switching to hydrogen, moreover, would require astronomical sums for investments in energy, storage and infrastructure, and could add decades to the 'net zero' transition in aviation, according to a CCC spokesperson (Hollinger, 2021). Moreover, burning hydrogen releases much more water vapour than the equivalent jet fuel, meaning it would contribute to global heating via contrails (Forster et al., 2023). In short, hydrogen is only 'green' in prohibitively expensive form, it offers no realistic alternative to kerosene in the near to medium future, and even its medium-term applications are limited to short-haul flights. Green hydrogen production may be ramping up, but often in problematic ways. European-owned green hydrogen projects in north Africa, for example, stand accused of displacing local populations and occasioning serious environmental harms, whilst siphoning off tens of millions of litres of water in areas with high levels of water insecurity. The hydrogen produced is largely exported to Europe, rather than contributing to a green transition locally. These activities, according to a recent report, reflect a broader strategy whereby Europe is externalising 'the climate costs of its energy consumption' in ways that entrench 'extractivist neocolonial structures' (Greenpeace & MENAFEM, 2025, p. 44).

Take off for economic growth?

Jet Zero was the brainchild of a Tory government whose goals for aviation dovetailed with those of the industry itself. This was tacitly acknowledged in the way in which aviation industry representatives referred to government plans. An example was the 2018 report*The Future of UK Aviation* (HM Government, 2018), in which the then aviation minister, Liz Sugg, framed the expansion of aviation as a given for future development. The Minister of Transport under Rishi Sunak went further, stating in Parliament that the sustainable aviation fuel (SAF) mandate (more on which below) 'is part of our approach to ensure that the rationing of flights through 'demand management' is ruled out' (Hansard HC Deb., 2024).

Expectations that the incoming Labour government of 2024 might take a different tack found support in the fact that its minister for Energy Security and Net Zero was (and at time of writing still is) Ed Miliband, while its prime minister, Keir Starmer, had voted against Heathrow expansion when it had been put to the Commons in 2018. Such predictions were quickly scotched, as environmental considerations found themselves trumped by the economic growth drive, centred on the expansion of energy infrastructure, IT infrastructure (such as data centres), housing, and, of course, aviation.[7] The most vocal growth booster in government, the Chancellor Rachel Reeves, explicitly stated at the 2025 World Economic Forum in Davos that in any conflict between growth and 'net zero', the latter ought to come second (Stewart, 2025a).

In relation to the Jet Zero plan, then, the new government opted for continuity. It established a Jet Zero Taskforce (Department for Transport, 2024b), formed overwhelmingly of the CEOs of aviation companies and oil companies, plus a smattering of representatives from the renewable fuels and carbon capture and storage (CCS) industries (HM Government, 2024b). And when the CCC, in its 2024 report to parliament assessing progress towards net zero, reiterated the call for a halt to all airport expansion (2024), the government doubled down on its commitment to increase aviation (HM Government, 2024a). The aviation sector responded warmly. Kenton Jarvis, CEO of easyJet, spoke for the industry as a whole when he praised Starmer's government for its 'recognition of the importance of aviation and the crucial role it plays as an enabler of economic growth'[8] (Alexander & Reeves, 2025).

Under particular scrutiny in this regard has been the decision to support airport expansion, with a third runway at Heathrow already approved, along with a huge extension to City Airport (Department for Transport, 2025b). The extra flights would be considerable, potentially increasing from 480,000 a year to 720,000 at Heathrow alone (Leggett, 2025). Plans to almost double the capacity of London Luton Airport have been approved by the Transport Secretary – notably going against the recommendations of the Planning Inspectorate, whose report found that the environmental harms of the expansion outweighed the public benefits (Planning Inspectorate, 2025). Similar plans to increase the capacity of Gatwick by over 100,000 flights per year have received backing from the Transport Secretary (Topham, 2025). Amid protests from environmentalists, and from some prominent Labour supporters such as the 'eco-entrepreneur' Dale Vince, the government insists that there is no tension between expanding the aviation sector and meeting its carbon emissions targets. For the former Secretary of State for Business and Trade, Jonathan Reynolds – who, with Reeves, voted in favour of Heathrow expansion in 2018

– airport expansion and decarbonisation 'go hand in hand' ('Today', 2025). But how exactly might this work? Reeves provided the answer. When pressed on why Starmer had completed a U-turn on airport expansion, she invoked the rapid development of sustainable aviation fuels. SAF, she claimed, has become a 'game-changer' in the expansion debate – a technological ticket to guilt-free flying (Georgiadis & Pickard, 2025).

The government's message, in short, is that a contradiction no longer exists between its commitments to economic growth and environmental sustainability. A growing aviation industry is compatible with the 'net zero' mission, thanks to efficiency gains and technological breakthroughs – in particular in SAFs.

