NEW ECONOMICS FOUNDATION

Possible.
Inspiring climate action

A FREQUENT FLYER LEVY

SHARING AVIATION'S CARBON BUDGET IN A NET ZERO WORLD

BY ALEX CHAPMAN, LEO MURRAY, GRIFFIN CARPENTER, CHRISTIANE HEISSE AND LYDIA PRIEG

CONTENTS

EXECUTIVE SUMMARY

WHY DEMAND FOR AVIATION MUST BE CAPPED

Responding to the Paris Climate Agreement to limit warming to 1.5ºC, the UK government passed into law in 2019 a commitment to deliver net zero greenhouse gas (GHG) emissions by 2050. The Climate Change Committee (CCC), which advises the government on climate policy, calculates that to meet this deadline aviation growth must be slowed so that passenger numbers do not exceed 25% above current levels. Aviation demand is forecast to grow well above this level and, while the international response to the Covid-19 pandemic has temporarily reduced departure levels, experience from previous shocks to the sector suggests demand will soon bounce back.

In the UK, 15% of people take 70% of all flights, while nearly 50% of the population do not fly at all in a given year. This is a hugely unequal division of the carbon budget for aviation (and a large share of the UK's total carbon budget). A just transition to net zero emissions has to reduce aviation emissions in a way that accounts for this inequality. Any aviation policy used to apply a cap on flights across the population will reflect a judgment – either explicitly or implicitly – on how these flights should be distributed.

ANY CAP MUST ADDRESS EXISTING INEQUALITIES

The total amount of flights – the 25% cap – is determined by the carbon budget for aviation. In this sense the 'size of the pie' (available flights) is fixed, but through policy it is possible to affect who gets what slice, and at what price. There are two broad approaches to reducing passenger numbers: restricting aviation capacity – such as through regulation and reduced airport expansion, and restricting demand for flights – such as through taxation. Both approaches are likely to lead to price increases, either directly , or due to the price effects of demand exceeding capacity. But the distributional effects of different options are highly variable. Policies designed to help cap the growth in aviation passenger numbers face a difficult challenge in keeping to a carbon budget for the sector, while considering how access to this carbon budget is distributed across society. Just as there is a risk of too much air travel breaking the carbon budget, there is also a risk that the choice of policy design puts air travel out of reach for many.

A FREQUENT FLYER LEVY IS THE FAIREST WAY TO DO THIS

In 2015, a report by the New Economics Foundation for the 'A Free Ride' campaign proposed a frequent flyer levy (FFL) to achieve the combined aim of limiting aviation emissions while ensuring a more progressive distribution of flights. The FFL applies a charge, starting at zero for the first flight, but increasing for every subsequent flight taken within a year. It would replace the existing Air Passenger Duty (APD) – £13 for short haul and £78 for long haul in economy class – that currently applies to every passenger ticket.

In 2018, a survey revealed that a FFL is the most popular option among a number proposals for reducing passenger numbers. This report presents new modelling comparing the distributional effects of an illustrative FFL with an increase to APD and restrictions on airport capacity.

All three options were set at a level consistent with a 25% cap in aviation growth by 2050 and compared to a baseline scenario of unconstrained growth. The distributional analysis of available supply and demand side aviation policies reveals that not only is a FFL the most popular of the available policies, it is also the most progressive.

NEF modelling shows that under our FFL scenario, the highest income 20% of the UK population reduces their flights significantly (by around 30%) compared to a world of unconstrained growth. At the same time, the lowest income 20%, which currently fly five times less frequently than the richest 20%, would be able to take just as many flights as if there was unconstrained growth. Under increased APD the opposite is true: as all tickets increase in price it is the lowest income quintile that reduces their flights the most (-19%) and the top quintile that reduces their flights the least (-13%).

A similar pattern is seen when examining the direct tax burden. On average, the lowest income 20% of the population would pay just £7.75 a year in FFL payments. This is less than the minimum tax burden paid under APD, irrespective of whether current rates are maintained (£13 per year) or whether APD rises consistent with a 25% cap (£41 per year). A far higher proportionate share of the FFL tax burden falls on the richest, with the highest income 20% paying on average £165.85 per year.

Constraining airport capacity would also represent a regressive policy choice in terms of greater reductions in flying in lower income groups due to a rise in average ticket prices. The regional impact of constrained capacity would be more mixed, with poorer groups losing out most in regions where the greatest gap between demand and airport capacity arose. By contrast, the FFL would generate larger reductions in London and the South East where a higher proportion of high-income earners and frequent flyers are located.

A JUST TRANSITION

Any caps or restrictions placed on aviation with the aim of achieving the UK's international climate commitments are likely to have knock-on effects on employment in the sector. However, in the medium term, the pre-eminent threat to employment remains automation and ongoing efficiency drives which have been accelerated through the Covid-19 pandemic. The chosen emissions reduction policy does, however, have relevant impacts on the likely regional distributional impact of any resulting job losses. In this regard the FFL is arguably, again, the most progressive policy, as it does the best job of protecting jobs in the UK's regions outside London and the South East where, at least historically, unemployment rates have been higher. In all eventualities it is critical that the government establishes a wider policy package for aviation which ensures a just transition for workers impacted by climate policy. This includes protecting their long-term employment prospects through new job creation, and where necessary supporting upskilling and retraining for workers to access the zero carbon jobs of the future. In delivering this agenda, it is vital that a just transition puts worker voices, and their union representatives, at the heart of the policy decision-making process.

1. AVIATION POLICY IN A NET ZERO WORLD

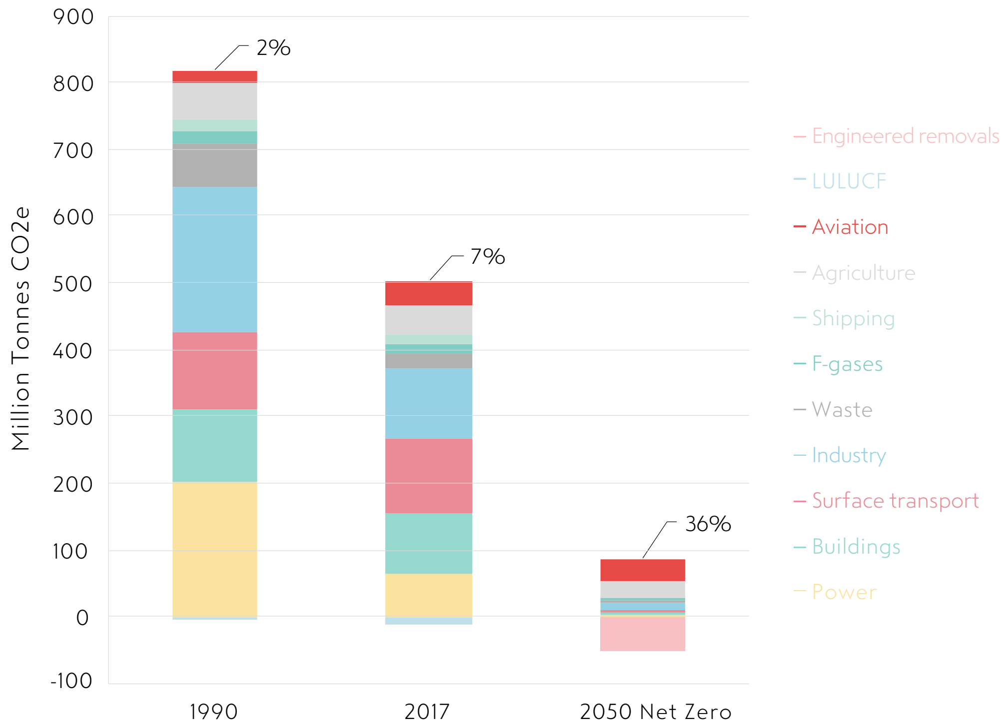
The climate crisis requires an urgent reduction in greenhouse gas (GHG) emissions. The UK government has committed to net zero emissions by 2050, but there are strong and credible arguments that this is not enough if we are to prevent catastrophic climate breakdown.[1], [2] The UK is not on track to achieve even this less ambitious target.[3] Under all scenarios there is a very limited carbon budget available and urgent action is required to support every sector in delivering rapid reductions in emissions.

AVIATION EMISSIONS

The aviation sector presents a difficult transition challenge. Between 1990 and 2017, while overall UK territorial emissions fell by more than two-fifths (42%), UK aviation emissions doubled. Aviation emissions were therefore an increasing share of the UK carbon budget, rising from 2% in 1990 to 7% in 2017. Due to the Covid-19 pandemic, however, GHG emissions from UK aviation fell by an estimated 60% in 2020, compared to 2019 levels.[4] The Climate Change Committee (CCC), which advises the government on climate policy, estimates that UK aviation demand will return to pre-pandemic projected demand levels from 2024 in four out of six of its proposed scenarios; although in the other two scenarios business travel halves by 2024 due to a long-term shift to video-conferencing.[5] It also calculates that – to meet the net zero 2050 goal and stay in line with the 2015 Paris Climate Agreement – aviation demand in 2050 cannot exceed a 25% increase over 2018 levels.[6] Even with this limit in place, aviation would

FIGURE 1: A LACK OF ADEQUATE TECHNOLOGICAL SOLUTIONS TO REDUCING AVIATION EMISSIONS MEANS AVIATION'S SHARE OF THE UK'S OVERALL CARBON BUDGET IS EXPECTED TO GROW SIGNIFICANTLY OVER THE NEXT THREE DECADES

Aviation share of UK GHG emissions, 1990, 2017 and 2050 (CCC net zero 'Further Ambition' projection). N.B. the CCC scenario shown actually results in a net reduction in emissions of 96% by 2050, not 100%



Source: Authors' calculations from *Climate Change Committee, 2019. Net Zero – the UK's contribution to stopping global warming and Climate Change Committee,* 2019. Reducing UK emissions 2019 Progress Report to Parliament constitute the largest source of UK emissions in 2050 and consume 36% of the available carbon budget (see Figure 1).

In apparent contradiction to the CCC's calculations, the UK aviation industry claims to be able to deliver its part in achieving UK-wide net-zero emissions by 2050 while also growing passenger numbers by 70% over 2018 levels. This is only made possible through a heavy use of carbon offsetting and a reliance on aviation technologies that it hopes will be invented and widely implemented in the coming decades.[7] However, the aviation industry is currently not achieving anywhere near the rates of technological development and rollout required on this theoretical pathway to net zero, and there are major concerns about the credibility of the proposed offsetting schemes.[8]

There is also a reluctance within the UK government to accept the CCC's conclusions on a carbon budget for aviation. In 2018, the newly appointed Aviation Minister, Baroness Suggs's, first speech asked a fundamental question: "How can we build and sustain a consensus around the need for growth?"[9] In 2019, the then Secretary of State for Health and Social Care, Matt Hancock, stated that "we shouldn't be flying less" to tackle climate change.[10] Even the aviation demand forecasts used by the Department for Transport (DfT) envisage demand increasing by nearly twice what the CCC's calculations allow. However, in adopting this position the UK government increasingly finds itself at odds with the scientific consensus on viable pathways to achieving net zero emissions. The International Energy Agency (IEA), in its global scenario for achieving net zero emissions by 2050, published in 2021, suggests that:

> *"aviation growth is constrained by comprehensive government policies that promote a shift towards high-speed rail and rein in expansion of long-haul business travel, e.g. through taxes on commercial passenger flights"*[11]

This sentiment echoes the original position of the CCC which, in a 2019 letter to the Secretary of State for Transport, urged that:

> *"Measures should be put in place to limit growth in demand to at most 25% above current levels by 2050. These could include carbon pricing, a frequent flyer levy, fiscal measures to ensure aviation is not undertaxed compared to other transport sectors (e.g. fuel duty, VAT), reforms to Air Passenger Duty, or management of airport capacity."*[12]

The necessary policy infrastructure is not in place to deliver even the government's less ambitious decarbonisation targets. This report looks at the government's options when it comes to delivering new policy architecture, or tweaking existing structures, to lower growth in passenger air departures to levels compatible with the UK's climate targets. This report compares a frequent flyer levy (FFL) to two other policy options to reduce aviation emissions: an increase to the existing Air Passenger Duty (APD), and constraints on airport capacity. The analysis begins with an overview of how flights are currently taxed, followed by an assessment of policy options. These policy options are compared using an elasticity model to determine the level of taxation/constraint required for each policy to constrain demand to target-compatible levels and how flights would be distributed under each policy option.

EXISTING FLIGHT TAXATION AND TAX EXEMPTION

There are several existing policies in the UK that impact aviation demand. These policies can be broadly characterised as either taxes or tax exemptions.

APD

All passenger flights departing from UK airports are subject to APD, a per-ticket charge introduced in 1994.[13] Passengers under 16 year old, flights from the Scottish Highlands and Islands, and international transfer passengers (less than 24 hours between flights) are exempt, so it applies to approximately 70% of departing flights.[14] APD is loosely related to distance and emissions – there is a short- and a long-haul tax band, each with different rates for economy tickets and business/first class tickets.[15] There is also a 'higher rate' APD for private planes although it is unknown how often this rate applies, as HMRC does not publish figures. Currently, 94% of chargeable passengers pay the reduced rate of £13 for short haul and £78 for long-haul flights.[16] APD reform became a political issue when Exeter-based Flybe, once the largest independent regional airline in Europe, blamed APD for its financial hardship, eventually striking a deal with the UK government for a tax holiday from outstanding APD charges.[17] In 2021 the UK government consulted on a permanent reduction to APD charged on domestic flights.

