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THE CLIMATE COST OF AIRPORT EXPANSION

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CONTENTS

EXECUTIVE SUMMARY

Despite the challenging period that the UK aviation sector has experienced since the start of the pandemic, a host of airports are moving to expand their capacity. These airports can be divided into two groups. Gatwick, Heathrow and Luton have officially notified government of their intent to apply for expansion as part of the 'nationally significant infrastructure' (NSI) process, but have yet to submit their full applications and appraisal documentation. Four smaller, non-NSI expansions at Bristol, Leeds Bradford, Southampton and Stansted airports are going through the local planning process. These latter applications are more advanced and all four have received an initial planning decision – two approved and two refused.

In the context of rapidly evolving scientific understanding of aviation's climate impact, and significant policy and forecast uncertainty as a result, in this report we look at the credibility of estimates of climate impact put forward by the four non-NSI airports as part of their planning applications. In this report, we conduct comparative analysis and 're-modelling' of carbon costs in order to present a credible range of estimates of the potential climate impact of each scheme at the airport level and put a monetary value on this impact. We identify a number of important failures of the non-NSI airport appraisals to follow best practice, often leading to significant understatement of the climate impact of the proposed schemes:

- All four schemes rely on optimistic estimates of long-term fuel-efficiency gains, and two do not test lower rates of technological development and roll-out, despite this assumption impacting significantly on the final climate impact estimate.
- Research shows that emissions such as aerosols, water vapour and nitrogen oxides have the potential to double or even triple the climate impact of airport expansion, yet only one of the four applicant airports quantifies this impact.
- Three out of the four airports do not present the climate impact of inbound flights. While not part of national emissions accounting protocol, emissions from new inbound flights may still represent a material impact of airport expansion and are therefore appropriate to include in an appraisal.
- Only one out of the four airports has submitted any monetised climate impacts. As a result, applicant airports have also failed to test the impact of higher future carbon prices and lower discount rates, despite the government warning that both may be on the horizon.

Taking these omissions in aggregate, applicant airports have ignored their exposure to uncertainty and risk and obscured potential airport-level climate impacts between two and eight times greater than indicated in their appraisal documentation. Expansion scheme promoters have also failed to account for the monetised cost of emissions caused by expansion, collectively worth £2.4 billion to 13.4 billion, and have overstated the economic case for expansion. Around 65% of this emissions cost will not be captured by current regulations on the aviation sector and will therefore be borne by society, either in the costs of capturing emissions elsewhere in the economy or in the social damage resulting from climate change.

This report questions whether decision makers had access to a complete and robust set of evidence upon which to base their determination; and further, whether local authorities are even the appropriate stakeholder to appraise the climate cost of expansion. In the case of the three large expansions at Luton, Gatwick and Heathrow which will be considered by central government, this report highlights the importance of ensuring applicants adhere to best practice in the appraisal process.

RECOMMENDATIONS

- The Secretary of State should call in all of the currently active airport planning applications and assemble a more robust and precautionary evidence base on climate change issues. This evidence can be measured against the forthcoming aviation decarbonisation strategy and the government's new 2035 emissions target, which is expected to include international aviation emissions. In addition, the government will need to demonstrate how the proposed expansions can be reconciled with the Climate Change Committee's recommendation of a no-net-expansion policy on airports.

- The Department for Transport (DfT) should ensure a more robust evidence base is assembled for the appraisal of future airport expansions, including in the case of future NSI proposals, all of which are expected to involve significant climate impacts. This should include tighter guidelines and expectations on the integration of non-CO_2 climate impacts, and the monetisation of said impacts.

1. INTRODUCTION

The years 2020 and 2021 so far have been exceptionally challenging for the aviation sector worldwide. Passenger numbers have collapsed as a result of public health measures imposed in response to the Covid-19 pandemic and are not expected to recover until 2024 at the earliest.[1] Yet, and in stark contrast, a significant number of UK airports have been pursuing expansion plans of different shapes and sizes (Table 1). At the time of writing, seven airports had expansion applications at different stages in the UK's planning processes and further airports are expected to submit applications in coming months and years.