The HEFAlump in the room

That government spokespeople such as Reeves extol SAF as the elixir of sustainable aviation comes as no surprise. As the prospects for electric and hydrogen-fuelled aviation have experienced a series of setbacks in the early 2020s, SAFs have returned to the forefront of debates around decarbonising aviation. On 1 January 2025, the government's SAF mandate came into force which requires flights to be fuelled by two percent SAF, rising to ten percent in 2030 and twenty-two percent in 2040 (Department for Transport, 2024c). The mandate also includes a revenue certainty mechanism for producers, but this is yet to be implemented (Department for Transport, 2023). Despite being hailed a 'game-changer' by the Chancellor, there are considerable doubts around the sustainability, scalability and efficacy of SAF as an alternative to kerosene. After examining these issues in detail, it will become clear why this central pillar of the plan for sustainable aviation is so flimsy.

First of all, SAF is not 'green' in the way one might think. Burning it produces a similar amount of CO_2 to kerosene. It is primarily in its production that the GHG savings are factored in. This green arithmetic should be carefully considered on a case-by-case basis, as SAFs have the potential, especially when land use is changed to produce crops for biofuel, to actually *increase* the net GHG emissions, thereby contributing more to global warming than burning fossil fuels (EUASA, 2025). The UK government defines three types of SAF. The first is called HEFA (hydroprocessed esters and fatty acids) – this is fuel made from animal fats and vegetable oils. The second is non-HEFA biofuels which can be produced from Municipal Solid Waste (MSW), alcohol from food crops ('Alcohol to Jet' (AtJ)), and from non-food crops, woody crops, and forestry and agricultural waste – this latter group is 'second-generation biomass'. The third is power-to-liquid synthetic electrofuel (PtL), which is generated using captured carbon and hydrogen (BP, 2023; Department for Transport, 2024c). Of the three, HEFA is the most established and by far the cheapest of the three methods. However, it has some major downsides, as we shall see, which explains the government's decision to include a steadily increasing cap on HEFA fuels in its SAF mandate.

The best-known HEFA-using aviation entrepreneur is Richard Branson. In the mid-2000s he arranged for coconut oil to part-fuel a flight from London Heathrow to Amsterdam. The event garnered a burst of media attention, but the sustainability implications were troubling. To have fuelled that short hop with 100 percent coconut oil would have required three million coconuts (Dale, 2008). The entire global crop would supply Heathrow for only a few weeks – and it is one of 18,000 commercial airports worldwide. Following this stunt, coconut oil was never used in a Virgin flight again. The Virgin flight

drew attention to intrinsic problems of using HEFA. Energy crops such as palm oil or coconuts are not sustainable in any reasonable definition of the term. For energy production they're a sub-par use of land: solar panels convert solar energy for human-use much more efficiently. In competing with agricultural crops, their downsides are legion (DeCicco, 2016). They contribute to GHG emissions from land-use change, and to land-ownership concentration; they cause food price rises, food insecurity, deforestation, peat burning, water shortages, and biodiversity loss. To give but one example, in 2019 alone, the palm oil suppliers to Neste, the world's largest biofuel producer, were accused of deforesting at least 10,000 hectares and setting 13,000 forest fires (Milieu Defensie, 2020). The scale of the potential demand is radically incommensurable with the availability of land to produce biofuel. If 100% of global jet fuel in 2050 were to be produced from SAFs derived from seeds and oilseeds, it would require a staggering two billion acres to grow – five times the cropland area of the United States (Qualman, 2024).

Biofuel crops produce GHG emissions in other ways too (Dale, 2007). Their inputs include large quantities of energy and fertilisers, a major source of nitrous oxide, as well as hydrogen – largely from fossil gas – for the hydrotreatment of oil (Hughes, 2021). Biomass from plantation-grown trees is seen by many in the aviation industry as the new cornucopia, but it suffers from all the same drawbacks. Branson's proposed solution after the coconut debacle was to pivot to algae, a solution which attracted sizable investment from major oil companies eager to give their polluting activities a green veneer. As a water-based crop, algae appealed in part because it was seen as a way to circumvent the issue of land use change. In 2008 we predicted that algae would not be a viable option (Dale, 2008), a forecast that was confirmed a decade and a half later when ExxonMobil was the final fossil-fuel investor to abandon the project (Westervelt, 2023).

Used cooking oil: flying on fumes and fraud

Britain's government is well aware of the significant limitations of HEFA-based biofuels.[9] This is reflected in its decision to impose a cap on HEFA-derived sustainable aviation fuel (SAF), which is set to fall from 71% in 2030 to just 35% by 2040. It has also ruled out fuel made from food, feed, or energy crops as eligible for designation as SAF (Department for Transport, 2024c). Yet even with these measures, the government's consistently optimistic projections for new technologies fall short of what is needed to meet the SAF mandate. At present, Britain has only one operational SAF facility: the Phillips 66 Humber refinery (USDA, 2025).