UK Emissions Trading Scheme

A UK Emissions Trading Scheme (UK ETS) was introduced in January 2021 to replace the UK's participation in the EU Emissions Trading Scheme (EU ETS). It applies to energy-intensive industries, including aviation, and specifically covers UK domestic flights, flights between the UK and Gibraltar, and flights departing the UK to European Economic Area states. It is a cap-and-trade scheme, where emitters can buy and sell a shrinking number of carbon emission allowances, and auctions launched in late May 2021. The UK government has pledged to offer 5% fewer allowances than those that would have been available if the UK had remained in phase four of the EU ETS.[18] The impact of the EU ETS on airlines, ticket prices and aviation demand has, however, been small, with one estimate putting the change in ticket price due to ETS inclusion at around €0.26 (£0.22) for a short-haul flight and €0.76 (£0.65) for a long-haul flight.[19] In addition, a large proportion of the allowances (82% between 2013 and 2020) are currently given away for free to airlines, in effect a government subsidy to the industry. The free allocation is scheduled to decline by 2.2% per year from 2021.[20]

Carbon Offsetting and Reduction Scheme for International Aviation

In exchange for the exclusion of extra-EU flights from the EU ETS, the International Civil Aviation Organization made a commitment at its annual assembly in 2013 to introduce a single global market-based measure. The details were agreed at its 2016 assembly when the UN aviation agency agreed that its scheme, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), would come into effect from 2021. The UK is one of the 66 participating countries. Together these countries cover 80% of global aviation emissions.[21]

There are a number of exemptions in the application of CORSIA that do not apply in the EU ETS such as the use of biofuels (CORSIA also exempts many low aviation, least developed, and island nations altogether). Of prime importance is that whereas the EU ETS is a 'cap-and-trade scheme', CORSIA is an 'offsetting scheme', meaning that emissions can grow as long as they are compensated for through the purchase of carbon offsets – a practice that is heavily criticised.[22],[23],[24] Even the use of offsets is extremely limited as they are only required to cover the *growth* in sector emissions over a 2021 baseline (the EU ETS uses a baseline year of 2005) and not the total emissions. This is problematic as the UK aviation sector needs to *reduce* its emissions in order for the UK to meet its climate targets, and CORSIA will provide no incentive in this regard. Furthermore, by calculating growth at the sector level, the policy breaks the incentive for each airline to reduce its own emissions due to the collective action or 'free rider' problem.[25]

Fuel tax exemption

Unlike road fuel which is charged excise duty – constituting a substantial proportion of the pump price paid by motorists – there is no tax on aviation kerosene for either domestic or international flights in the UK.[26] The exemption for international flights stems from the Chicago Convention on International Civil Aviation of 1944 signed to 'create and preserve friendship and understanding among the nations and peoples of the world.'[27] Domestic flights are not covered by the Chicago Convention, with the Netherlands and Norway levying a kerosene tax on domestic flights.[28],[29] Currently the German government is seeking an alliance of countries to tax kerosene on international flights between participating countries.[30]

Value added tax exemption

Tickets for flights from UK airports are 0% rated for value added tax (VAT). This zero-rate designation puts flight tickets in a category with many 'essentials' (e.g. children's clothes, wheelchairs, water, food, bus and train tickets, nappies, bike helmets) as opposed to the reduced rate VAT (e.g. solar panels, children's car seats, sanitary pads, gas, electricity) or standard rate VAT (e.g. car rental, taxis, adult clothes, bicycles, electronics, restaurant food). The UK, along with Ireland and Denmark, are the only EU countries without VAT on domestic flights.[31]

Summary of existing aviation taxation

The tax policy landscape for UK aviation is extremely complex, with APD, the UK ETS, and CORSIA all interacting, sometimes in conflicting ways. Taken together, it is also clear that the treatment of aviation in the UK in the tax system (and across Europe and globally) is exceptionally lax and ineffective at shifting demand anywhere near the levels required to mitigate the climate crisis.

This lax treatment is made more extreme by the exemptions that flights received from VAT and fuel duty. The Treasury is short-changed to the tune of £7.4 billion a year as the VAT and fuel duty exemptions add to a gap of £11 billion while APD raises just £3.6 billion a year.[32] As a result, air travel is not only taxed too low to reduce demand, but also effectively 'subsidised'. There is an argument that this subsidy grows larger still when aviation's free allocation of credits under the UK ETS and the many loans and grants supplied during the Covid-19 crisis are factored in. Aviation cannot fly by while other sectors are making steep reductions. A new policy is needed, or perhaps a new policy approach entirely.

2. ASSESSING THE POLICY OPTIONS

In the UK, 15% of people take 70% of all flights, while nearly 50% of the population do not fly at all in a given year.[33] This is a hugely unequal division of the carbon budget for aviation (and a large share of the UK's total carbon budget). A just transition to net zero emissions has to reduce aviation emissions in a way that accounts for this inequality in responsibility and impact (financial impacts as well as climate change impacts). Fiscal reform faces a difficult challenge in keeping to a carbon budget for aviation, while considering how this carbon budget is applied across society. Just as there is a risk of too much air travel breaking the carbon budget, there is also a risk of tax policy putting air travel out of reach for many and a carbon budget being used by a minority of frequent flyers.

A FREQUENT FLYER LEVY

In 2015, a report by the New Economics Foundation for the campaign 'A Free Ride' proposed a frequent flyer levy (FFL) as an alternative to Air Passenger Duty (APD) to achieve the combined aim of limiting aviation emissions while ensuring the distribution of flights is more progressive.[34]

The FFL would be levied as an escalating charge applied to each flight over a one-year period. The proposed schedule for the levy starts at a rate of zero for the first outbound flight and then increases progressively with each outbound flight thereafter (inbound flights are subject to taxation from the departure country).

The research showed that a FFL could contribute in meeting the demands of the UK Climate Change Act, while raising additional funds for the exchequer. Crucially, the FFL would change the distribution of flights with a smaller tax burden for infrequent flyers but a higher tax burden (and demand reduction) for frequent flyers.

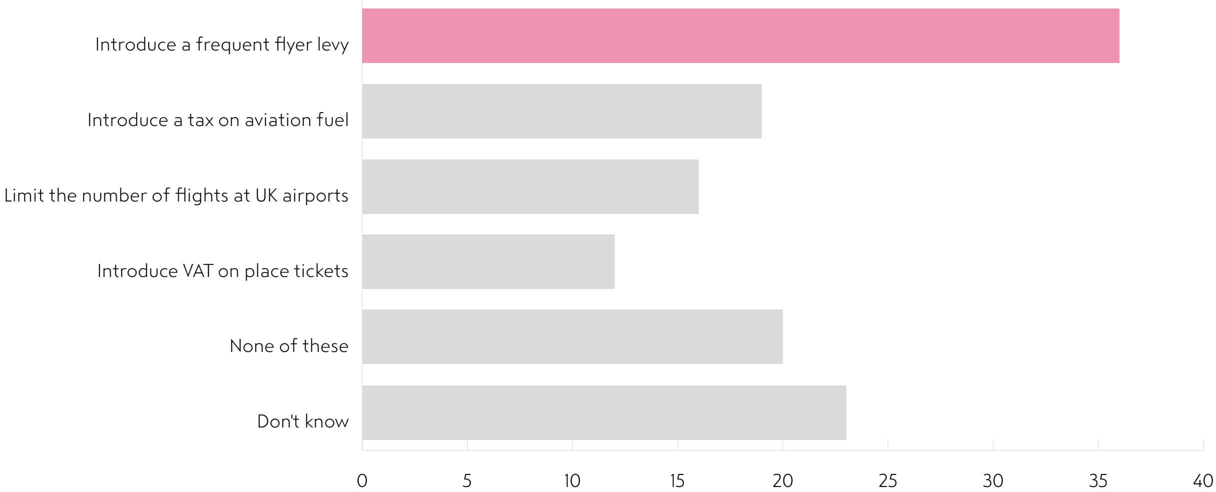
A 2018 survey revealed that a FFL is the most popular option among a number proposals for reducing passenger numbers (see Figure 2). This support is crucial as aviation policy has faced a great deal of resistance. For example, even at its existing low rate, APD is resisted and there are calls to scrap it entirely. The UK government has also resisted calls to levy a basic kerosene tax for domestic aviation.

For aviation policy to be effective (and not just efficient) it needs to be set at a high enough level to incentivise reductions while at the same time garnering public support (or limiting opposition).

FFL design

The 2015 NEF report proposed a 'stepwise' FFL where the levy increases based on the number of flights taken in a given period (this can be

FIGURE 2: SUPPORT FOR AVIATION DEMAND MANAGEMENT POLICIES



Source: YouGov 'Daily Polling', Fieldwork Dates: 26–27 November 2018. Prepared for 10:10 Climate Action differentiated using multiple bands for class and distance). A stepwise FFL is not the only approach, however. Two alternative approaches that could be employed to more closely correlate a levy with emissions are:

1. A 'percentage' approach: an increasing levy as a percentage of the ticket price.
2. An 'odometer' approach: an increasing levy based on the total distance flown.

Adding a percentage to ticket prices (e.g. 1% for flight one, 2% for flight two, 5% for flight three) is relatively straightforward to apply but may be a poor proxy for climate damage as ticket prices are determined by several factors beyond fuel use (and thus emissions). Compared to the stepwise approach, a percentage approach would disproportionately impact legacy carriers as their tickets are more expensive for the same journey distance compared to low-cost carriers.

Annex A explores the relationship between flight distance and flight price. The findings indicate that ticket price is not a good proxy for flight distance and, by extension, emissions. It is likely that price is driven predominantly by the time of purchase and overall demand, rather than by fuel use. For this reason, we have opted not to model the percentage approach.

An odometer-style approach measures the distance travelled by a passenger in a year and charges an increasing rate on the travel distance (for example £1 for the first 100km, £2 for the second 100km, £5 for the third 100km). A 2019 report produced by Imperial College London for the Climate Change Committee (CCC) recommended an 'Air Miles Levy' that escalates with the air miles travelled by an individual within a three-year accounting period.[35]

The main advantage of the odometer approach is that it directly aligns with distance and is closely related to emissions. A flight from London to Australia has approximately 15 times the carbon impact of a flight from London to Barcelona.[36] This approach could incentivise a change in the composition of flights with more short-haul flights and fewer long-haul flights leading to more flights in total for the same carbon budget. This contrasts with other levy approaches that could, in theory, incentivise people to take longer flights.

A disadvantage of the odometer approach is that there is a different kind of unfairness in basing a levy on distance, notably when it comes to individuals who are travelling long distances for an important reason like visiting family. However, the main reason we have discounted this approach in our analysis is because through the UK ETS, which charges per tonne of carbon emitted, the UK already operates a system which charges by distance (or will charge once the allocation of free allowances ceases). We envision the FFL as a policy which would replace APD (which itself replaces VAT) as a predominantly non-distance linked tax and, as with APD, would sit alongside the UK ETS.

The modelling in Section 3 adopts applies the original, stepwise design. The elasticities which form the backbone of the model are based on number of flights rather than distance travelled. Full details of the modelled FFL are described in Section 3.

Examples of progressive pricing by usage: increasing block tariffs for utilities
To manage prices for energy and water utilities, providers are sometimes required to use 'increasing block tariffs' (IBT). IBTs are a form of price discrimination where consumers are charged increasing amounts for different levels of energy or water use. For example, the first 10 units could be priced at £1 per unit, the next 10 at £2 per unit, and everything after that at £5 per unit reflecting the 'essential', 'moderate', and 'excess' use of the resource. There are several reasons why a progressive tariff structure would work even better for airlines than utilities, namely: purchase prices are visible and take place before the transaction to incentivise behaviour, levies are on individual tickets and avoid problems of household/ family size, and there is greater inequality in the distribution of air travel than utility use. Variable pricing is already accepted in airlines.

INCREASING APD

The approach of levying a flat tax across flights like the APD can, if set at the right level, limit aviation demand to a 25% increase above 2018 levels and a net zero world. However, at the moment, confirmed both in the CCC's calculations and in the DfT's own demand forecasts, the existing level of APD is insufficient to limit demand to sustainable levels. Section three analyses the distributional impacts of setting APD at a high enough level to achieve this goal.

NEW TECHNOLOGIES

This report does not model policy options that focus on developing new technologies. The CCC's assumption that a 25% growth in passenger demand since 2018 can be accommodated to 2050 – even as absolute emissions from aviation fall by around 20% – is already premised on a set of fairly optimistic assumptions about the rate of efficiency improvements in technology and airspace management. If this assumed rate of improvements is not achieved, the level of demand attenuation needed will be even greater.

In assessing the viability of synthetic fuels in supporting the UK's net zero ambitions, for instance, the CCC concluded that:

> *"synthetic fuels should not be a priority for government policy, but if the aviation industry wants to pursue them it should focus on demonstrating that these fuels, used in aviation, would be genuinely low-carbon, and could become cost-competitive and scalable in a global market."*[37]

Similarly, the CCC found little potential for new aircraft design and other technology-led reductions, noting that "a fully zero-carbon plane is not anticipated to be available by 2050, particularly for long-haul flights which account for the majority of emissions."[38] Lastly, the expectation that negative emissions technologies that can remove carbon from the atmosphere will be available at scale is already included in the CCC's 2050 net zero calculations that require limiting aviation demand to 25% above 2018 levels.

By keeping the UK ETS in place alongside all of the aviation sector policy packages considered in this report, we have maintained an incentive for aviation sector businesses to innovate and reduce per-flight emissions. For this incentive to function more effectively, an ETS style policy is required which covers all international flights, as opposed to EU routes. CORSIA, which does apply internationally, fails to deliver this same incentive, for the reasons given above. Notably, the existence of a carbon price on all departing flights, similar to that applied to EU destinations by the UK ETS, is assumed in the DfT's 2017 aviation forecasts, which (at the time of writing) represented the most up-to-date forecasts of the demand for air travel up to 2050. As such, there remains a gap between the regulatory environment forecast by the government and the environment currently being administered by the government.