The expansion procedures in train can broadly be divided into two categories, as set out in the government's *Making Best Use of Existing Runways* policy, 2018 (henceforth the *Making Best Use* policy): those expansions proposing more than 10 million new passengers per annum (Gatwick, Heathrow, and Luton), which therefore are designated Nationally Significant Infrastructure (NSI) and must apply to the Secretary of State for approval; and those expansions proposing less than 10 million new passengers per annum (Bristol, Leeds Bradford, Southampton and Stansted), which must apply to the relevant local authority for approval.[2] Each of these planning routes places different procedural requirements on applicant airports but the need for a high quality, robust, appraisal remains the same.

Airport expansion has always been controversial at the local level, with the significant noise, air quality and traffic impacts experienced by local residents being set against the economic benefits claimed by scheme proponents. However, the urgency of the climate crisis and the aviation industry's substantial carbon footprint has significantly increased the weight of the planning decision. Decision makers across the UK, in different layers of government, are grappling with understanding and weighing up the benefits and costs of the different schemes.

This is the first of two reports taking a fresh look at the relative benefits and costs of airport expansion in the midst of national economic, health and climate crises. In this first report we focus on perhaps the most topical issue of the airport expansion conundrum: the climate impact. We consider both the latest emerging science

TABLE 1

Details of seven expansion schemes which have recently been active in legal planning procedures, these can be divided into nationally significant infrastructure (NSI) and non-NSI projects.

Group	Airport	Application stage	Proposed capacity increase (departing passengers)
Non-NSI	Bristol	Rejected by council, appeal under way	2,000,000
Non-NSI	Leeds Bradford (LBA)	Approved by council, paused by Secretary of State	1,500,000–3,000,000
Non-NSI	Southampton	Application approved by full council vote following rejection by sub-committee	2,324,000
Non-NSI	Stansted	Rejected by council, appeal under way	8,000,000
NSI	Gatwick	Planning inspectorate notified of intention to submit	13,000,000
Non-NSI	Luton 1	Application under consideration by council	1,000,000
NSI	Luton 2	Planning inspectorate notified of intention to submit	14,000,000
NSI	Heathrow	Airports National Policy Statement passed. Planning inspectorate notified of intention to submit	45,000,000

and government advice on how the climate impacts of airport expansion should be measured and monetised in the decision-making process. Using this guidance we conduct an independent analysis of the climate costs associated with airport expansion proposals currently under consideration, and focus in particular on the sensitivities of those cost estimates to different underlying assumptions.

In the second part in this series we focus on the wider components that make up the benefits and costs derived in airport expansion appraisal, including job creation, business productivity, tourism and non-climate related environmental impacts. In addition we focus on the key issue of 'additionality' or 'displacement' which defines the extent to which benefits and costs associated with a scheme are newly created versus relocated from one area to another.

2. AIRPORT EXPANSION APPRAISAL

Decision making on significant changes to public infrastructure and the built and natural environments should be underpinned by cautious and meticulous impact analysis. Appraisal must be underpinned by a significant body of evidence assembled according to a robust methodology. In the UK, public bodies are supported in this process by official government guidance documents. At the heart of public appraisal is the Green Book. The government states:

The Green Book sets out the broad framework for the appraisal and evaluation of all policies, programmes and projects. The supplementary and Departmental guidance contains more detailed guidance on specific issues and applying the Green Book in particular contexts.[3]

In the case of airport expansion, the relevant detailed guidance is the Department for Transport's (DfT) Transport Analysis Guidance (TAG).

It is sometimes claimed by expansion proponents that because airport expansion is primarily privately financed, and airports are majority privately owned, related planning applications should not be subject to the stipulations of the Green Book and TAG. However, the DfT states:

Projects or studies that require government approval are expected to make use of this guidance in a manner appropriate for that project or study. For projects or studies that do not require government approval, TAG should serve as a best practice guide.[4]

Airport expansion applications require government approval and as such should make use of TAG guidance. The phrase "in a manner appropriate for that project or study" does leave some room for manoeuvre, which airports often use to avoid completing all of the components of a TAG-compliant assessment. However, TAG is clearly established by the DfT as the best practice standard. Evidence submitted for appraisal by expansion scheme proponents should clearly be held-up to the standard set by DfT. Given the significance of aviation to the UK's climate change commitments, particularly close attention should be paid to ensuring best practice is followed in the estimation and monetisation of carbon emissions.