This helps explain why, as of 2023, a staggering 97% of the UK's SAF supply came from used cooking oil (UCO). Only 8% of this originated domestically (due to its limited total supply), with the bulk imported from Malaysia and China (Purvis, 2025). China, the world's largest UCO producer, is already struggling to meet demand from Europe and the US, while Malaysia has reportedly exported more 'used' cooking oil than it actually produces (Goulding Carroll, 2022). These discrepancies have raised serious concerns about virgin vegetable oil being fraudulently mixed into the UCO supply (T&E, 2024). If confirmed, some UCO-derived SAF is in significant respects more damaging even than kerosene, especially where palm oil plantations – linked to deforestation – are used to meet the demand.[10] Importantly, even where UCO is authentic (i.e. verified waste

rather than virgin oil), it is not only a finite waste resource, for which demand is already outstripping supply, but its environmental cost remains high as it displaces use from other, arguably more important, sectors such as domestic biodiesel and animal feed – which in turn further drives deforestation (T&E, 2021b).[11]

For sustainable fuel, attention has consequently shifted to other sources. One is CO_2 extracted from the air by Direct Air Capture technologies and converted into SAF, also called Power to Liquid (PtL) (Keith et al., 2018). This may offer potential in the distant future but currently is far too expensive at £94.50/gigajoule (GJ), compared with the £16/GJ it costs to refine jet fuel from crude oil (IEA, 2023b). The process is also extremely energy intensive. It would take 468–660 terawatt-hours (TWh) of energy to replace the 'UK's fossil jet fuel consumption'(The Royal Society, 2023). To put that into perspective, in 2023 Britain's total electricity consumption was 266 TWh (Statista, 2025).

Other sources include forestry residues – such as bark, branches, and sapling thinnings, municipal and business waste, and industrial offgases – but these are not a serious alternative. They compete with more pressing uses: decarbonising electric power, fuelling ground transport, and Bioenergy with Carbon Capture and Storage (BECCS). Waste and offgases, in contrast, do look potentially promising. In 2021 we spoke to two companies which together have received over £50 million in government funding to construct the first wave of non-HEFA SAF plants – Velocys and Lanzatech (Department for Transport, 2025a).

Velocys

Of the 27 million tonnes of waste collected annually by Britain's councils and businesses, a Velocys representative told us, much consists of water, and recyclable substances such as metals and 'inerts'. These are removed. The remainder is heated using the Fischer–Tropsch process (Steynberg, 2004). Contaminant gases are washed out and what remains, chiefly hydrogen and carbon monoxide, is converted to SAF. The Fischer–Tropsch process is a proven technology that dates back to the 1920s, but questions remain as to whether it is capable of delivering *sustainable* fuel in sufficient quantities, and in time to achieve the government's Net Zero target. Several obstacles merit attention.

First, SAF from waste is expensive to produce – at least twice the cost of fossil jet fuel (The Royal Society, 2023). Producing fuel to meet the high quality and safety requirements necessary to keep a passenger jet in the air is more complex – and thus more costly – than producing biodiesel for buses, trucks or tractors. This leads to the second problem: the amount of municipal waste available is hugely insufficient. Even if all of the available Municipal Solid Waste (MSW) were converted, it would only meet about ten percent of UK jet fuel demand (The Royal Society, 2023). One might reasonably ask if this limited supply would not be better used to meet the needs of land vehicles without viable alternatives in sectors such as agriculture. Third, as with PtL fuels, the energy requirements are prohibitive. Britain is predicted to fall significantly short of its 2030 green energy target – despite having revised this down in December 2024 (Cornwall Insight, 2025). Globally, energy-transition investment actually declined in 2024, and currently stands at just over a third of the amount required to reach net zero by 2050(Corradi, 2025). There simply is not sufficient surplus renewable energy to warrant its diversion to SAF.

The recent development of SAF production, moreover, does not inspire confidence. None of the Velocys projects have reached commercial production. The promise was that its plant in Immingham would start supplying British Airways in 2024, but the site is still 'a dusty field, empty but for a blue portable toilet lying on its side' (Plucinska et al., 2025). If it does eventually open, it will presumably draw power from the national grid, fuelled to a very substantial amount by non-renewable energy, seriously denting any green credentials it may have had (NESO, 2025). On top of this, its direct GHG emissions will be considerable. Over its entire lifetime including combustion, SAF from municipal solid waste produces up to two thirds as much CO_2 as fossil kerosene (The Royal Society, 2023).

In short, Velocys, like most alternative SAF projects, has not demonstrated commercial-scale viability and there are strong grounds for scepticism. Its case is not atypical. According to a Reuters investigation, of the 165 SAF projects announced by airlines worldwide over the past 12 years, only ten have produced commercial quantities of fuel (Plucinska et al., 2025). The oil giant Shell has scrapped construction of its SAF plants in Singapore and in Rotterdam (Almeida, 2025). In Britain, there are two other proposed MSW-to-SAF projects, both of which have received government funding (Department for Transport, 2025a). One, from the American firm Fulcrum, was set to be twice the size of Velocys' Immingham facility. However, when their flagship plant in Nevada – the first of its kind – was finally opened after years of delays, it was beset by a multitude of problems including nitric acid corrosion of pipes, massive nitrous oxide emissions and a huge overestimation of the amount of fuel it would actually be able to produce (Howard, 2024). The fiasco ended with Fulcrum filing for bankruptcy in 2024 (Hussain, 2024). According to research by Andrew Rollinson, most large-scale commercial gasification plants fail. The technology, he notes, 'has high risks associated with multiple pathways for fire, explosion, and the release of environmental toxins' (Rollinson, 2018). Even if we were to set aside the criticisms of the technology raised above, there is little reason to believe that Velocys' project will be the kind of success story the government is hoping for.