3. MODELLING DEMAND SIDE POLICY OPTIONS

This section compares two policy options of aviation demand management through tax: a frequent flyer levy (FFL), and an uplift in Air Passenger Duty (APD). Both options are modelled at the rates necessary to limit air passenger demand to 25% above 2018 levels and meet the 2050 net zero carbon budget.

Our model combines flight and income data from the National Travel Survey with the Department for Transport's (DfT) latest demand forecasts to model different scenarios up to 2050. The report uses pre-pandemic aviation demand forecasts, despite uncertainty around how the pandemic may affect demand for flights, particularly business flights, as the DfT has not updated its forecasts since the onset of the pandemic. There is thus significant and unavoidable uncertainty. This is, however, always true with long-term forecasts, and this report is primarily concerned with the distribution of impacts, as the total quantity of flights will ultimately be capped by the carbon budget for aviation. In addition, as discussed earlier, the Climate Change Committee (CCC) estimates that UK aviation demand will return to pre-pandemic projected demand levels from 2024 in four out of six of its proposed scenarios, and experience from previous shocks to the sector suggests demand will bounce back, albeit after a few years. For example, while UK aviation emissions fell in the immediate aftermath of the 2008 financial crisis, and stayed approximately constant in the first half of the next decade, they then started to rise again and regained their 2008 level by 2018.[39]

We estimate the demand response for each policy option compared to the 'no policy change' option of business as usual, including a breakdown of demand changes by income quintile and by region of England. These demand responses are derived by applying elasticities of demand to price changes implicated by different FFL levels. The elasticities applied are those utilised by the DfT in its 2017 aviation forecast modelling. Separate elasticities are provided by the DfT for different flight types (business vs leisure) destinations (domestic vs international) and elasticity to change income and ticket price are supplied. The price of each flight is calculated by applying the appropriate levy-level to each flight taken by each income quintile. The number of flights taken by each quintile is derived from data extracted from the National Travel Survey (NTS). Annex D explains the data and methodology in further detail.

RESULTS

Table 1 shows a hypothetical tax schedule for a FFL, sufficient to contain demand growth to 25% over 2018 levels in 2050. This schedule is illustrative, as many different schedules with different distributions and weightings towards higher/lower flight counts could meet the desired target. The first flight is charged £0, the second flight £25, and the increment increase rises by £10 thereafter (£35, £45, £55) for each additional flight. This levy schedule is applied to flights within a year. Following the Carmichael proposal,[40] this year can be set based on birth year rather than a calendar year to smooth demand. In line with the idea of 'a free ride' on leisure flights,[41] the first leisure flight is charged £0 whereas for business flights the levy schedule shifts forward one flight (£25 on the first flight). This also supports the IEA's recommendation that reducing the frequency of business travel should be a particular priority if the sector is to meet its climate targets.

Differentiation by purpose of travel is required to avoid work travel affecting the levied rate for an

TABLE 1: PROPOSED TAX SCHEDULE FOR A FREQUENT FLYER LEVY

Flight	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Leisure (£)	0	25	60	105	160	225	300	385	480	585
Business (£)	25	60	105	160	225	300	385	480	585	700

Source: Authors' calculations

TABLE 2: AVERAGE NUMBER OF FLIGHTS AND COSTS INCURRED BY INCOME GROUP IN 2050 (2016 PRICES)

Income quintile	Number of flights (No policy change)	Number of flights (FFL)	Percentage change	Average cost per flight (FFL)	Total cost for all flights (FFL)
Lowest real income	1.30	1.31	+0.5%	£5.91	£7.75
Second level	1.48	1.47	-1.0%	£7.99	£11.75
Third level	2.13	2.03	-4.9%	£13.20	£26.80
Fourth level	2.62	2.40	-8.4%	£20.42	£49.00
Highest real income	5.37	3.77	-29.7%	£43.99	£165.85

Source: Authors' calculations

individual taking personal flights (and vice versa). This differentiation opens the possibility of tax avoiding behaviour, for example misstating one form of transport for another. This could become a material problem if business flights were exempt or were charged at a low rate, especially in a context of low barriers to business creation (including self-employment), and business activity not being monitored or enforced. The levy structure proposed here, with a higher rate charged on business flights, mitigates the likelihood of a business being created for the purposes of FFL tax evasion. There are also policy options to change business monitoring that can be applied to reduce the likelihood of tax evasion (e.g. separate registration process for FFL purposes, a FFL return submitted as part of annual tax return, auditing and penalties).

The changes in demand in 2050 if a FFL was introduced from 2020 onwards are shown in Table 2. In a FFL scenario, the lowest real income group gains a slight increase (+0.5%) in average flights taken compared to an unconstrained growth in passenger demand ('no policy change'). By far the highest reduction takes place in the highest income quintile (-29.7% compared to 'no policy change'). This is because the richest 20% are forecasted to take on average 5.37 flights in 2050, facing levies of more than £100 per ticket from the fourth flight onwards. The results show that while this FFL scenario contains demand growth within the CCC's net zero ambition, lower income groups can still afford to fly.

Because of the levy's escalating structure, frequent flyers face a higher average charge (dividing the total tax bill by the number of flights taken). Those in the highest income group will pay an average tax of £43.99 for a return flight because of high charges for the third and fourth flight. Actual rates paid will be £700 or higher for 'high frequency' flyers as shown in Table 1.[1] Those in the lowest income group, on the other hand, pay an average of just £5.91 per flight which is about half of existing APD for an economy flight.

Comparing FFL to non-differentiating tax options

This section compares the FFL to a tax that would achieve the same environmental outcomes but does not vary by the number of flights a person takes. A non-differentiating tax could be an increase to the existing APD, or a carbon tax.

In reality, these would differ as follows. A carbon tax would vary with emissions per seat, that is by distance and class flown. One would expect the ticket for a first-class trip to Australia to include a much higher carbon cost than an economy class seat to Germany. Increasing the current APD bands is a less accurate reflection of actual emissions per seat but would also differ by distance and class flown. However, because we are using the DfT's average cost forecasts to model the demand response, the results show up as an average carbon tax, or average APD increase added to a ticket.

1 However, these high rates do not enter our calculations as the model runs on averages, and the highest income average is between five and six flights. The extent to which the highest earners will respond to such high fees depends on their individual willingness to pay, price elasticity, and the availability of alternative modes of travel.

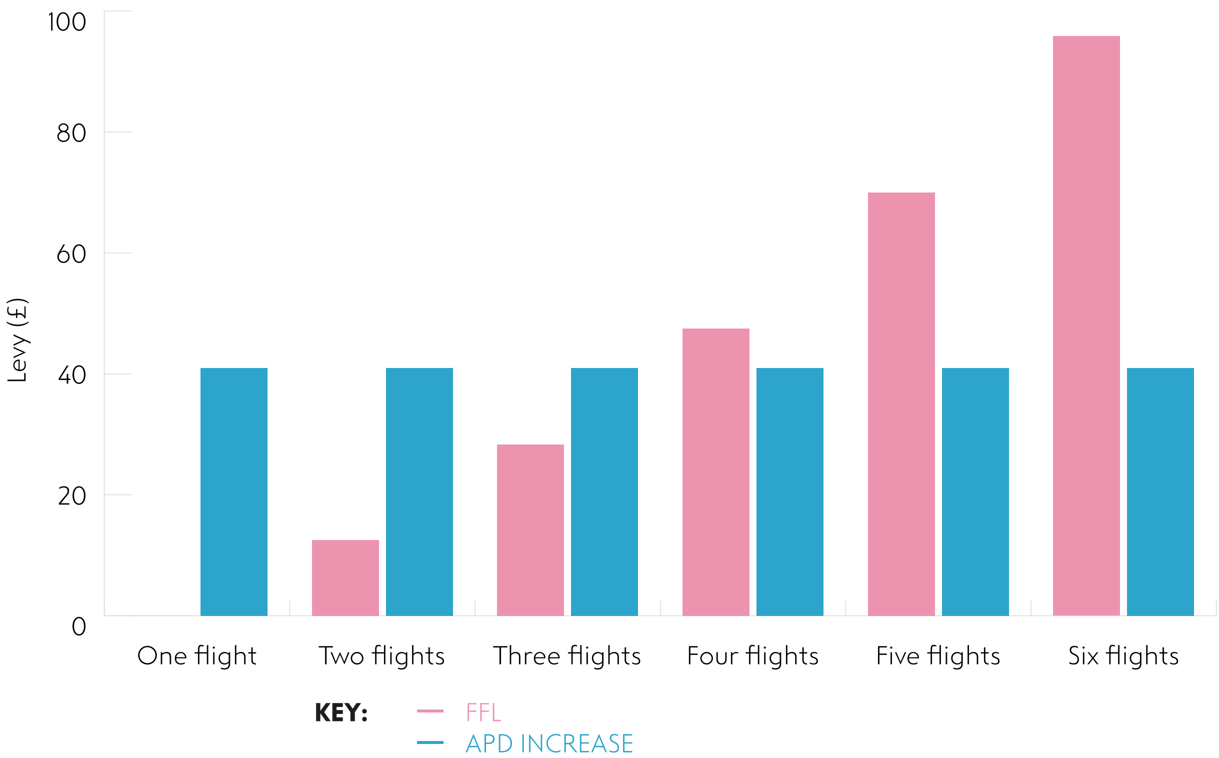
TABLE 3: PROPOSED TAX SCHEDULE FOR A NON-DIFFERENTIATING TAX

Flight	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Tax £	41	41	41	41	41	41	41	41	41	41

Source: Authors' calculations

FIGURE 3: THE AVERAGE TAX PAID PER FLIGHT RISES STEEPLY THE MORE FLIGHTS THE INDIVIDUAL TAKES OVER A 12-MONTH PERIOD. AFTER FOUR FLIGHTS THE TAX PAID SURPASSES THE AVERAGE AMOUNT PAID UNDER THE APD SCENARIO

Average tax levied per leisure flight by number of flights taken under two policy scenarios



Source: Authors' calculations

Constraining demand growth to 25% over 2018 levels with a non-differentiating tax requires an average increase of £41 for each ticket, as shown in Table 3.

This is equivalent to a CO_2e price of £150 per tonne,[2] or a roughly £30 increase of the existing APD rate for short-haul economy class flights. Compared to the FFL, both 'non-differentiating' policy options make flying more expensive for those that take few annual flights. Figure 3 calculates the average tax levied per leisure flight by number of flights taken in each policy scenario. A person taking three flights a year pays an average of £28 per flight under the FFL scenario ((0+25+60)/3), while they pay an average of £41 per flight with an APD increase. Only from the fourth flight onwards is the FFL more expensive, on average, than a non-differentiating charge.

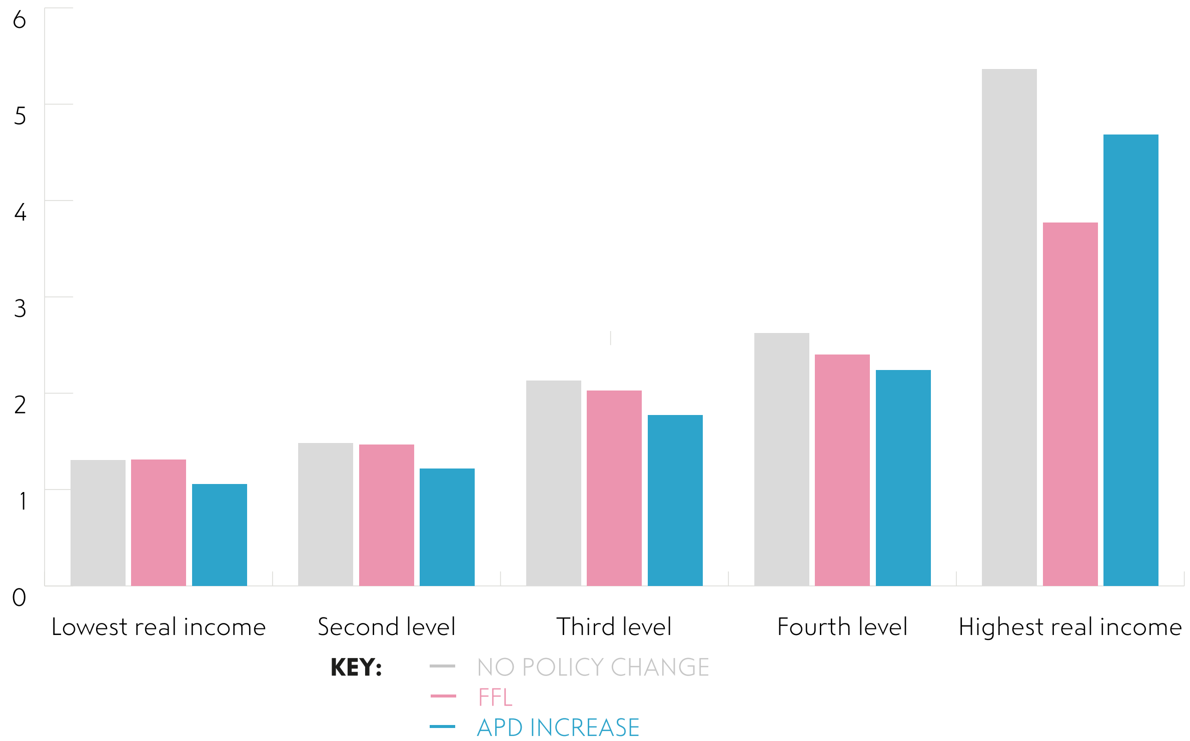
Only the highest income group is expected to take an average of more than three flights per person in 2050. As a result, the policies differ substantially in who gets to take flights in 2050 (see Figure 4 below). The FFL allows all but the highest income groups to take more flights in 2050 than the 'non-differentiating' option.