Modern day scheme appraisal relies heavily on the monetisation of changes in outcomes to establish a project's value. Monetisation of outcomes is preferred by government as it allows proportionate comparison of diverse financial and none financial impacts. The overall value of a scheme is often expressed in a monetised benefit-cost ratio. Supporting this the DfT have issued a Value for Money Framework which advises on desirable benefit-cost ratios from transport infrastructure investments.[5]

There are good reasons to question the hegemony of money as our metric for value. Across the globe there is a growing movement to establish more direct measures of individual and societal wellbeing as our core measures of impact.[6] However, at the present time monetisation remains the government's preferred approach. Due care should be applied to the monetisation of non-financial outcomes, and the use of benefit-cost ratios as both processes can disguise scheme nuances, including risks, and can undervalue impacts that are difficult to quantify. Monetisation of greenhouse gas emissions can nonetheless be useful as a route to integrating the social cost of carbon into decision making. This recognises that for every tonne of carbon emitted there will be a cost to society, either in re-sequestering that tonne of carbon elsewhere in the economy, or in the damaging social impacts that unmitigated climate change has on people, livelihoods and ecosystems. The DfT is clear in its best practice guide (TAG) that carbon emissions should be monetised in scheme appraisal:

The monetary value of the impacts of proposed transport schemes on greenhouse gas emissions should also be calculated. When carrying out monetary valuation, it is important to distinguish between the emissions from those sectors that are included within the EU Emissions Trading System (EU ETS) – the 'traded sector' – and those that are not – the 'non-traded sector'. The traded sector covers emissions from power and heat generation; energy-intensive industry and, since 2012, aviation.[7]

3. CLIMATE CONSIDERATIONS

Air travel results in significant emissions of carbon dioxide (CO_2) and other pollutants with great potential to warm earth's climate. In 2019, 37,000,000 tonnes of CO_2e (37.0 $MTCO_2e$) were emitted by international flights departing from UK airports, equivalent to 7% of all UK-based emissions.[8] A further 1.5 $MTCO_2e$ was emitted by domestic air travel. Significant additional emissions result from incoming aircraft (i.e. arrivals), but the extent to which these emissions should be accounted for in the UK is a matter of contention which is discussed later in this report. Air travel contributes further to climate change through the emission at high altitude of other, non-CO_2, pollutants with the power to warm the earth.

While most other sectors of the UK economy have begun to reduce their greenhouse gas emissions, emissions from aviation have risen steadily over the past three decades, interrupted only by the temporary impacts of global crises. In its pathway to net zero by 2050, the UK's statutory advisor on climate change, the Climate Change Committee (CCC) has afforded the aviation sector a luxurious position. Aviation represents one of only a small number of sub-sectors that the CCC modelling suggests will be unable to reach absolute zero emissions by 2050, requiring these residual emissions to be balanced by some form of 'negative emissions' (i.e. net sequestration of carbon from the atmosphere) elsewhere in the economy.

Aviation is afforded an exemption from achieving true carbon neutrality because it is not seen as likely that technological advancements will be able to deliver zero carbon flight within the required time frame, and because the international connectivity aviation provides is seen as too important to sacrifice entirely. However, aviation is not given a free pass, tough restrictions on emissions from aviation are still required, particularly because there are significant limits on the capacity for carbon sequestration outside of the sector. In all five scenarios set out in the CCC's Sixth Carbon Budget Advice[9] UK emissions from aviation departures are expected to fall to at least 25 $MTCO_2e$ by 2050, around a 33% decline on their 2019 level. In the CCC's preferred scenario, the 'balanced pathway', emissions fall to around 30 $MTCO_2e$ by 2035 and around 23 $MTCO_2e$ by 2050.