Lanzatech

LanzaTech's core technology is ingenious: Clostridium bacteria combines carbon monoxide and hydrogen to produce ethanol, for conversion into jet fuel (AtJ). Its ideal locations are blast furnaces, the offgases of which include carbon monoxide and hydrogen. LanzaTech anticipated that its facility adjoining the Port Talbot steelworks would yield 80,000 tonnes of fuel annually. Although this sounds impressive, we learned from a LanzaTech representative that it represents '0.6 percent' of Britain's jet fuel usage. As steel production shifts away from fossil fuels in pursuit of its net zero goals, moreover, the supply of those offgases will dwindle – and indeed the last blast furnace in Port Talbot closed in 2024. Hence, LanzaTech has had to look beyond the steel industry, but the feedstocks they have found contain little or no hydrogen, which must then be manufactured. They are exploring DAC-to-SAF projects, but here, again, the energy needs are colossal, and the bottleneck is the availability of renewable electricity.

Other possible feedstocks would include forestry waste, which we discussed above, as well as sources of 'second-generation bioethanol', such as straw. These too face many competing uses, the available quantities are low, and the jet fuel would be expensive –

perhaps two to four times dearer than kerosene. LanzaTech's CEO, Jennifer Holmgren, notes that using recycled CO_2 or CO costs far more than refining oil, and bringing the cost curve down could take '30 or 40 years' (Gertner & Payne, 2021). Production cannot, needless to say, be scaled up at will: it takes three years, at minimum, to get a plant up and running, and only then can the efficiency improvements be transferred to future projects. Construction of LanaTech's plant was due to commence in winter 2024, but this deadline was missed. The company hopes to begin production in 2026, but notes that this timeline is 'subject to securing the legislation, investment and off-take agreements that are needed to move forward to a final investment decision' (LanzaTech, n.d.; Smith, 2025).

The aviation industry knows that synthetic fuels cannot be ramped up quickly. As to SAFs in general, in Britain, as the Sustainable Aviation group admits, annual production of 600 kt won't be achieved until the mid-2030s at the earliest. Even the lowest usage scenario it envisages 'would exceed globally available waste oils and fats' and would require 'substantial new volumes of oil crops' (Sustainable Aviation, 2020).

Carbon capture and storage

Even if one were to set aside scepticism regarding the technological assumptions underpinning the Jet Zero strategy – to accept, for instance, that fuel efficiency will improve at an unprecedented rate, that electric and hydrogen aircraft will overcome existing technical and financial barriers to constitute a meaningful share of the fleet, and that SAFs can be scaled commercially without inflicting further ecological harms – the framework remains fundamentally reliant on negative emissions technologies. This reliance persists even under the most optimistic scenarios, raising critical questions about the feasibility and integrity of the Jet Zero pathway.

By 2050, the Jet Zero strategy anticipates that approximately 21 $MtCO_2$ will need to be removed annually for the aviation sector to achieve 'net zero'. (The Sustainable Aviation group (2020) projects an even higher figure, estimating that at least 26 $MtCO_2$ will need to be either offset or removed each year; and the CCC (2020) suggests that aviation will require around 40% of the UK's total negative emissions capacity by mid-century.) This raises serious ethical concerns regarding the allocation of limited carbon removal resources to a sector characterised by extreme inequality in access and impact. Globally, just 1% of the population is responsible for half of all aviation emissions (Niranjan, 2025), while only 2–4% of people fly in any given year (Gössling & Humpe, 2020). In the UK, the disparity is equally stark: 15% of the population accounts for 70% of flights, and half of the population does not fly at all in a given year (Hopkinson & Cairns, 2021). Moreover, the wealthiest 10% of Britons generate more emissions from aviation alone than do the poorest 20% from all their activities combined (Baltruszewicz et al., 2023). Citizens of the Global South, meanwhile, typically take between zero and one flight per year. The disproportionate allocation of financial and carbon budgets to what is effectively a luxury activity for the affluent raises serious questions of environmental justice and equity.

Even if we leave morality to one side, there remain significant doubts regarding the storage capacity for CCS, and the yawning gap between the diminutive scale of monitored and verified carbon removal and the gargantuan scale required for the Jet Zero sums to add up (de Coninck & M. Benson, 2014; Ketan, 2021). There are currently forty-

one CCS facilities in the world, of which 82.5% are used to aid the extraction of oil in mature wells (Zero Carbon Analytics, 2024). In most countries, CCS is unregulated. Those forty-one plants are expensive, potentially dangerous, and are failing to meet their targets (Weyler, 2022; Zoledziowski, 2022). A recent report on Norway's Sleipner and Snøhvit pilot plants revealed unexpected behaviour of CO_2 in even the most intensively studied of aquifers, a reminder that the danger of leakage is all too real (Hauber, 2023). In its most recent roadmap, the International Energy Agencynotes that the history of CCS is one of 'unmet expectations' and delayed deployment, that 'removing carbon from the atmosphere is costly and uncertain' and that the technology remains 'unproven at scale' (IEA, 2023a). Its entire efficacy has been called into question by the IPCC, with serious doubts raised over the technology and its claims to carbon neutrality (Robertson, 2022; Sekera & Goodwin, 2021).