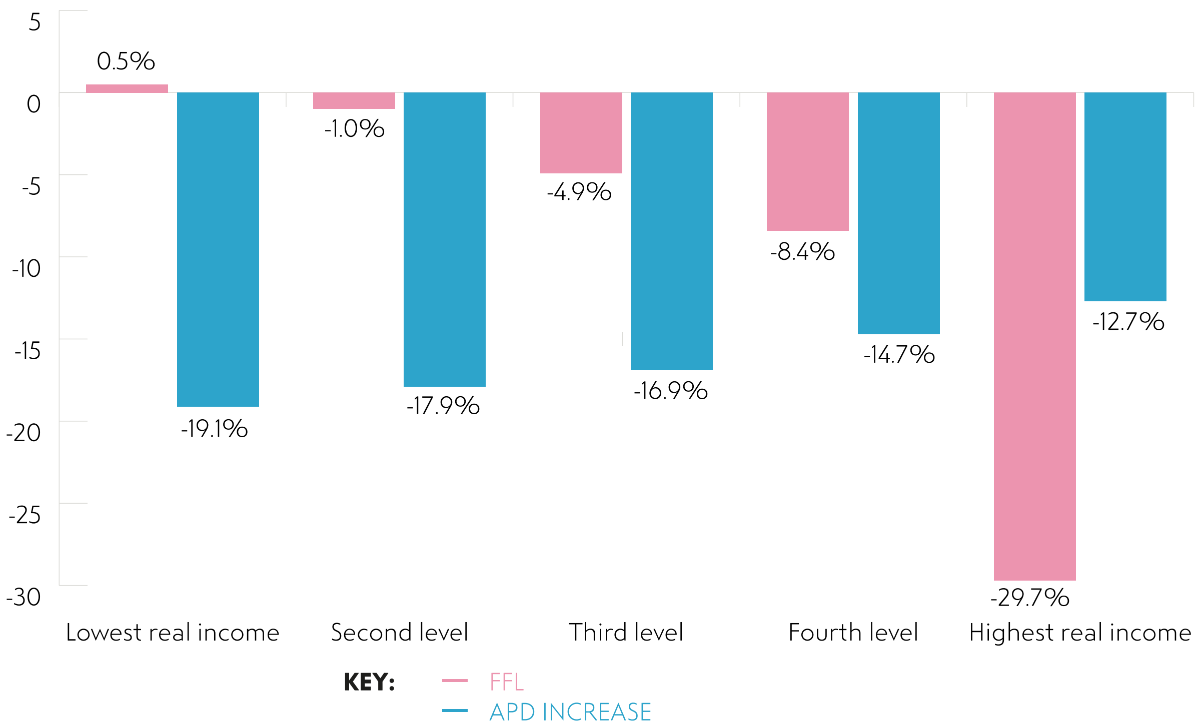
A non-differentiating policy option, such as APD increase, requires the richest quintile to fly just 13% less while the poorest quintile fly 20% less.

2 Authors' calculations based on CAA airport data for 2016 and 2018. Assumes that the emissions per person on an average flight are (total domestic emissions + UK originating international emissions) / (total domestic passengers + (0.5 x international passengers).

FIGURE 4: AN APD INCREASE IS A REGRESSIVE POLICY, RESULTING IN LARGER REDUCTIONS IN THE NUMBER OF FLIGHTS TAKEN BY LOWER INCOME INDIVIDUALS. THE FFL SEES HIGHER EARNERS REDUCE THEIR FLIGHTS PROPORTIONATELY MORE

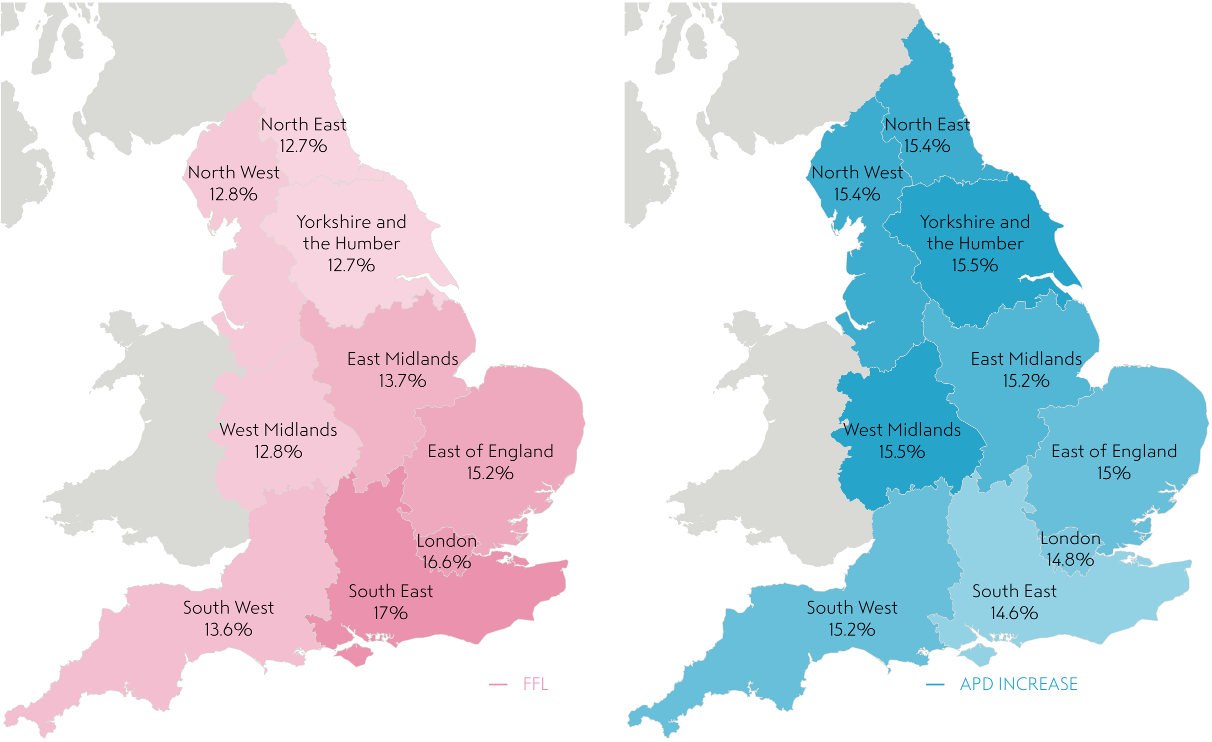
Average number of flights by income group in 2050 compared to no policy change (top) and the percentage change in the average number of flights taken by individuals in each income group compared with the no-policy-intervention baseline (bottom)





Source: Authors' calculations

FIGURE 5: DEMAND REDUCTION IN 2050 COMPARED TO NO POLICY CHANGE BY REGION OF ENGLAND



Source: Authors' calculations

Regional impact

The NTS provides information on the region of England in which respondents live. This allows us to match flight frequency, income and location and to assess the geographical impact of the different policy options.

To understand the regional impact, we first determine how many people of each income group live in each of the regions (see Annex C). We then multiply the estimated national demand responses for each income group (Figure 4) with the percentage share of that income group living in a region. Adding up these 'region-income' responses produces the average expected demand response for a person in each region, weighted by the income distribution in that region. Results for 2050 are shown in Figure 5.

Under a FFL, the highest percentage reduction in air travel demand would be in the South East and London, followed by East of England. This is because proportionally more high-income people live in these regions, take more flights and will be subject to higher tax rates when they fly frequently. A 'non-differentiating' option like the APD increase, on the other hand, results in a relatively even demand response across all regions (around 15% reduction).

The policy options vary strongly in their ability to raise government revenue. Projecting our flight estimates onto 2050 population numbers shows that the increased APD can raise over £7bn pounds in government revenue, more than three times as much as the DfT's forecasted APD (no policy change). The model further suggests that a FFL can raise over £5bn pounds although the true figure is likely to be much higher due to extreme frequent flyers not captured in the model's averages.

Comparison to different climate scenarios

The CCC's net-zero target by 2050 has been criticised for not decarbonising the economy fast enough.[42] Therefore, we estimate the tax rates required to meet two stricter, alternative carbon scenarios: no growth from 2018 levels (0% until 2050), and Zero Carbon Britain's scenario of cutting current demand by two thirds (-66.7% until 2050). Both scenarios require substantially higher tax rates than the net-zero scenario, as reported in Annex E. The strictest scenario (Zero Carbon Britain) requires a levy to be charged from the first leisure flight onwards, so not everyone who currently flies would be able to take a flight in the future under this scenario.

4. SUPPLY-SIDE POLICY THROUGH AIRPORT CAPACITY CONSTRAINTS

LIMITING THE SUPPLY OF FLIGHTS THROUGH AIRPORT CAPACITY CONSTRAINTS

As an alternative (or additional) approach to the demand-side policies analysed in Section 3, supply-side policies could be used to bring down the emissions of the UK aviation sector to a level compatible with net zero. Airport capacity will play an important role in the regional dynamics of the UK's future industrial strategy. Airport capacity is also likely to have some level of influence on the regional distribution of passenger departures under any of the emissions reduction approaches considered. In their 2021 progress report to parliament, the Climate Change Committee (CCC) made a number of recommendations on airport capacity. This included:

> *"Government should not plan for unconstrained leisure flying at or beyond pre-pandemic levels in its strategy for airport capacity and demand management"*

The CCC also made a very clear recommendation:

> *"There should be no net expansion of UK airport capacity unless the sector is on track to outperform its net emissions trajectory. Government needs to assess its airport capacity strategy and develop and put in place a demand management framework to assess and, if required, control sector GHG missions and non-CO2 effects."*[43]

Here we consider a scenario in which airport capacity constraint is used as the primary policy lever for curtailing aviation sector emissions. In its crudest form, supply side policy involves capping the departure numbers at any given airport. Such a cap could either apply to passenger departures or plane departures and a cap might take many forms, examples are shown in Table 4.

In the following section we use a simple model to test the extent, and likely impact, of policies that

TABLE 4: POTENTIAL FORMS OF CAPACITY CONSTRAINT, ADVANTAGES AND DISADVANTAGES

Form of capacity constraint	Example	Advantages	Disadvantages
Applying a flat percentage reduction to departures at every UK airport.	5% reduction in departures at every UK airport.	Simple design.	Assumes that present-day airport capacity distribution is optimal. Hurts airports which are already near capacity far more than those with spare capacity.
Giving an allowance to each airport according to its size and the characteristics of the people who form its 'catchment'.	Wales contains 5% of the UK's population so Cardiff airport is allocated 5% of the pool of flights.	Has an implicit element of regional fairness.	Ignores the fact that flight departures are currently concentrated in certain regions.
Implementing a cap-and-trade system in which airport can bid for the right to fly.	Similar to the principle of a carbon cap and trade, airports pay for their flight allocation.	Theoretically produces the most 'market optimal' allocation.	Strongly benefits those who have the capacity to pay, at the expense of the poorer.

Source: NEF

constrain capacity. The levels of constraint mirror Section 3: net-zero in 2050, net-zero in 2030, and capped demand at 2018 levels.

DATA

As before, the model uses the Department for Transport (DfT's) Aviation Forecasts from 2017, including projected ticket prices and airport capacity levels. In line with demand-side modelling in Section three, we use the average ticket price minus the cost of carbon to model the price response.

Some discrepancies were identified where passenger departures in 2018 – as reported by the Civil Aviation Authority (CAA) – appeared higher than the DfT's modelled capacity. In this instance either capacity in later years of the DfT model was utilised, or capacity as reported by Finney and Mattioli (2019).[44] Different capacity levels are shown in Annex F.[3] Passenger numbers in 2018 were around 282 million and total capacity was estimated at 341 million. DfT plans, as of the 2017 aviation forecasts, would take capacity to 450 million by 2050. We assume that expansion of Birmingham airport goes ahead, with or without Heathrow expansion

METHOD

To the baseline level of capacity (2018), we applied levels of constraint sufficient to achieve the rate of reduction required for different carbon scenarios. As we do not have access to the DfT's underlying model it was not possible to fully model the redistribution of passengers. Lower capacities being set at already full airports would likely lead to some (but not complete) redistribution to nearby airports with remaining capacity. Our model produces scenarios of:

1. total redistribution and
2. zero redistribution

The true value will fall somewhere within this range. Rough estimation of airports which are likely to capture 'spillover' from at-capacity airports can be conducted using the DfT's sensitivity scenarios.[45]

In order to provide rough estimates of the price impact of capacity constraints we make the crude assumption that in a functioning market, when supply is constrained, prices will rise to the highest level possible at which all capacity remains utilised. Multiplying the percentage change in flights taken caused by the capacity constraint with the DfT's overall airfare price elasticity of -0.6 provides an estimate of the percentage change in average ticket price to be expected from the policy.

RESULTS

If Heathrow expansion goes ahead, the CCC's least stringent target – no more than a 60% rise in passengers over 2005 levels (25% growth over 2018 levels) – would become unachievable even if all remaining airport capacities were frozen at 2018 levels. A third runway at Heathrow would require a reduction in capacity elsewhere by approximately 5–9% – equivalent to closing Birmingham or Manchester airport. All plans and planning applications currently under-consideration at other UK airports, notably Southampton (approved in April 2021), Leeds Bradford (currently under review), and Bristol (the airport is currently appealing North Somerset Council's 2020 rejection of its expansion bid), would also have to be rejected. In contrast, maintaining 2018 capacity at all airports, including Heathrow, would have a smaller price impact, and this impact can be distributed in different ways according to the chosen constraint mechanism (see Table 5).