The CCC sets out the steps necessary to achieve this reduction. A combination of fuel efficiency improvements, fuel-type changes and limiting passenger numbers (or 'demand management') are required. Demand management is of particular significance to the question of airport expansion. The Department for Transport's (DfT) 2017 aviation forecasts suggested there will be significant growth in demand for air travel over the next three decades.[10] Indeed, greater demand than current airport capacity can cater to. While the Covid-19 pandemic has set back demand temporarily, most stakeholders currently expect demand to return to pre-crisis expectations within four to five years, quicker than after the 2008 financial crisis.[11]

However, the CCC is clear in stating that unconstrained growth is incompatible with the UK's climate change commitments and averting climate breakdown. The CCC's preferred pathway involves passenger departure numbers growing to a maximum of 25% above 2018 levels. There is already sufficient airport capacity in the UK to cater for this level of demand. As such, in its latest advice the CCC makes the following policy recommendation:

There should be no net expansion of UK airport capacity unless the sector is on track to sufficiently outperform its net emissions trajectory and can accommodate the additional demand.[12]

At the time of writing, the UK government had yet to issue its response to this advice, although it announced in April 2021 that it would accept the CCC's recommendation to legislate for the inclusion of emissions from international aviation and shipping in the sixth carbon budget established by the Climate Change Act. This announcement came too late for local authority decision makers in North Somerset, Eastleigh, Leeds and Uttlesford to incorporate into their decision making processes over respective airport expansion proposals. At the time of writing, further details on the government's response to the CCC's specific recommendations around aviation emissions – such as its recommendation on airport expansion referenced above – had yet to be released.

As a result, local authorities tasked with making a decision on airport expansion were confronted with a challenging legislative vacuum. No clear government line on airport capacity growth, nor an aviation sector decarbonisation pathway, had been provided. In 2018, the government issued its *Making Best Use* policy statement recommending that airports make 'best use' of their existing runways.[13] Under this 2018 policy, airport capacity expansions that do not involve creation of additional runways (e.g. runway extension or terminal expansion) might have a viable case (subject to passing other considerations in the planning process). However, this policy was designed on climate ambitions which almost immediately became outdated when, in 2019, the government legislated for net zero emissions by 2050.[14]

When designing the *Making Best Use* policy, emissions reductions in aviation were targeted at achieving a level of 37.5 $MTCO_2e$ in 2050 – emissions around 60% higher than the level recommended in the CCC's balanced pathway to net zero.[15] In this scenario, passenger numbers also rise around 50% above 2018 levels, compared to the 25% rise recommended by the CCC. The Making Best Use policy suggests that future airport expansion decisions will need to defer to any "new environmental policies emerging from the aviation strategy", but as this strategy has not been released and the government has yet to respond to the CCC's most recent recommendations, a policy vacuum prevails.

Looking beyond the UK's existing national policy landscape, decision makers also have a duty to review and take consideration of national and international climate risk and responsibility. Many in the research community have put forward evidence and arguments that the UK's 2050 net zero target is inadequate if global society is to meet its internationally agreed targets and avoid catastrophic climate breakdown. These contributions relate both to issues of equitable distribution of emissions reduction and national capability.[16] Additionally, however, policymakers must consider international progress in emissions reduction. As of the end of 2020, combined international pledges and targets were estimated to be sufficient to limit warming to around 2.6°C, significantly greater than the Paris Climate Agreement's targets of 1.5°C/2°C. This 2.6°C estimate assumes pledges and targets are met. Concerns of even greater levels of warming arise when the limited scope of the emissions reduction policies that have actually been implemented is considered.[17]

4. DEALING WITH UNCERTAINTY

The UK is in a state of flux. The combined impacts of the Covid-19 virus and the public policy response, Brexit, and the climate crisis are having a disruptive effect on life in the UK. Permanent shifts in public behaviour, economic norms and the industrial makeup of the UK are expected. The evidence available to decision makers aiming to appraise the pros and cons of airport expansion is changing on a regular basis. This relates not just to the impacts of the pandemic on the future of demand for air travel. The science of aviation's impact on the environment today; the technologies that will influence its impact tomorrow; and the policies and guidance that define the appropriate approach to appraisal are all evolving rapidly.