While funding, especially from the polluting industries, should be invested into CCS research and trials, one should also recognise that its primary purpose, today, is as a technofix, built on insecure foundations and geared to short-circuiting difficult political decisions and supporting fossil-fuel giants (Anderson & Peters, 2016; Laville, 2021; Quiggin, 2024). Even the US climate envoy under the Biden administration, John Kerry, admits that CCS risks becoming a dangerous distraction from the need to reduce emissions, while former US vice-president Al Gore dismisses it as 'an absolute fraud' (Breeze, 2024; Harvey, 2023).

Offsets

The solutions discussed so far are vastly overestimated in the Jet Zero programme, manifesting a blasé disregard for scarcities, realistic timescales, and technical obstacles. Yet all are based on technologies that do, or might one day, function. Offsetting, by comparison, is an outright scam. That it is accorded a prominent role in Jet Zero – even in its 'high ambition' scenario, offsetting is billed as providing the second-largest 'reduction' in emissions, after CCS – is scandalous.

Offsetting is the right to pollute in one location purchased by certificates declaring its reduction in another, relative to 'business as usual' – certificates that can then be traded on carbon markets. The logic by which it functions is questionable, to say the least. It's as if, when a factory poisoning a Malaysian river reduces its pollution ahead of a regulatory deadline, a factory in Liverpool were thereby licensed to discharge mercury into the Mersey. Of carbon offsetting, the great majority relates to protecting areas from future deforestation. Forests, alongside ocean and peatland, are vital carbon sinks that absorb half of human emissions; many of these are losing their ability to absorb carbon (Greenfield, 2024; IPCC, 2023). Halting deforestation plays, naturally, a vital role in climate change mitigation. But this should not give licence to corporations to continue pumping CO_2 into the atmosphere somewhere else (Milman, 2018). The carbon credit system into which offset certificates are poured, moreover, is ripe for corruption and fraud (Chan et al., 2023). This was made abundantly clear when multiple studies into the world's largest carbon offsetting certifier revealed that ninety percent of their offsets were utterly worthless (Guizar-Coutiño et al., 2022; West et al., 2020, 2023).

*Re*forestation schemes may *prima facie* appear more justifiable, but they too are flawed. Crucially, they fail to take into account the fact that trees are not interchangeable

units. Old forest is a complex ecosystem with dense understories; it cannot be 'replaced' by plantation silviculture (Monbiot, 2021). Moreover, trees take decades to grow and if they are then caught in wildfires for example, they release all the carbon they have been absorbing (Hodgson, 2021). People inhabit the places where the offset industry wishes to site plantations. Their fields, livestock and livelihoods are in the crosshairs of carbon offsetting projects. The quantity of land required is staggering – a forest the size of the Isle of Wight would need to be planted every year just to keep up with the carbon footprint of the Royal Air Force (Defence Committee, 2023; MoD, 2023; Moseman et al., 2025). Carbon credits concerned with reforestation and funding renewable energy have been linked to a litany of social and environmental harms. For example, projects connected to Chevron's carbon offsets include planting rubber monocultures, which are disastrous for local ecosystems and are ineffective at carbon offsetting. A large portion of Chevron's carbon offsetting schemes involved construction of large hydroelectric dams. These projects would in all likelihood have been constructed anyway, so their status as 'offsets' is risible; they have also been accused of undermining local communities, with use of violent methods to suppress resistance (Corporate Accountability, 2023). Critics have pointed to the neocolonial and exploitative nature of such relationships (Olúfẹmi, 2019). Ill-advised if not outright damaging practices of offsetting are taking place in the context of centuries-old unequal relationships of extractivism, sometimes by the very same corporations – as in the case of Chevron in Colombia. We are left with a troubling picture: ineffective carbon offsets threatening food security in the Global South in order to maintain the lifestyles of the world's frequent flyers (Harvey, 2021).

The flaws of reforestation schemes are emblematic of the broader problems with carbon offsetting. These issues are not limited to individual projects but are systemic, as evidenced by the ICAO's carbon trading scheme, CORSIA. The scheme, which Britain was instrumental in setting up, will account for the majority of the UK aviation sector's offsets. Beyond the general issues raised above, CORSIA has come under significant criticism from experts. None of the offsetting programmes under the scheme address issues of double counting (where an area of, say, rainforest that was already protected under a national scheme is then counted again for offsetting). Neither do the price mechanisms work, due to oversupply: when buying credits is cheaper than buying SAF, it undermines the incentive to decarbonise. Finally, the entire scheme is beset by a lack of transparency and enforceability (T&E, 2021a). That the Jet Zero plan places such emphasis on offsetting seriously undermines its claims to be aiming for 'net zero'. To repeat: with every fraction of a degree of heating, climate breakdown becomes more severe, unpredictable and irreversible, and the earth's ecosystems deteriorate further. Carbon offsetting, by giving corporations the green light to continue emitting greenhouse gases, is detrimental to the future habitability of Earth.