As shown in Table 5, achieving more ambitious levels of carbon reduction can be achieved through capacity constraint from 2018 levels, as well as cancellation of currently outstanding expansion plans. Freezing passenger departures at 2018 levels requires capacity constraint in the region of 17–26% depending on whether Heathrow expansion goes ahead. With Heathrow expansion, the required constraint is equivalent to closing Birmingham, Manchester and Aberdeen airports. The need for capacity constraint reflects the expected future growth in demand for flights in the DfT's aviation sector model, which would otherwise lead to increased utilisation of currently-under-capacity airports. This leads to a price impact in the region of £51–£63 depending on the Heathrow expansion scenario and the extent of passenger overspill from at-capacity airports (Table 5). Meeting the most stringent target modelled here, the 66% reduction on 2018 passenger departures set in the Zero Carbon Britain report, requires very significant capacity constraint. This constraint is estimated

3 Note we only restrict our model to the UK's major airports open to use by all members of the public.

TABLE 5: SCENARIOS OF AIRPORT CAPACITY CONSTRAINT AND CORRESPONDING PRICE RISES
Ranges represent the differences between zero, and total redistribution of passengers from at-capacity airports

Climate target	Heathrow expansion decision	Capacity change compared to 2018 baseline (%)	Change in maximum passenger capacity compared to 2018 baseline	Airports reaching capacity in 2050 based on DfT forecast (cumulative)	Expected average base price response compared to DfT forecast price (%)
Current DfT 'unconstrained' forecast – Breach of all CCC targets	Expanded	+32% (DfT planned sector growth)	+109 million	Bristol, East Midlands, Gatwick, Heathrow, Leeds-Bradford, Luton, Stansted	0
Current capacity + Heathrow 3rd runway – Breach of all CCC targets	Expanded	+12% (capacity frozen at 2018 levels + Heathrow)	+40 million	+ Birmingham, Edinburgh, Exeter, Glasgow, Inverness, Liverpool, London City, Manchester, Southampton	£17 to £25 (+16% to +23%)
CCC 60% growth target met	Expanded	-5% to -9%	-27 million		£29 to £35 (+27% to +33%)
CCC 60% growth target met	No expansion	0% (capacity frozen at 2018 levels)	0	+ Bournemouth	£25 to £30 (+23% to +28%)
Passenger numbers frozen at 2018 levels	Expanded	-23% to -26%	-99 million		£60 to £63 (+55% to +58%)
Passenger numbers frozen at 2018 levels	No expansion	-15% to -17%	-58 million	+ Cardiff, Southend	£51 to £55 (+47% to +50%)
Zero carbon Britain aviation sector scenario	Expanded	-73%	-278 million	All major airports at capacity	£136 to £137 (+126% to +127%)
Zero carbon Britain aviation sector scenario	No expansion	-70%	-239 million	All major airports at capacity	£133 to £134 (+123% to +124%)

Source: Authors' calculations

in the region of 70% from today's levels. The corresponding price increase would be significant, we estimate an increase in the region of +125%, adding around £135 to the expected average ticket price.

As capacity constraint increases, airports hit terminal capacity at different points. London airports hit capacity under all scenarios (see Table 5). Larger regional airports (e.g. Edinburgh) hit capacity when expansion is frozen at today's levels, and some smaller regional airports (e.g. Southend) hit capacity when tighter constraints are applied. All airports are likely to hit capacity under the Zero Carbon Britain scenario. While Table 5 shows projected average price rises, these rises are likely to be unevenly distributed around the UK airport system. Airports with greatest demand are likely to be able to raise ticket prices the most, meaning rises in and around London.

Airport capacity constraint is not a progressive approach to aviation sector carbon reduction. In this scenario, poorer consumers in the London and South East region are likely to be penalised and priced out of flying. As demand increases at regional airports – amid overspill from London and in scenarios of capacity constraint – prices there may also begin to rise, pricing out poorer consumers. Critically, the revenue generated by raising prices will be captured not by the state through a system of taxation, but by the airlines and airports. Some state revenue might be raised by taking a cap-and-trade approach to capacity constraint, but this system would be particularly regressive, likely making flying exclusive to the UK's wealthiest travellers and highly concentrated in London and the South East. In summary, while no further UK airport expansion is consistent with any of the climate targets assessed, our argument here is that constraints on UK airport capacity should not be relied on as the exclusive means of managing passenger demand within safe limits.

5. IMPLICATIONS OF CAPPED PASSENGER NUMBERS ON AVIATION SECTOR EMPLOYMENT

When considering the fairness of aviation tax policy, it is also important to assess the potential impacts of different approaches on job security and the quality of employment in the sector. As employment levels in aviation are closely dependent on passenger numbers, any policy which aims to suppress growth in passenger numbers will inevitably also suppress potential growth in employment. At the national level, different approaches to capping passenger departures are likely to have similar results in terms of their impact on aggregate employment. However, different approaches will have different distributional impacts by geography. Suppressing demand via flat rate taxes (carbon tax/Air Passenger Duty (APD)) suppresses demand at regional airports more than at airports in London and the South East, while the frequent flyer levy (FFL) has the opposite effect. On this basis, the FFL is likely a better policy than an APD increase from the perspective of protecting employment in the UK's poorer regions. The impact of suppressing passenger numbers through airport capacity controls alone will depend entirely on how capacity is distributed across the country.

A perhaps greater driver of changes in the future employment potential of the UK's aviation sector will be the rate of automation in the workforce. Over the past 20 years, automation and efficiency drives have reduced the sector's job intensity (e.g. the number of jobs sustained per passenger) by an average of around 2.6% per year.[46] The challenge this presents, and where climate policy becomes significant to current aviation sector employees, is that passenger growth is required just to maintain existing employment levels. The impact of curtailing passenger growth with climate policy, is potentially to put some jobs at risk of redundancy, but in the short to medium term this has already been circumvented by the effects of Covid-19 pandemic, which has temporarily (at least) reduced passenger numbers much further than the cap necessitated by current climate goals.[47] Covid-19, automation and corporate efficiency drives (including use of insecure contracts and practices such as 'fire and rehire') therefore remain the pre-eminent threat to the security of work in the sector.

With work in aviation facing a short-term crisis, and long-term automation and climate policy risks, there is a clear case for a wider package of employment and employability support to aviation sector workers. In 2020, NEF worked with aviation unions to set out an initial policy infrastructure to support this process. This included: a sector panel bringing together businesses, unions, and government to oversee a sector wide crisis recovery strategy; union-negotiated restrictions on redundancy rates and a government backed job protection scheme; legislating a right to retrain and upskill to prepare workers for the green transition; as well as new sector tax policies which can help cover the government's costs in supporting workers through the green transition.[48]

Improving access to retraining and upskilling and providing the necessary income support while in education represents a particularly important offer. Not only to address the UK's macroeconomic issues, such as stagnant productivity and labour supply imbalances, but also to support lower wage earners currently working in aviation to find good quality work. However, the policy package described above represents only a rough outline of a potential sector scheme. In order to prevent workers slipping through the cracks in such policies, and to avoid failings that have left communities across the UK behind over the past three decades, a deeper worker-led approach to designing supportive transition arrangements is required. Such an approach is essential to understanding issues such as aspiration and local cultural identity, and to removing wider barriers to job transitions, such as the availability of local opportunities, and factors inhibiting access to work for underrepresented groups such as women and ethnic minorities.

6. KEY MESSAGES AND POLICY IMPLICATIONS

For a number of years, the aviation sector has been afforded an extremely generous bespoke tax arrangement. Recently it has received further state support in the form of emergency loans and wage subsidies through the Covid-19 pandemic.[49] A new aviation policy is required both to ensure a fair return to the public and to ensure the UK government meets its net zero climate target set in line with the Paris Climate Agreement. To stay within the available carbon budget there is no business-as-usual option. According to the Climate Change Committee (CCC), the effective cap on aviation emissions is 25% above 2018 levels.

The challenge is to apply this cap fairly. Any aviation policy to achieve this limit is a judgment on how these flights should be distributed. This is a political choice over who gets to fly in the future and who pays for carbon emissions from flying. This report compares a frequent flyer levy (FFL) – which incorporates a progressive structure – to:

1. an increase to the existing Air Passenger Duty (APD)
2. airport capacity constraints to limit aviation supply.

Table 6 summarises how the different options compare to each other. Our results reveal that the policy options differ substantially in terms of who could fly in 2050. A FFL would see the greatest reduction in future demand from frequent flyers and the highest income quintile (-30%), with almost no change in lowest quintile. Even if some very wealthy frequent flyers do not respond to the highest tax rates of £700+, our calculations show that considerable reductions are achievable in the top-income quintile.[4] Non-differentiating policy options like APD have the opposite effect: the biggest reduction for the poorest quintile (-19%) and smallest reduction for the richest quintile (-13%). In terms of regional impacts, FFL would generate the largest reductions in London and the South East where a higher proportion of high-income earners and frequent flyers are located.

Constraining airport capacity can also meet aviation's carbon budget. Here, income and geographical impacts diverge. Although constraining airport capacity would be good news for regional airports that could absorb excess capacity from elsewhere, lower income groups could be priced out of the market, in a similar way to the scenarios that increase APD. Airport capacity constraints are also the least desirable option from the government's perspective because the additional revenue raised through increased ticket prices goes to the airline rather than the government.

This distributional analysis of available supply and demand side aviation policies reveals that not only is a FFL the most popular of the available policies, but it is also the fairest. The policy options also vary strongly in the extent to which they can raise government revenue.

4 The model runs on quintile-averages of flights taken, the true response will depend on the actual number of flights taken, as well as the individual's willingness to pay and individual price elasticity.

TABLE 6: SUMMARY OF THE POLICY OPTIONS

Policy/impact	APD increase	Carbon tax	FFL	Capacity constraint
Description	Increase existing APD.	Replace existing APD with a tax per tonne of carbon emissions.	Replace existing APD with a per-ticket charge that increases progressively with each additional flight taken in a calendar year.	Limit airport capacity, for example not allowing airport expansions to go ahead and limiting the number of planes allowed to take off.
Distribution of flights by income	Shows a regressive distribution of flights where the lowest income group fly 19% less and the highest income group 13% less than without a policy change.	Shows a regressive distribution of flights where the lowest income group fly 19% less, and the highest income group 13% less than without a policy change. Expectedly more progressive if higher income groups fly longer distances.	Shows a progressive distribution of flights where the lowest income group flies 0.5% more and the highest income group 30% less than without a policy change.	Difficult to predict as it will vary across airports depending on their existing excess capacity. Poorer people near near-capacity airports are likely to be priced out of flying.
Distribution of costs by income	All income groups face the same average costs (£41).	All income groups face the same average costs (£41).	The first leisure flight is tax-free for everyone. The lowest income group faces an average levy of £5.91 for 1.31 flights, while the frequent flying behaviour of the richest quintile increases the average charge to £43.99 per flight.	Difficult to predict as it will vary depending on existing airport capacity as well as the availability and price of ground transport to airports below capacity.
Distribution of flight by region of England	Shows the highest reductions in the North East, and Yorkshire and the Humber.	Shows the highest reductions in the North East, and Yorkshire and the Humber.	Shows the highest reductions in London and the South East.	Unevenly distributed across airports, depending on existing excess capacity. Airports with much excess capacity can continue to grow, while those already at the limit face reductions.
Government revenue	Higher tax revenue than existing APD.	Higher tax revenue than existing APD.	Higher tax revenue than existing APD.	No tax revenue for the government as surplus revenue from the price response accrues fully to the private sector.
Incentives	Loosely aligned with per-flight emissions due to APD banding by class and distance. Does not discourage frequent flying.	Closely aligned with per-flight emissions due to per-tonne charge on air carriers. Does not discourage frequent flying.	Not aligned with per-flight emissions due to flat rate. Strongly discourages frequent flying, thus closely aligned with per-person emissions.	Not aligned with per-flight or per-person emissions. Does not discourage frequent flying.
Complexity	Can use existing APD infrastructure.	Might be implemented via expansion of the new UK Emissions Trading System.	Set up new infrastructure.	Requires complex decisions where to reduce capacity.

Of course, a government implementing a FFL could alter the proposal set out in this paper to consider per-passenger emissions. Rather than just increasing by the frequency of flying, the tax schedule could differentiate by class of travel. First/business class seats could have higher rates as they take up a larger proportional share of the plane and are responsible for more emissions.

Moreover, it must be noted that while we model the options as alternatives, in practice they could be combined. Abandoning some airport expansion proposals, a FFL, alongside an international carbon price would make it more likely that demand would be kept to safe levels than if a single policy option were relied on. A policy mix could also maximise tax revenue for government to support decarbonisation and promote zero carbon travel alternatives. This is preferable to returns on increased ticket prices accruing to airlines and airports under airport capacity constraints.

Not only will aviation consume a third of the UK's future carbon budget, aviation use is heavily skewed towards the most well off in society. In addressing aviation emissions, we have the choice of compounding this problem by raising the price of all tickets or tackling it with a FFL. There are choices in design, but the fundamental feature of a FFL is that aviation policy can be made progressive, setting an example for other areas of environmental policy.

ANNEXES

The calculations detailed in the following annexes were based on the best available data at the time of production, and as such do not capture some recent impacts of the Covid-19 pandemic, and the public health measures applied in response to it. As the modelling horizon runs to 2050, and the aviation sector has demonstrated on multiple historic occasions its ability to bounce back from external shocks these projections are considered to be robust for long-term decision making.

ANNEX A: FLIGHT PRICES AND DISTANCE

To analyse the relationship between flight distance and flight price we used the kiwi.com API to retrieve data on UK flights for 90 days from 01/02/2020. The API endpoints used were api.skypicker.com/flights for flight searches, and api.skypicker.com/airlines to convert airline codes to airline names (e.g. FR -> Ryanair).