In guidance issued following the onset of the Covid-19 pandemic, the Department for Transport (DfT) underscored the importance of sensitivity analysis as a tool to cater for change, risk and uncertainty which is challenging decision making. Sensitivity analysis involves testing the impact of changes to uncertain parameters in economic or environmental models in order to explore how robust the initial assessment of the scheme is to change. If a scheme looks desirable initially, but this desirability is highly sensitive to values given to parameters that are very uncertain, this is useful information for decision makers. In circumstances of extreme uncertainty and risk it may be appropriate for decision makers to turn down a scheme, or delay a decision until greater clarity emerges. In its guidance the DfT particularly emphasises the importance of sensitivity testing in relation to carbon values:

Sensitivity testing is a useful way of providing insight on the potential impacts of emerging evidence, so that decision makers can have a wider sense of the potential impact of change on their considerations. As well as taking into account new evidence on long-term economic growth and carbon values, scheme promoters may wish to work with their scheme sponsors to develop their own sensitivity tests, to account for the likely impact of potential changes that may occur in the future that may be important to examine at certain stages of business case development.[18]

In this guidance the DfT also recommends the sensitivity testing of 'long-term economic growth'. In the case of airport expansion, economic growth relates closely to demand growth. The most common sensitivity test seen over the past 12 months has been the updating of passenger forecasts to account for the pandemic impact on passenger numbers, as was performed by Bristol, Leeds Bradford (LBA) and Southampton airports. While such an assessment is useful, a feature of airport expansion appraisal is that passenger number projections can be a less important parameter when it comes to determining a scheme's merits than a parameter which determines the scheme's per-passenger benefit. For example, it is less important to a scheme's overall appeal whether it will lead to 1.4 million new passengers or 1.8 million passengers than whether each passenger leads to 40kg of carbon emissions or 80kg. The key parameters are the coefficients, which determine the net marginal impact of increasing passenger numbers, rather than the increase in passenger numbers itself. The key coefficients that drive the marginal climate impact of each passenger are the focus of this report.

5. METHODOLOGY

In a series of prior reports looking at airport expansion NEF has identified consistent failures to consider the sensitivities in the claimed costs and benefits of airport expansion, and a tendency not to appraise scheme impacts in a systemic way. In this paper we take a cross-cutting look at the appropriate estimation of the carbon costs of airport expansion and sensitivities inherent in projections.

We use examples from ongoing airport expansions as case studies. Our assessment of the climate cost of expansion treats the processes of both estimating and monetising emissions as important to understanding the proportionate impact of each scheme's emissions.

We divide the process of measuring a scheme's climate impact into six stages, five of which are addressed in this report, and one which is left to the next report in this series. At each stage we identify the process steps and parameters of greatest material significance to the final model output, i.e. the process steps and parameters to which the final output is most sensitive. We then examine the strength of the assumptions underpinning practice seen in the expansion cases put forward in recent months, and test the impact of alternative assumptions grounded in the latest science and guidance.

- **Estimating base emissions:** Emission estimates are derived from assumptions about the number of flights that will take place, the size of aircraft that will fly and the number of passengers they will carry (i.e. the load factor), the technology and fuel efficiency of those planes, and the distance they will travel.

- **Estimating net climate impact:** Net climate impact is derived by integrating CO_2 emission estimates with the non-CO_2 climate impacts of air travel. These are calculated using the latest science on the role of other pollutants emitted during flight such as water vapour, nitrogen oxides, and aerosols in driving global warming.

- **Applying a carbon price:** Carbon prices are applied to arrive at a monetary value for emissions over the lifetime of a proposed scheme. Prices can be derived a number of different ways including via traded values, the social cost of carbon, and the cost of abatement. Values for appraisal are supplied by the Department for Business Energy and Industrial Strategy (BEIS).