Policy proposals

Travelling through an airport in Britain, you might be forgiven for thinking that today's jetliners are as light as birds. From Gatwick to Bristol, advertisements proudly declare that the airport from which you are taking a flight halfway across the globe is 'carbon neutral'. Despite the absurdity of such statements being summarily pointed out

(Walker, 2021), the aviation industry's attempts to paint a green image of itself are unending. From Ryanair's banned advertisement that declared it was 'Europe's lowest emissions airline' (ASA, 2020) to KLM's green claims for SAF being ruled 'misleading' (Sterling & Plucinska, 2024), there are countless examples of aviation-industry 'greenwashing'. Indeed, a recent study found that 44% of aviation industry publicity regarding carbon offsets was misleading (Guix et al., 2022). This is not a new development. ExxonMobil's 2011 advert promoting biofuel from algae, to give one of many examples, was banned for making similarly dishonest claims (Euractiv, 2011). This example is particularly instructive given that the much-vaunted algae 'solution' culminated in a dead-end, as we discussed above. The aviation industry has a history of deliberately misleading the public in order to justify its unhindered expansion. To do this it relies on exaggerated, unrealistic and disingenuous claims put forward for a slew of techno-fixes. However, it does not act alone. Obliging governments and compliant media organisations should be held accountable too.

Considering the body of research surveyed in this article, it is evident that the Jet Zero plan prioritises the wellbeing of the aviation industry over the environment. Were the habitability of the planet its driving concern, Jet Zero would recommend demand management measures, such as a ban on aviation advertising and frequent flyer programmes, and the removal of tax exemptions on aviation fuel. It would emphasise 2030 targets, not 2050. It would prioritise consultations with young people, environmentalists, and scientists, rather than aviation lobbyists. It would take seriously the Absolute Zero report from Cambridge University's FIRES research group (Allwood et al., 2019). If Britain's 'net zero' target is to be achieved by mid-century, the FIRES engineers have shown, the aviation industry 'faces 'rapid contraction'. This entails the phasing out of 'all aviation activity' within 30 years', with the mothballing of all British airports except Glasgow by 2030, and Heathrow too by 2050 – and only then, if the necessary technologies and sufficient renewable electricity come onstream, could some reopening plausibly begin.

The case for aviation contraction is unlikely to be universally popular, and won't be a vote winner, unless two conditions obtain. One is a meaningful shift in attitudes to climate breakdown. The other is that transport reforms are linked to proposals that address popular concerns. If campaigners are to bring the aviation industry back down to earth, the vision must be of a habitable planet together with feasible and appealing travel alternatives.

As discussed above, aviation is an elite activity both in the West and worldwide. An opinion survey from 2024 reports that, Rachel Reeves' pronouncements notwithstanding, the British public does not see aviation growth as essential to economic growth, supports taxation of aviation fuel and raising ticket prices, and 'strongly supports' equalising the cost of train travel versus air travel – even if this requires higher taxes on aviation (Chapman, 2025b). While jet owners represent 0.0008% of the global population, in Britain private jets represent one in ten flights taking off (Collins et al., 2023; Vaughan, 2023). A passenger on a private jet travelling from New York to Washington DC – the same distance as London to Paris – is responsible for around 45 times the emissions of a passenger flying the same route on a commercial flight, and 1,100 times one travelling by train (Collins et al., 2023). The case for banning private jets, in short, is overwhelming. Business travel should be shrunk, too. The Covid-19 pandemic demonstrated that much of it can be replaced by online meetings. If even just those business trips deemed

'unnecessary' were curtailed, Heathrow's traffic would, at a stroke, shrink by nearly a fifth (Statista, 2023). Meanwhile, a frequent-flyer levy could equitably reduce demand – without punishing once-a-year holiday goers – during the period in which alternatives to flying are rolled out. Such levies are popular among the British public (Chapman, 2025b), and should be imposed with particular priority on the luxury-ticket classes (first, premium, business), for these, while by far the most environmentally damaging, face relatively low taxation under Air Passenger Duty. Alongside the redirection of fossil fuel subsidies, these tax revenues could also provide 'innovative sources of finance' to provide 'Loss & Damage' assistance to populations most adversely affected by climate breakdown, on the basis of the polluter pays principle (Amnesty International & CIEL, 2022).

Beyond these reforms, short-haul and domestic flights should be rapidly phased out. A first step has been taken by France, with its prohibition on flights covering routes that could be travelled within 2.5 hours by train.[12] Again, evidence suggests these policies are popular, with one EU-wide survey finding that two in three Europeans would support a ban on short-haul flights to destinations that could be reached in twelve hours by train (Garton Ash et al., 2020). To replace short-haul flights, investment in rail and battery-electric coach infrastructure could enable reliable and accessible public transport for all, at affordable prices or even free. Within Europe, night trains present a viable and convenient substitute and should be revived and upscaled. Surveys consistently demonstrate that people prefer train journeys to flying (Carn & William, 2021). Where rail offers a viable alternative, such as between London and Paris, we see passenger demand for aviation collapsing (Rowland, 2019). Cruising at a modest 125 mph, a train from London could, with stops, reach Barcelona in eight hours, Ankara in twenty.