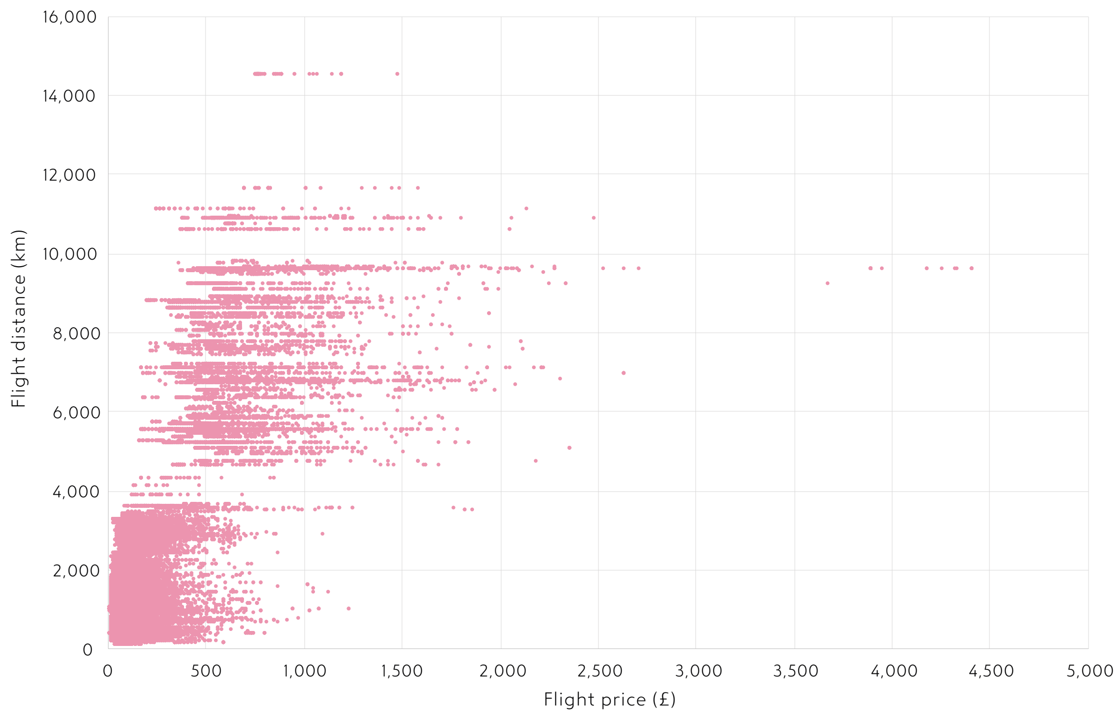
The key search parameters used in both the preliminary and final runs were:

- Airport IATA codes for departure and destination airports
- one-way flight for one adult
- economy fare
- no luggage or extras
- any airline
- paying in GBP.

Of the maximum possible number of date/route combinations (90 days x 1092 routes = 98,280 searches), 77,884 searches returned at least one flight on the date. This provided a total of 210,976 individual flights operated by 95 airlines. Figure A1 plots these data points.

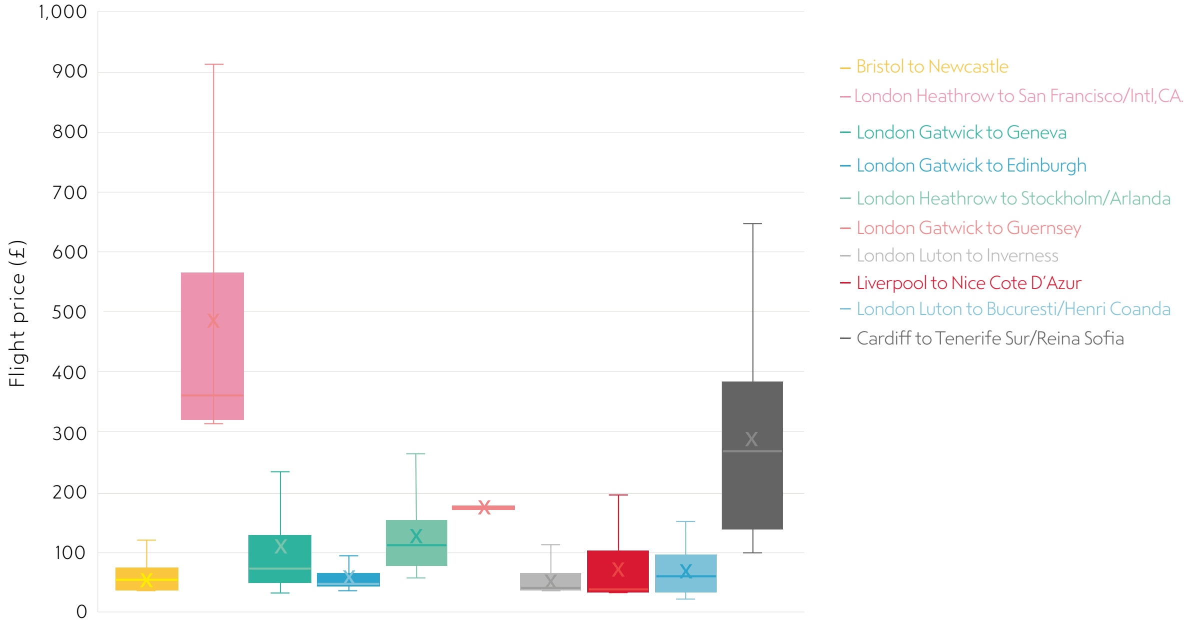
With an R2 of 0.6, the correlation suggests that ticket price is not a good proxy for flight distance and, by extension, carbon emissions. Figure A2 below confirms this, showing a wide range of prices for each of the ten randomly generated flight routes (i.e. the same distance). It is likely that price is driven predominantly by the time of purchase and overall demand, rather than by fuel use.

FIGURE A1: CORRELATION BETWEEN FLIGHT DISTANCE AND PRICE IN THE UK



Source: Authors' calculations based on Kiwi.com data download for flights 26/01/2020–26/03/2020

FIGURE A2: TICKET PRICE FROM TEN RANDOMLY GENERATED FLIGHT ROUTES FROM THE UK OVER A 90-DAY PERIOD



Source: Authors' calculations based on Kiwi.com data download for flights 26/01/2020–26/03/2020

We consider the method used to be robust in terms of the very high coverage of flights from the UK market. However, there are a few important considerations with this approach:

- Prices are a snapshot and likely to change over time. Were we to repeat the data collection at a different time, prices would be different.
- Data only covers 90 days, Feb-April which lie outside of typical peak demand periods such as the summer or Christmas holidays when prices might be even higher.
- Business passengers may have lower negotiated rates, though this is unlikely to influence prices for personal flights.
- Passenger numbers/routes are from 2018 and airlines may have made changes to routes since then.

To randomise route selection, we used information on the frequency of flights leaving UK airports from the Eurostat dataset on air passenger transport. This dataset contains quarterly passenger numbers for each route with the most recent complete calendar year being 2018. Ten flights were randomly selected using Microsoft Excel's RDM function weighted by frequency.

ANNEX B: PRINCIPLES OF TAXATION

In the application of taxes (like the APD, a FFL, or a carbon tax), certain principles have been generally agreed upon. The Ottawa Taxation Framework Conditions developed five such principles (neutrality, efficiency, certainty/simplicity, effectiveness/fairness and flexibility), similar in content to the original four principles of taxation (fairness, certainty, convenience and efficiency) set out by Adam Smith in The Wealth of Nations (1776).[50] A sixth principle of equity has been added to the Ottawa Taxation Framework Conditions in many recent frameworks, for example the one used by the OECD.[51] The principles of taxation are as follows:

TABLE B1: ASSESSING AVIATION DEMAND MANAGEMENT POLICIES AGAINST TAX PRINCIPLES

Principle	APD increase	Carbon tax	FFL
Meets policy intent	Emission reductions are achieved if the duty is set at the right level.	Emission reductions are achieved if the tax is set at the right level. A carbon tax could provide an incentive for fuel efficiency and therefore increase the flight opportunities within an available carbon budget.	Emission reductions are achieved if the levy is set at the right level.
Neutrality: A tax that is neutral between different forms of activity contributes to efficiency by ensuring that optimal allocation of the means of production is achieved.	Overall efficiency is achieved if the duty is set at the right level. Economic efficiency is undermined by several exemptions including under 16s, flights from the Scottish Highlands and Islands and <24hr transfers.	Economic efficiency is achieved as a carbon tax is neutral at the point of being levied.	Economic efficiency will not be fully achieved as a FFL intentionally discriminates between passengers (or potentially purpose of travel). A FFL is not neutral over time as prices escalate within an accounting period.
Efficiency: Compliance costs to business and administration costs for governments should be minimised as far as possible.	Existing APD has proven efficient to apply.	Carbon taxes have proven efficient to apply.	A FFL requires the creation of a new database of passports that links to ticket prices.
Certainty and simplicity: Tax rules should be clear and simple to understand, so that taxpayers know where they stand (more likely to make optimal decisions and respond to intended policy choices and fewer losses from tax planning).	Many air passengers are unaware of the existing APD, so awareness of an APD increase might be limited.	Airlines, as the taxpayer (at the point of being levied), would be aware of the tax.	The FFL is more complex than an APD increase or a carbon tax. Taxpayers would most likely be aware of the FFL due varying rates across flights and over time.
Effectiveness and fairness: Taxation should produce the right amount of tax at the right time. It avoids double taxation and unintentional non-taxation, while minimising the potential for evasion and avoidance. Enforceability is a critical component.	While the current APD is too low to be effective, the structure itself has proven to work in application. Domestic airlines object to 'double taxation' from APD, although they avoid taxes from aviation policy in other countries.	The international dimension of air travel carries a significant risk of 'fuel tourism' where planes simply fill up with fuel outside the UK (unintentional non-taxation).	The interaction between business and leisure travel could present problems of double taxation or non-taxation which can be minimised by design solutions. There may be tax avoidance through passport issuing, especially with foreign passports.

Flexibility: Structural features of the system should be durable in a changing policy context. But they should also be flexible and dynamic enough to allow governments to respond as required to keep pace with technological and commercial developments.	The duty is flexible as the rate can be changed.	The tax is flexible as the rate can be changed.	The levy is flexible as the rate can be changed.
Equity: With horizontal equity, taxpayers in similar circumstances bear a similar tax burden. Vertical equity is a normative concept with many potential definitions. For example, one common view of equity is that taxpayers in better circumstances should bear a larger part of the tax burden as a proportion of their income.	The APD targets neither equity in environmental impacts nor equity in sharing the carbon budget.	A carbon tax targets equity in environmental impacts as flights would be taxed in proportion to their emissions, following the 'polluter pays principle'.	A FFL targets equity in distributional impacts by maintaining the opportunity for international travel for lower income quintiles and sharing the available carbon budget more evenly.

Source: Principles adapted from OECD principles of Taxation.

ANNEX C: FORECASTED NUMBER OF FLIGHTS TAKEN BY INCOME GROUP

This annex shows the forecasted demand for flights for five people, split into leisure flights (by income quintile) and business flights.[5] The base period is a three-year average calculated from NTS survey data for 2015–17.[52] Data for 2020-2050 are estimates derived by applying DfT growth forecasts to the base period. These tables are the 'no policy' scenario, from which the FFL ad alternative policies are then calculated in each year.

Key trends and patterns:

- Overall demand is expected to grow by almost 50% from 2018 levels if unconstrained.
- Those in the highest income quintile fly roughly twice as much as those in the quintile just below them – the biggest step increase between any two adjacent income groups.
- Business flights make up 19% of total demand.
- The fifth and sixth flights only show in average numbers from 2030 onwards. This means the high corresponding tax rates for a FFL only come into effect in our model from 2030 onwards.

5 The total is for five people because the number for each income quintile is for one average person from that quintile, plus the total business flights (quintile shares added together).

TABLE C1: FLIGHT MATRIX IN THE BASE PERIOD 2015–17

Flight	1st	2nd	3rd	4th	5th	6th	Total
Lowest real income	0.72	0.00	0.00	0.00	0.00	0.00	0.72
Second level	0.81	0.01	0.00	0.00	0.00	0.00	0.82
Third level	0.81	0.37	0.00	0.00	0.00	0.00	1.18
Fourth level	0.81	0.64	0.00	0.00	0.00	0.00	1.45
Highest real income	0.81	0.81	0.81	0.53	0.00	0.00	2.97
All business	0.91	0.42	0.19	0.12	0.00	0.00	1.63
Total	**4.89**	**2.24**	**1.00**	**0.65**	**0.00**	**0.00**	**8.77**

Source: National Travel Survey 2018, Department for Transport

TABLE C2: FLIGHT MATRIX IN 2030

Flight	1st	2nd	3rd	4th	5th	6th	Total
Lowest real income	0.81	0.00	0.00	0.00	0.00	0.00	0.81
Second level	0.81	0.11	0.00	0.00	0.00	0.00	0.92
Third level	0.81	0.51	0.00	0.00	0.00	0.00	1.33
Fourth level	0.81	0.81	0.01	0.00	0.00	0.00	1.63
Highest real income	0.81	0.81	0.81	0.81	0.09	0.00	3.34
All business	0.93	0.51	0.19	0.19	0.02	0.00	1.83
Total	**5.00**	**2.76**	**1.01**	**1.00**	**0.11**	**0.00**	**9.87**

Source: Authors' calculations based on the National Travel Survey 2018, and aviation forecasts 2017, Department for Transport

TABLE C3: FLIGHT MATRIX IN 2040

Flight	1st	2nd	3rd	4th	5th	6th	Total
Lowest real income	0.81	0.12	0.00	0.00	0.00	0.00	0.93
Second level	0.81	0.25	0.00	0.00	0.00	0.00	1.06
Third level	0.81	0.71	0.00	0.00	0.00	0.00	1.52
Fourth level	0.81	0.81	0.25	0.00	0.00	0.00	1.88
Highest real income	0.81	0.81	0.81	0.81	0.58	0.00	3.84
All business	0.93	0.62	0.24	0.19	0.13	0.00	2.11
Total	**5.00**	**2.76**	**1.01**	**1.00**	**0.11**	**0.00**	**9.87**

Source: Authors' calculations based on the National Travel Survey 2018, and aviation forecasts 2017, Department for Transport

TABLE C4: FLIGHT MATRIX IN 2050

Flight	1st	2nd	3rd	4th	5th	6th	Total
Lowest real income	0.81	0.25	0.00	0.00	0.00	0.00	1.06
Second level	0.81	0.39	0.00	0.00	0.00	0.00	1.21
Third level	0.81	0.81	0.11	0.00	0.00	0.00	1.73
Fourth level	0.81	0.81	0.51	0.00	0.00	0.00	2.14
Highest real income	0.81	0.81	0.81	0.81	0.81	0.30	4.37
All business	0.93	0.70	0.33	0.19	0.19	0.07	2.40
Total	**5.00**	**3.78**	**1.75**	**1.00**	**1.00**	**0.37**	**12.90**

Source: Authors' calculations based on the National Travel Survey 2018, and aviation forecasts 2017, Department for Transport

TABLE D1: AVERAGE FLIGHTS TAKEN BY INCOME QUINTILE IN THE BASE PERIOD 2015–17

Flight	1st	2nd	3rd	4th	5th	6th	Total
Lowest real income	0.89						**0.89**
Second level	1	0.01					**1.01**
Third Level	1	0.45					**1.45**
Fourth Level	1	0.78					**1.78**
Highest real income	1	1	1	0.65			**3.56**

Source: National Travel Survey 2018, Department for Transport

ANNEX D: TECHNICAL ANNEX DATA, METHOD AND LIMITATIONS OF DEMAND SIDE MODELLING

DATA

To establish how many flights people in different income groups take, we used the National Travel Survey (NTS). The NTS is a continuous household survey commissioned by the Department for Transport (DfT).[53] It has been collecting nationally representative information on personal travel by UK residents since 1965, including on how many flights they take and the household income quintile. A review of the survey's sampling methodology in 2013 reduced the sample to cover England only and therefore modelling a policy for the whole of the UK is not possible. Our NTS dataset comprises almost 50,000 observations over three years (2015–17).