- **Applying a discount rate:** The total monetary value of emissions over a scheme's lifetime is summed after applying a discount rate to costs incurred in future years. Various discount rates are supplied by HM Treasury in the government's Green Book and subsequent guidance notes as well as in academic and professional literature – the issues involved are nuanced, particularly when considering intergenerational equity and the relative trade-offs between temporary economic prosperity and long-term environmental degradation.

- **Calculating internal and external costs:** The complex legislative landscape of aviation means that some of the costs of carbon emitted are internally accounted for (e.g. recollected through tax or credit systems such as the UK Emissions Trading System), while some are not, and therefore will be borne by wider society. The Department for Transport (DfT) emphasise the importance of distinguishing these two types of cost.

- **Establishing net impact:** The final step in the process of appraisal is to understand net scheme impact within the wider system. In the case of aviation appraisal this means modelling displacement, i.e. the extent to which a scheme creates new activity (flights/passengers/business) versus relocating activity from one location to another. At the system level, a scheme's impact is determined net of displaced activity. This system level consideration is not addressed in this report, and instead is addressed in the second part in this series which looks at the holistic appraisal of airport expansion. The direct implication of this is that emissions estimates presented herein relate to changes in individual airport-level emissions, and not to net UK emissions.

In this report we use active airport expansion plans as case studies to illustrate the importance

TABLE 2

Key documentation reviewed.

Grouping	Airport	Documentation reviewed
Non-NSI	Bristol	Environment Statement Addendum submitted to the 2021 planning inquiry
Non-NSI	Stansted	Environment Statement submitted to the 2021 planning inquiry
Non-NSI	Leeds Bradford	Environment Statement submitted to Leeds City Council Planning portal
Non-NSI	Southampton	Environment Statement and Environment Statement Addendum submitted to the Eastleigh Borough Council Planning portal
NSI	Gatwick	Environmental impact assessment scoping report submitted to the Planning Inspectorate in 2019
Non-NSI	Luton 1	Environmental impact assessment submitted to Luton Borough Council in 2021
NSI	Luton 2	Environmental impact assessment scoping report submitted to the Planning Inspectorate in 2019
NSI	Heathrow North West Runway	Updated Appraisal Report published in October 2017 ahead of the parliamentary vote on the Airports National Policy Statement in June 2018. Environmental impact assessment scoping report submitted to the Planning Inspectorate in 2018

of consideration of the sensitivities inherent in appraising a scheme's carbon impact. In our review of the methods and data presented we evaluate expansion appraisal documentation submitted to decision makers. Our key objective is to assess the strength, quality and robustness of the evidence base which was supplied to decision makers on the carbon impacts of airport expansion. The reports reviewed and listed in Table 2 represented the most up-to-date assessment made on each scheme at the time of writing. As shown in Table 2 the expansion applications we have reviewed are divided into non-NSI applications and NSI applications. Those in the non-NSI grouping are typically further progressed, with multiple detailed appraisals having been conducted. As none of the NSI applications have yet submitted an application for development consent they have yet to submit their own formal appraisal documentation. All three airports have submitted formal scoping reports, but these documents detail only the intended methods, and not the assessment results. In the case of Heathrow's planned expansion, significant appraisal has already been conducted by the Department for Transport ahead of the 2018 vote on the Airports National Policy Statement.

6. ESTIMATING EXPANSION EMISSIONS

Appropriate methods for calculating the total emissions of greenhouse gases are well established but do involve – as is often the case when forecasting complex processes – some simplifications and assumptions. Consultants working on behalf of expansion scheme proponents typically simplify the calculation of emissions by modelling in detail only a selection of specific years, or 'time slices', rather than every year in the assessment period. Modellers then make simple assumptions about what happens over the full assessment period on the basis of the modelled years. Key information on the modelling conducted for each case study airport is shown in Table 3.