The challenge of addressing emissions from long-haul flights remains particularly complex. Alternatives are less readily available than for short-haul travel, yet their significance is greater. A study of flights departing from 31 European countries revealed that those exceeding 4,000 km constituted only 6% of total departures yet were responsible for 47% of total fuel consumption. Similarly, a global analysis found that just 5% of flights – those longer than 3,000 km – accounted for nearly 40% of total aviation fuel consumed (Dobruszkes et al., 2024).

To date, there appear to be no viable proposals for long-haul aviation that simultaneously meet ecological sustainability criteria, uphold social equity, and remain politically feasible. What is certain, however, is that a single return long-haul flight from Britain can exceed an individual's entire annual per capita carbon budget, assuming adherence to the 1.5°C climate target. In this context, substantial reductions in long-haul air travel appear to be the only ecologically defensible course of action. While such measures may face resistance, the imperative to remain within the boundaries of a stable planetary system must surely take precedence. The alternative is to risk pushing the Earth system into a state incompatible with the complex societal structures developed over the past five millennia. As Al Gore aptly stated, 'the maximum that is politically feasible, even the maximum that is politically imaginable right now, still falls short of the minimum that is scientifically and ecologically necessary' (McKibben, 1995).

The absence of clear alternatives to long-haul aviation should not be used to justify the continuation of current practices. That said, we can take inspiration from the slow travel movement (Kieran, 2013). If legislation encouraged flexibility from employers, slow-moving zero-emission ships could offer an alternative for some long-distance journeys

(Neale, 2021). And airships – we venture tentatively, aware that we may be afflicted by the techno-utopianism that this article cautions against – may offer an additional low emissions alternative to aeroplanes (Hall, 2024; Jolly, 2025).

All these initiatives, whether night trains, ships or airships, would create new jobs, for which workers departing the aviation industry should, in a 'just transition', be given priority. A report commissioned by Possible found that if British aviation shrank by two-thirds, around 200,000 jobs would be lost, but by replacing these journeys with alternatives (e.g. trains and ferries), together with the resulting growth in domestic tourism, a *net* gain of over 300,000 jobs would result (Meadway, 2022).

The 'just transition', as has been widely observed, is a contested concept. We follow Stefania Barca in her attempt to reclaim the just transition strategy from a simple jobs campaign yoked to a 'green growth' agenda, to a programme that, while centred on trade-union mobilisation for 'green jobs', simultaneously draws upon 'Indigenous knowledges' and advocates for disinvestment from the fossil fuel and nuclear sectors, coupled with energy democracy and food sovereignty at the community level (Barca, paraphrased in Rainnie & Snell, 2024, p. 38). International solidarity would be close to its heart; the risks of reinforcing neo-colonial and extractivist relationships with the Global South in the pursuit of 'green' policies are well documented (Abram et al., 2022; Ambrose, 2024; Bell, 2024; Hamouchene & Sandwell, 2023; Okpanachi et al., 2022).

As an embryonic example of a 'just transition' in aviation, consider the case of 'A Green New Deal for Gatwick'. It was convened by eco-socialists and union officials from the Public and Commercial Services Union (PCS), a union that has been at the forefront of campaigning and policy work on 'climate jobs' and the just transition (Lethbridge, 2024), during the Covid-19 pandemic when aviation workers were facing mass layoffs. We asked Robert Magowan, one of the proposal's instigators, what lay behind the Gatwick plan. 'We know that aviation must degrow', he replied, 'and it was degrowing during the pandemic, but this must not come at the cost of workers. The pandemic response showed what governments can do when pressure is on – especially when the Broughton manufacturing site of Airbus was retooled to produce ventilators'.

Magowan and his colleagues surveyed the manifold ways in which Gatwick workers' skills sets could be adapted to jobs elsewhere, in decarbonising industries. With PCS backing, they found support among the workforce, including from a pilot whose words eloquently sum up what is at stake:

> It has been my lifelong dream to fly. To face up to losing this massive part of our lives is incredibly scary; to lose our job is like losing a part of ourselves. But as pilots, we use our skills to identify this existential threat to the natural world and our lives. If this was an emergency in flight, we would have diverted to a safe destination long ago. We can't just fly blindly to the planned destination as the flight deck fills with smoke. Our industry's impact on global emissions is irrefutable. The so-called solutions to 'green' the industry at its current scale are decades away and are not globally or ecologically just. With environmental consciousness rising, the aviation sector will either shrink by design, through a 'Just Transition' for workers, or by disaster. We must find a way to put workers at the forefront of the green revolution, to ensure we have the option to be retrained into the green jobs of the future (Latif et al., 2020, p. 24).

A just transition of this kind could have numerous positive impacts on local communities. €4 million is lost every hour by European governments because aviation is untaxed (T&E,

n.d.). This aid received by airports and the aviation industry could be redirected to fund local leisure and sustainable transport infrastructure. Even redundant airports could be transformed into community hubs, museums, or green spaces (as was done at the former Berlin airport at Tempelhof) (Magowan, 2022).

Conclusion

The Jet Zero plan, with its reliance on unproven techno-fixes and industry-friendly policies, exemplifies a complacency that has underpinned climate inaction for decades. It not only fails to address the scale of the aviation sector's contribution to the climate crisis, but risks exacerbating it. Its techno-solutionism would have us believe in the alchemical power of new technology: it can turn carbon into gold. But the evidence is clear: carbon capture and storage, sustainable aviation fuels, hydrogen-fuelled and battery-electric planes are not the silver bullets they are made out to be, and offsetting is a farce. These proposals serve chiefly as window dressing for the aviation industry, an alibi to provide cover for unchecked expansion while delaying the difficult decisions needed to mitigate global heating.