The NTS asks two questions about air travel. "How many times have you left the country by plane in the last 12 months?" reports the number of outbound international flights taken by the respondent in a year. The real number of international flights a person takes is likely to be twice as high as most residents also return to the UK by plane.

"How frequently do you take an internal air flight within Great Britain?" reports the number of UK domestic flights taken by the respondent in a year, counting each single trip as one journey and each return trip as two journeys.[54] Respondents answer this question in categories such as "3 or more times a week", or "once or twice a year". We converted these categories into annual numbers by projecting the response onto a 12-months period. "Three or more times a week" equals 3*52=156 flights per year, "once or twice a year" equals 1.5 flights per year. This produces a slight but unavoidable bias compared to the true number of flights taken, especially for frequent flyers, as the true average of those in the 3+ category is likely to be higher than three.

Following previous work from the New Economics Foundation, we calculated the total number of flights taken by each respondent by adding up their domestic and international trips.[55] From this we then calculate the weighted average of 'total flights' by income quintile over the three years 2015–17, shown in Table D1.[6],[7] Full 'flight matrix' tables for all years are in Annex B.

While the lowest income group takes on average less than one flight per year (0.89), the richest quintile takes almost four flights per year (3.56). There is a marked increase between the fourth and fifth income group, confirming that the richest are those that fly the most. Spreading the demand for flights into a matrix as in Table D2 enables us to apply differentiated tax rates for the 1st, 2nd, 3rd, etc. flight and to estimate individual demand responses for each income group.

The DfT's aviation forecast provides the average cost of a flight ticket for each year from 2016–2050.[56] It splits out the different cost components: fuel cost, carbon cost, APD and other costs.[8] The DfT's price estimates are a per-flight average across international and domestic passengers and different travel classes, weighted by the number of passengers in each market segment. There is reason

6 Using the sampling weights W3 for individual level analysis as advised by the NTS codebook.
7 A three-year average of the most recently available data evens out any outliers and is more likely to be a representation of the true average number of flights taken by the English population.
8 We remove the cost of carbon as there is no policy mechanism in place to deliver it. The limitations at the end of this section explore possible resulting bias.

TABLE D2: MATRIX OF PRICE ELASTICITIES BY INCOME GROUP AND NUMBER OF FLIGHTS TAKEN

Flight	1st	2nd	3rd	4th	5th	6th
Lowest real income	-0.79	-0.80	-0.81	-0.82	-0.83	-0.84
Second level	-0.74	-0.75	-0.76	-0.77	-0.78	-0.79
Third level	-0.69	**-0.70**	-0.71	-0.72	-0.73	-0.74
Fourth level	-0.59	-0.60	-0.61	-0.62	-0.63	-0.64
Highest real income	-0.49	-0.50	-0.51	-0.52	-0.53	-0.54

Source: Authors' calculations based on National Travel Survey, Department for Transport

to believe that lower income groups would, on average, purchase cheaper tickets. However, ticket price data is not available by income group. We therefore assume the same average ticket price for each income group.

We use price elasticities for UK leisure (-0.7) and UK business (-0.2) flights provided by the DfT.[9] One might expect the price elasticity to for leisure flights to vary with the number of flights taken and a person's income.[57] We therefore take -0.7 as the 'median elasticity' for leisure flights, applying it to the second flight in the third income level. From there, the elasticity is spread so that it increases as household income decreases, and vice versa as shown in Table D2. The resulting elasticities range from -0.49 (first flight of highest income group) to -0.84 (last flight of lowest income group).The DfT also provides estimates of demand growth for UK air travel until 2050.To calculate the forecasted base demand in each decade, we multiply the base demand (2015–17 average) by the DfT's forecasted 'central scenario' grand total demand growth rate, adjusting for population growth rates retrieved from Eurostat.[58],[59] This results in a forecasted average number of flights taken in each decade, which serves as the 'no policy' scenario.

METHOD

We model the FFL as a specified charge (in GBP) that increases stepwise with the number of flights taken. The model assumes a FFL was introduced in 2020 and estimates demand responses every ten years up to 2050, giving a total of four points in time plus the baseline of 2015–17. A simplifying assumption is that the charge does not differentiate by distance travelled or class of travel. This assumption allows us to add the levy amount on to the DfT's price data, which is a weighted average across different travel segments. Section five discusses the policy implications from these simplifying assumptions.

Before Covid-19, almost one-in-five plane trips departing the UK was for business purposes (including UK and foreign residents, and domestic and international trips).[60] As the price elasticity of demand for business flights (-0.2) is substantially lower than that for leisure flights (-0.7), we split the flight matrix into business and leisure flights by multiplying the forecasted average number of flights per income group by the forecasted share of business out of total flights. This allows us to calculate the demand response for business and leisure separately.

The base price for estimating the demand responses is the DfT's average ticket price for the given year.[10] We then remove APD from the DfT's average ticket price, add the new tax onto it and calculate the demand response by multiplying the percentage price change by the respective elasticity of demand. Repeating this for each decade until 2050 generates a timeline of emissions reductions until 2050.

LIMITATIONS

The calculations presented in this section face a number of limitations that come from data availability and simplifying assumptions. First, because the NTS only surveys English households, the demand responses are based on the flying behaviour of English residents. This introduces a potential bias in our results if the flying behaviour of residents of Scotland, Wales and Northern Ireland is different than in England, for example due to airport accessibility in Scotland, Wales and/

9 This is to split out business from leisure demand responses, assuming that those surveyed in the NTS predominantly fall into one of these two market segments. A small bias results from not also using the elasticity for domestic flights.

10 Less the 'cost of carbon' component, as no policy mechanism exists to deliver the carbon price assumed by the DfT.

TABLE E1: TOTAL NUMBER FLIGHTS PER DECADE AND POLICY SCENARIO

	2015–17	2020	2030	2040	2050	Cumulative total flights	Growth over 2016 levels
No policy							
Leisure	7.14	7.50	8.04	9.23	10.51	42.42	47%
Business	1.63	1.71	1.83	2.11	2.40	9.68	47%
Total	**8.77**	**9.21**	**9.87**	**11.34**	**12.90**	**52.10**	**47%**
FFL							
Leisure	7.14	7.13	7.54	8.26	8.89	38.96	24%
Business	1.63	1.57	1.68	1.88	2.08	8.84	28%
Total	**8.77**	**8.71**	**9.21**	**10.14**	**10.97**	**47.81**	**25%**
Carbon Tax/ APD increase							
Leisure	7.14	7.09	7.38	8.11	8.70	38.43	22%
Business	1.63	1.68	1.78	2.02	2.26	9.38	39%
Total	**8.77**	**8.77**	**9.16**	**10.14**	**10.96**	**47.81**	**25%**

Source: Authors' calculations

or Northern Ireland compared to the English regions.

Second, by modelling everything based on average ticket prices some policy options seem identical where they would not be in reality (carbon tax, APD increase). Unlike the FFL, these options do not differentiate between frequent flyers and non-frequent flyers and this is taken as their defining characteristic in our analysis. However, a more granular analysis of income and geographical impact of a carbon tax would be an interesting research project going forward.[11]

Third, our calculations do not explicitly treat non-Co2 emissions. Scientists suggest that 75% of human-induced global heating is from CO2, with the rest caused by other GHGs.[61] Planes emit considerable amounts of nitrogen oxides alongside Co2, but because this varies by flight route and type of plane, we cannot expect a perfectly proportional reduction in these emissions as CO2 is reduced.[62]

Finally, the DfT forecasts already assume a carbon price, but our analysis removes it from the price of a ticket as there is currently no policy mechanism in the UK to deliver the carbon price. The DfT forecasts are therefore likely to underestimate demand growth until 2050, which means that the levy/ APD increase has to be even higher to meet the true increase in demand.

ANNEX E: TIMELINE OF AVIATION DEMAND GROWTH IN DIFFERENT POLICY SCENARIOS

This annex shows how the different policy scenarios reduce demand compared to no policy, split into business and leisure travel segments. Key findings are:

- The frequent flyer levy (FFL) allows more growth in the leisure sector than in business, while the reverse is true for a non-differentiating charge such as carbon tax/APD increase.
- Growth in business is higher than growth in the leisure segment in all scenarios, due to the lower price elasticity of demand for business travel.

ANNEX F: APPORTIONING INCOME GROUPS TO ENGLISH REGIONS

Table F1 below shows the % split of NTS respondents from each income quintile by region of England. Our estimates of the geographical impact of the demand response in section four base on this table. If income was evenly distributed across England, each region would be populated by exactly 20% of each income quintile. However, this is not the case. For example, in Yorkshire and the Humber 26% of people are in the lowest real income group and just 15% in the highest real income group. In the South East, this is almost exactly the other way around.

11 Because (1) those with less disposable income are expected to buy cheaper tickets and (2) long-haul flights are not available from all airports.

TABLE F1: PERCENTAGE OF PEOPLE FROM EACH INCOME GROUP IN THE NINE REGIONS OF ENGLAND (THREE YEAR AVERAGE, 2015–17)

	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber
Lowest real income	21%	18%	22%	27%	23%	14%	16%	27%	26%
Second level	22%	18%	17%	21%	21%	17%	22%	20%	21%
Third level	21%	24%	19%	19%	20%	23%	24%	21%	22%
Fourth level	20%	20%	18%	19%	21%	21%	21%	18%	17%
Highest real income	17%	21%	25%	15%	15%	26%	17%	15%	15%
Region total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: National Travel Survey, Department for Transport

ANNEX G: DEMAND REDUCTION FOR STRICTER CARBON SCENARIOS

We modelled two policy alternatives:

1. Zero demand growth over 2018 levels.
2. Reducing current demand by two thirds as proposed by Zero Carbon Britain for net zero 2030.[63]

For comparison to the CCC net zero reduction schedule, we keep 2050 as an end date for both alternative scenarios.

Table G1 and G2 below show the required tax schedule. Keeping demand growth at 2018 levels can be achieved while keeping the 'zero' tax rate on the first leisure flight in a year. However, this is not possible in the strictest scenario (Zero Carbon Britain). Because all 'first flights' taken together exceed one third of current demand, some people who currently take one flight will not be able to fly at all. Therefore, the frequent flyer levy (FFL) schedule does not grant a first free flight for leisure travel in this scenario.

Comparing average costs per flight in a year shows that the FFL is cheaper for a person taking up to two flights per year, while a non-differentiating charge such as a carbon price or Air Passenger Duty (APD) increase is cheaper for those taking three or more flights per year. In the next zero scenario the FFL was on average cheaper up until three flights per year (Section Four), reflecting the fact that it is a less strict emissions reductions plan.

TABLE G1: TAX SCHEDULES TO KEEP DEMAND GROWTH AT 2018 LEVELS UNTIL 2050

Flight	1st	2nd	3rd	4th	5th	6th
Levy – leisure	0	50	150	250	350	450
Levy – business	50	150	250	350	450	550
Non-differentiating tax[12]	75	75	75	75	75	75

TABLE G2: TAX SCHEDULES TO CUT DEMAND BY -66.7% FROM 2018 LEVELS UNTIL 2050

Flight	1st	2nd	3rd	4th	5th	6th
Levy – leisure	80	200	400	600	800	1000
Levy – business	200	400	600	800	1000	1000
Non-differentiating tax[13]	175	175	175	175	175	175

12 15% increase per decade up to 2050 numbers showing in table G1 to keep cumulative emissions equal.
13 5% increase per decade up to 2050 numbers showing in table G2 to keep cumulative emissions equal.