There is considerable variance in the length of the assessment period, and in the date of the final fully modelled year. While part of this is a result of the piecemeal application process – whereby some years have passed since the first scheme modelling was conducted – a lot of this variation is relatively arbitrary, resulting in difficulty in comparing schemes. Part of NEF's work for this report has been to conduct supplementary modelling in order to allow direct comparison between schemes.

The carbon emissions involved in the construction of the proposed airport expansion typically represent a fixed cost, independent of the eventual number of air traffic movements (ATMs), but these emissions are usually several orders of magnitude smaller than the flight emissions and as such are not the focus of this carbon analysis.

In order to generate flight emissions outputs at each time slice a number of assumptions are made when setting up the emissions model. For example the number of ATMs that will take place, the distance the aircraft will travel and the capacity and fuel efficiency of the aircraft.

Passenger numbers and ATMs are usually highly correlated. In addition, changes in passenger or ATM numbers will tend to impact on the benefit and cost sides of the appraisal in similar proportions. As a result, the coefficient determining emissions on a per-ATM, and hence per-passenger basis, is of critical importance. This coefficient is highly sensitive to assumptions about the future fuel efficiency of aircraft, as demonstrated below.

6.1 FUEL EFFICIENCY

The fuel efficiency of aircraft on a per-passenger, per-kilometre, basis is determined by a number of factors, including air traffic management and efficiency in operating practices, as well as the number of passengers per plane (inclusive of both the plane's internal seat design, and its load factor) and the technological advances that determine the rate of fuel burning required. While advances in many of these areas have provided improvements in fuel efficiency in the past, some have limited remaining potential to deliver savings. The Department for Transport (DfT) considers air traffic management and operational efficiencies to now be near to maximised in its aviation forecasts report in 2017.[19]

TABLE 3

Key modelling information.

Airport	First model year / start of assessment period	Scheme open year	Scheme capacity year	Final model year	End of assessment period
Bristol	2017	2024	2030	2050	2050
Leeds Bradford	2018	2024	2032	2050	2050
Southampton	2021	2021	2036	2036	2140
Stansted	2016	2023	2028	2028	2050
Heathrow North West Runway	2023	2023	2040	2050	2084/2085

Source: Airport appraisal documentation

TABLE 4

Assumed rates of annual fuel efficiency improvement (central scenarios).

Stakeholder	2016-2030	2030-2040	2040-2050	Sustainable aviation fuel assumption
DfT 2017 (central demand)	0.62%	1.31%	1.45%	5% by 2050
CCC 6th Carbon budget	1.4%			25% by 2050
Bristol Airport	0%	0%	1.50%	10% by 2050
Leeds Bradford Airport	1.4%			10% by 2050
Southampton Airport	0.62%	1.31%	1.45%	0%
Stansted Airport	0%	1.4% (2028-2050)		32% by 2050

Source: CCC, DfT, and airport appraisal documentation

The rates of fuel efficiency assumed by different stakeholders are shown in Table 4. Most airports, albeit with some slight variation, align themselves with the central estimates of either the DfT or Climate Change Committee (CCC). It is important to note however, that most of the rates of efficiency improvement assumed over the longer-term time horizons are relatively ambitious when compared with current rates of improvement. New analysis for NEF by the International Council on Clean Transportation (ICCT) using their Global Aviation Carbon Assessment (GACA) model suggests that fuel efficiency improvements relating to technological enhancements delivered only around 0.5% of annual fuel efficiency improvement between 2013-2019.[20] This would suggest that while Bristol and Stansted airports have made conservative assumptions in assuming 0% improvement between 2016–2030, the remaining airports have all made relatively optimistic assumptions about short-term rates of improvement. The industry will also need to significantly scale up its research, development and technology roll-out rates to achieve the rate of improvements assumed by all stakeholders in the 2040–2050 period.