As the mercury continues to rise, governments, rather than working urgently to reduce aviation emissions, are placing their bets on yet-to-materialise technologies (Schleussner et al., 2024). The airlines, hand in glove with policymakers, are using these 'solutions' to carve out space to expand their operations. If such solutions, however, are false promises, as this paper argues, the aviation industry ought to be scaled down, and permitted to re-grow only if the lifecycle of aircraft can be designed to avoid GHG emissions entirely. The methods necessary to curb aviation emissions exist; what is lacking is the political ambition to implement them. They includes policies to equitably reduce demand for air travel, and investment in sustainable alternatives, with measure to ensure a just transition for workers and communities dependent on the aviation industry. The flaws of governmental responses to the Covid-19 pandemic notwithstanding, they hinted at the rapid, transformative change that can occur where the political will exists.

For the rising global temperature to be stabilised at 1.5°C, high-emissions industries must be rapidly reined in. This requires not only a radical reassessment of how we travel, but also structural transformations, with respect to the logics of economic growth and the goals of social justice and the habitability of the planet.

Notes

1. For suggestions and comments on an earlier draft, we wish to thank Jamie Morgan. The usual caveat applies.
2. The CCC acknowledges the problem: 'Aviation's non-CO2 effects refer to the additional climate impacts from aviation not due to GHG emissions, such as line shaped contrails, high cloud increases, and the impacts from air pollution. Since 1990, the warming effect of non-CO2 effects has tripled'. (CCC, 2025, p. 223).
3. The figures from the MOD suffer from a lack of transparency in reporting (Parkinson, 2020).
4. 'Taken back', of course, raises problematic questions of dependence on carbon capture and negative emissions technologies.
5. Block fuel efficiency is higher than the metric value (MV), as airlines have steadily increased seating density over time. MV does not account for cabin configuration. Similarly, operational improvements, such as advances in flight management systems, are also excluded from MV.

6. Average measures of fuel efficiency conceal substantial variation across periods. During the late 1960s, the replacement of first-generation with second-generation jets yielded significant efficiency improvements (5.6% annually in block fuel and 3.7% in MV). By contrast, from the 1990s through the early 2010s, the absence of major technological advances resulted in near-zero gains. The introduction of more efficient aircraft types in the 2010s, notably the Boeing 787, produced improvements of up to 3.5%. However, efficiency growth stagnated again in the early 2020s (Hameed & Rutherford, 2024). That average fuel efficiency has struggled to climb substantially above 1% pa is confirmed by the International Civil Aviation Authority (ICAO) which in 2019 admitted that while they aspire to efficiency gains of 2% pa, "today's aircraft are approximately 80 per cent more efficient in use of fuel per passenger kilometre than that in the 1960s" – in other words around 1.1%pa (ICAO, 2019).
7. Recent research suggests that the energy demands of data centres may already exceed, globally, the electricity produced by renewables (Castro et al., 2024). This should be of concern to the Starmer government, given its commitment to a breakneck expansion of data centres (Gross et al., 2025).
8. It is important to point out that even if we were to put aside the environmental and social costs of airport expansion, its contributions to growth are debatable. A recent report carried out by the New Economics Foundation found that as expansion primarily increases outbound passengers, it is "highly unlikely" that it offers "any growth benefits to the UK" (Chapman, 2025a). And in an extensive analysis of the economic case for the expansion of Leeds Bradford Airport, a report found that it would in fact lead to a net loss for the region's economy (Chapman & Postle, 2020).
9. The EU's SAF mandate suffers from similar problems. Based on the projections of Boeing and Airbus, emissions savings from the EU's 42% SAF mandate will be cancelled out by growth, with CO_2 emissions in 2049 predicted to be just slightly lower than their 2019 level (T&E, 2025). However, given the low forecast for the availability of efuels, like Power to Liquid (PtL), we infer that a hefty portion of that SAF demand will be met by HEFA-based biofuel or similarly unsustainable sources. If this is accounted for then European aviation emissions would likely rise to a *peak* in 2049 (T&E, 2025).
10. Despite knowing of the concerns regarding authenticity of the oil, the British government has excluded SAF from its investigation into Chinese biodiesel imports (Hussain, 2024). Instead, it relies on industry-led certification schemes like the International Sustainability and Carbon Certificate to verify authenticity. These schemes depend heavily on self-reporting rather than independent verification, casting doubt on their reliability (Greenpeace, 2021).
11. In the UK, biodiesel is primarily used for road transport (DEFRA 2025), as well as agricultural machinery, and power generators.
12. Despite France's ability to whisk passengers across vast distances in under 2.5 h thanks to its extensive high-speed rail network, Britain still sees multiple daily flights on routes that are easily covered by train. From London, you can reach all the major northern cities in less than 2.5 h. And yet, there are still around five flights a day from London to Newcastle, and a similar number to Manchester.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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