ANNEX H: PASSENGER NUMBERS AND CAPACITY AT DIFFERENT UK AIRPORTS

TABLE H1: PASSENGER NUMBERS AND CAPACITY AT DIFFERENT UK AIRPORTS

Airport	2018 total passengers[64]	Current (2018) capacity (millions)	Capacity constraint used (2018)	Planned capacity: Carbon brief (millions)	Planned 2050 capacity: DfT17 (millions)
Aberdeen	3,055,995	6.0	DfT17	4.0	6.0
Birmingham	12,454,642	18.0	Carbon brief	18.0	37.0
Bournemouth	674,972	3.0	DfT17	3.0	5.0
Bristol	8,696,653	10.0	DfT17	12.0	10.0
Cardiff	1,579,204	3.0	DfT17	3.2	8.0
Doncaster Sheffield	1,222,295	2.0	DfT17	11.8	2.0
Durham Tees Valley/Teeside	139,549	1.0	DfT17	1.0	1.0
East Midlands	4,873,757	6.0	DfT17	10.0	10.0
Edinburgh	14,291,811	15.0	DfT17	16.5	35.0
Exeter	931,182	2.0	DfT17	2.0	4.0
Gatwick	46,081,327	50.0	DfT17 2040	53.0	50.0
Glasgow	9,652,516	10.0	DfT17	16.4	20.0
Heathrow	80,100,311	90.0	DfT17	130.0	90.0/130.0
Humberside	191,828	1.0	DfT17	1.0	3.0
Inverness	892,971	1.0	DfT17	1.0	3.0
Leeds-Bradford	4,037,686	5.0	DfT17	7.0	8.0
Liverpool	5,042,312	7.0	DfT17	7.8	15.0
London City	4,820,292	5.0	DfT17	6.5	7.0
Luton	16,766,552	18.0	DfT17	18.0	18.0
Manchester	28,254,970	30.0	DfT17	55.0	55.0
Newcastle	5,332,238	9.0	DfT17	9.4	9.0
Newquay	456,511	1.0	DfT17 2030	1.0	1.0
Norwich	536,578	2.0	DfT17	2.0	3.0
Prestwick	680,958	3.0	DfT17	3.0	3.0
Southampton	1,990,930	3.0	DfT17	5.0	7.0
Southend	1,480,139	5.0	DfT17	5.0	5.0
Stansted	27,995,121	35.0	DfT17	43.0	35.0
Total	**282,233,300**	**341**		**446**	**450**

ENDNOTES

1 Jackson, T. (2019) '2050 is too late – we must drastically cut emissions much sooner', The Conversation. https://theconversation.com/2050-is-too-late-we-must-drastically-cut-emissions-much-sooner-121512

2 Blakey, J. and Hudson, M. (2019) 'New net zero emissions target won't end UK's contribution to global warming – here's why', The Conversation. https://theconversation.com/new-net-zero-emissions-target-wont-end-uks-contribution-to-global-warming-heres-why-116386

3 Climate Change Committee (2020) Reducing UK emissions: Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/

4 Climate Change Committee (2020) The sixth carbon budget: Aviation. https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf

5 Climate Change Committee (2020) The sixth carbon budget: Aviation. https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf

6 Climate Change Committee (2019) Net Zero: The UK's contribution to stopping global warming. https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

7 Business Green (2020) Future of flight or flight of fancy? UK aviation industry launches net zero roadmap. https://www.businessgreen.com/news/4010017/future-flight-flight-fancy-uk-aviation-industry-launches-net-zero-roadmap

8 Chapman, A. and Postle, M. (2021) Turbulence Expected: The climate cost of airport expansion, New Economics Foundation. https://neweconomics.org/2021/05/turbulence-expected

9 Sugg L. (2018) Speech to Airport Operators' Association. https://www.gov.uk/government/speeches/aviation-minister-pledges-to-help-aviation-sector-prosper

10 BBC News (2020) Interview with Matt Hancock: 'We shouldn't be flying less'. https://www.bbc.co.uk/news/av/business-51121875/matt-hancock-we-shouldn-t-be-flying-less

11 IEA (2021) Net Zero by 2050: A roadmap for the global energy sector, International Energy Agency. https://www.iea.org/reports/net-zero-by-2050

12 Climate Change Committee (2019) Net-zero and the approach to international aviation and shipping emissions. https://www.theccc.org.uk/publication/letter-international-aviation-and-shipping/

13 Larsson J., Elofsson A., Sterner T. and Akerman J. (2019) 'International and national climate policies for aviation: A review', Climate Policy DOI: 10.1080/14693062.2018.1562871

14 Authors' calculations based on Department for Transportation statistics.

15 UK government (2019) Rates for Air Passenger Duty. https://www.gov.uk/guidance/rates-and-allowances-for-air-passenger-duty

16 HM Revenue and Customs (2019) Air Passenger Duty Archives. https://www.uktradeinfo.com/Statistics/StatisticalBulletins/Pages/BulletinArchive.aspx?viewname=Air%20Passenger%20Duty%20Archive

17 Heisse, C. and Carpenter, G. (2020) 'Flybe's near collapse should be a wakeup call for the government', New Economics Foundation. https://neweconomics.org/2020/01/flybes-near-collapse-should-be-a-wakeup-call-for-the-government

18 Hodgson, C., Sheppard, D. and Pickard, J. 'UK carbon trading system to launch in May', Financial Times. https://www.ft.com/content/1157028b-d074-476b-862c-9eec70010dfc

19 De Bruyckere, L. and Abbasov, F. (2016) 'Aviation ETS – gaining altitude: An analysis of the aviation EU ETS 2013-2015', *Transport and Environment*. https://www.transportenvironment.org/sites/te/files/2016_09_Aviation_ETS_gaining_altitude.pdf

20 Gov.UK (2021) UK Emissions Trading Scheme for aviation: how to comply. https://www.gov.uk/guidance/uk-emissions-trading-scheme-for-aviation-how-to-comply

21 Elliot, D. (2018) 'Aviation and carbon markets', Frontier Economics. http://www.frontier-economics.com/uk/en/news-and-articles/articles/article-i4747-aviation-and-carbon-markets/

22 Andersen, K. (2012) 'The inconvenient truth of carbon offsets', *Nature* 484 (7392). https://www.nature.com/news/the-inconvenient-truth-of-carbon-offsets-1.10373

23 Ambrose, J. (2019) 'Can carbon offsets tackle airlines' emissions problem?', *The Guardian*. https://www.theguardian.com/environment/2019/nov/19/can-carbon-offsets-tackle-airlines-emissions-problem

24 United Nations Environment Programme (2019) 'Carbon offsets are not our get-out-of-jail free card'. https://www.unenvironment.org/news-and-stories/story/carbon-offsets-are-not-our-get-out-jail-free-card

25 Elliot, D. (2018) 'Aviation and carbon markets', Frontier Economics. http://www.frontier-economics.com/uk/en/news-and-articles/articles/article-i4747-aviation-and-carbon-markets/

26 Seely, A. (2019) 'Taxing aviation fuel', House of Commons Briefing Paper Number 523. House of Commons Library.

27 International Civil Aviation Organization. 'The History of ICAO and the Chicago Convention' (webpage). https://www.icao.int/about-icao/History/Pages/default.aspx

28 Transport and Environment (2019) 'State of the aviation ETS'. https://www.transportenvironment.org/state-aviation-ets

29 Transport and Environment (2019) 'Legal obstacles no barrier to introducing aviation fuel tax in Europe, say experts'. https://www.transportenvironment.org/press/legal-obstacles-no-barrier-introducing-aviation-fuel-tax-europe-say-experts

30 Schulz, F. (2019) 'Why we are far from imposing a tax on kerosene', Euractiv. https://www.euractiv.com/section/aviation/news/why-we-are-far-from-imposing-a-tax-on-kerosene/

31 Fullerton, D., Leicester, A. and Smith, S. (2010), 'Environmental taxes', Dimensions of Tax Design: the Mirrlees Review, Oxford

University Press

32 Murray, L. (2020) 'An understanding of how growth in demand for air travel could be reduced', Possible. https://www.climateassembly.uk/documents/42/Leo_Murray_-_reducing_emissions_from_air_travel.pptx

33 Devlin, S. and Bernick, S. (2015) Managing aviation passenger demand with a frequent flyer levy, New Economics Foundation. https://neweconomics.org/uploads/files/58e9fad2705500ed8d_hzm6yx1zf.pdf

34 Ibid.

35 Carmichael, R. (2019) Behaviour change, public engagement and Net Zero, Imperial College London. https://www.theccc.org.uk/publication/behaviour-change-public-engagement-and-net-zero-imperial-college-london/

36 Ibid.

37 Climate Change Committee (2019) Net-zero and the approach to international aviation and shipping emissions. https://www.theccc.org.uk/publication/letter-international-aviation-and-shipping/

38 Climate Change Committee (2019) Net Zero – The UK's contribution to stopping global warming, Climate Change Committee. https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

39 Climate Change Committee (2020) The sixth carbon budget: Aviation. https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf

40 Carmichael, R. (2019) Behaviour change, public engagement and Net Zero, Imperial College London. https://www.theccc.org.uk/publication/behaviour-change-public-engagement-and-net-zero-imperial-college-london/

41 A Free ride (2020) (Website). http://afreeride.org/

42 Weston, P. (2019) 'Zero carbon 2050 pledge is too slow to address catastrophic climate change, campaigners warn', The Independent. https://www.independent.co.uk/environment/climate-change-uk-2050-net-zero-carbon-climate-change-act-a8955796.html

43 Climate Change Committee (2021) *Progress in reducing emissions: 2021 report to parliament*. https://www.theccc.org.uk/publication/2021-progress-report-to-parliament/

44 Finney, D. and Mattioli, G. (2019) Planned growth of UK airports not consistent with net-zero climate goal.https://www.carbonbrief.org/guest-post-planned-growth-of-uk-airports-not-consistent-with-net-zero-climate-goal

45 Accessed via freedom of information request, Reference: P0017549.

46 Chapman, A. and Wheatley, H. (2020) Crisis Support to Aviation and the Right to Retrain, New Economics Foundation. URL: https://neweconomics.org/2020/06/crisis-support-to-aviation-and-the-right-to-retrain

47 IATA (2020) Recovery delayed as international travel remains locked down. International Air Travel Association. https://www.iata.org/en/pressroom/pr/2020-07-28-02/

48 Chapman, A. and Wheatley, H. (2020) Crisis Support to Aviation and the Right to Retrain, New Economics Foundation. URL: https://neweconomics.org/2020/06/crisis-support-to-aviation-and-the-right-to-retrain

49 https://www.ft.com/content/7ab638c8-d5f7-4e42-a786-3610f2c445fb#post-49d1e231-962f-4c89-b2e1-8ac1e5272ebc

50 Smith, A. (1999) [1776] The Wealth of Nations: Books I-III, Penguin Books

51 OECD (2014) Addressing the tax challenges of the digital economy – fundamental principles of taxation. https://www.oecd-ilibrary.org/taxation/addressing-the-tax-challenges-of-the-digital-economy/fundamental-principles-of-taxation_9789264218789-5-en;jsessionid=C64_eA8u6Jme4mY1vww0fdGC.ip-10-240-5-132

52 The was the most recent data available when the analysis was performed. Data on up to 2019 has since been released; however, the distribution of flights across income quintiles stayed approximately the same, with a slight rebalancing away from the highest quintile. This small shift in distributional data will not significantly change the results and recommendations in this report.

53 Department for Transport (2019) The National Travel Survey. https://www.gov.uk/government/collections/national-travel-survey-statistics

54 Department for Transport (2019) National Travel Survey 2018 Technical Report.

55 Devlin, S. and Bernick, S. (2015) Managing aviation passenger demand with a frequent flyer levy, New Economics Foundation. https://neweconomics.org/uploads/files/58e9fad2705500ed8d_hzm6yx1zf.pdf

56 Department for Transport (2017) UK Aviation forecast. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/781281/uk-aviation-forecasts-2017.pdf

57 Devlin, S. and Bernick, S. (2015) Managing aviation passenger demand with a frequent flyer levy, New Economics Foundation. https://neweconomics.org/uploads/files/58e9fad2705500ed8d_hzm6yx1zf.pdf

58 Department for Transport (2017) UK Aviation forecast. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/781281/uk-aviation-forecasts-2017.pdf

59 Eurostat (2019) 'Population projections database'. https://ec.europa.eu/eurostat/web/population-demography-migration-projections/data/database

60 Department for Transport (2017) UK Aviation forecast. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/781281/uk-aviation-forecasts-2017.pdf

61 The Climate Change Committee (2019) Net Zero The UK's contribution to stopping global warming. https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

62 Transport and Environment (2018) 'Aviation: 2 to 3 times more damaging to the climate than industry claims'. https://www.transportenvironment.org/news/aviation-2-3-times-more-damaging-climate-industry-claims

63 Centre for Alternative Technology (2019) Zero Carbon Britain: Rising to the Climate Emergency. Zero Carbon Britain. https://www.cat.org.uk/info-resources/zero-carbon-britain/research-reports/zero-carbon-britain-rising-to-the-climate-emergency/

NEW ECONOMICS FOUNDATION

Possible. Inspiring climate action

WWW.NEWECONOMICS.ORG
info@neweconomics.org
+44 (0)20 7820 6300 @NEF
Registered charity number 1055254

WWW.WEAREPOSSIBLE.ORG
WWW.AFREERIDE.ORG
@_wearepossible / @a_free_ride
Registered charity number: 1157363

COVER IMAGE BY:
stocksy.com/Audrey Shtecinjo

PUBLISHED:
July 2021

NEF is a charitable think tank. We are wholly independent of political parties and committed to being transparent about how we are funded.

Possible is a UK based climate charity working towards a zero carbon society, built by and for the people of the UK. Our A Free Ride campaign aims to protect access to reasonable levels of flying for the less well-off, whilst maintaining aviation emissions within safe limits for the climate.

WRITTEN BY:
Alex Chapman, Leo Murray, Griffin Carpenter, Christiane Heisse, Lydia Prieg

ACKNOWLEDGEMENTS:
With thanks to Sally Cairns, Richard Carmichael, Jamie Beevor, Richard Murphy, Miatta Fahnbulleh, David Powell.