In addition to their core estimates of fuel efficiency improvement, three airports (Bristol, Leeds Bradford, and Stansted) conducted sensitivity tests on their assumed rates of change. Leeds Bradford Airport's application tests only a higher, or more optimistic, rate of 2% per year between 2030–2050. Stansted's application tests both pessimistic (0.9%) and optimistic (1.9%) constant rates of improvement. In doing so, Stansted highlight how sensitive model outputs are to this assumption. Switching from its central value to its pessimistic value adds 19% to the scheme's net emissions in 2050, and switching from its optimistic value to its pessimistic value adds 37%. The equivalent figures in Bristol Airport's application are lower, at 10% and 18% respectively, but nonetheless are material. The lower nature of these values relates to Bristol Airport's decision only to apply efficiency improvements between 2040 and 2050 (Table 4).

A further uncertainty regarding the future fuel efficiency of aviation lies in the uptake of so-called 'sustainable aviation fuels' (SAFs). These are fuels which are carbon neutral across their lifecycle from production to consumption. In its sixth carbon budget advice, the CCC assumes that 25% of the aviation sector fuel mix will derive from SAFs by 2050. As shown in Table 4, applicant airports have made a variety of different assumptions.

Data from the application of Leeds Bradford, the only airport to run a sensitivity test on different rates of SAF uptake, highlights how sensitive carbon emission estimates are to this parameter. Its optimistic scenario (which differs both in uptake of SAFs and fuel efficiency as shown in Table 4) sees a reduction in emissions equivalent to around 33% when compared to its central scenario in the year 2050.

6.2 CO_2 EMISSIONS

Based on the different inputs described above each airport has arrived at an estimate of its emissions in selected future years spanning the assessment period. These estimates are shown in Table 5. NEF has conducted additional analysis to identify the total emissions over the period 2025–2050 and to estimate the relative fuel efficiency each applicant airport is projecting (also Table 5). This analysis, and identifying annual estimates for the years 2030 and 2050 where these were not provided by

TABLE 5

Summary of base carbon emissions estimates resulting from each non-NSI airport expansion project, including corrected emissions estimates at Stansted.

	Bristol	LBA	Southampton	Stansted	Stansted *corrected*
Additional passenger capacity per annum	2,000,000	1,500,000	2,324,000	8,000,000	8,000,000
Additional ATM capacity per annum	11,590	9,700	16,660	40,500	40,500
2030 snapshot (tonnes CO_2)	86,400	42,000	79,000	226,000	303,000
2050 snapshot (tonnes CO_2)	70,000	93,000	120,000	189,000	283,000
2025–2050 total (tonnes CO_2)	2,002,000	2,371,000	2,666,000	5,220,000	7,014,000
2025–2050 annual average (tonnes CO_2)	80,000	95,000	107,000	209,000	281,000
kg CO_2 per passenger	40	63	46	26	35
kg CO_2 per ATM	6,900	9,800	6,400	5,200	6,900

Source: NEF analysis of airport appraisal documentation reported in Table 2 and Department for Transport data

the applicant (see Table 3), was conducted using linear interpolation between single year emissions estimates.

Detailed scrutiny of the full set of model inputs used by each applicant airport was outside of the scope of this analysis (some airports do not make all of the required inputs for such scrutiny publicly available). In order to sense-check the level of emissions each airport has estimated we cross referenced each airport's fuel efficiency estimates against those projected by the DfT in its analysis underpinning the *Making Best Use policy statement*.[21]

Comparing the DfT's estimates of fuel efficiency at UK airports with the data in Table 4 identified Stansted Airport as a particular outlier among the four non-NSI airports. Fuel efficiency estimates put forward by the scheme applicant suggest emissions on a per-ATM and per-passenger basis around 30% lower than expected by the DfT. Not only this, but Stansted Airport's estimates appeared notably low when compared with other schemes. Given this inconsistency we have bias corrected Stansted's emissions using the DfT's data. Our revised emissions estimates are also shown in Table 5. This correction results in a 34% increase in the estimated climate impact of the scheme when compared with the airport's estimates, and this carries through into monetised carbon values presented later in the report.

Per-passenger emission estimates at Bristol and Southampton also seems low when compared with the DfT's estimates of average fuel efficiency at non-London airports (around 60 $KgCO_2$ per passenger over the 2020-2050 period) but some of this shortfall may be explained by expectations around routes and aircraft types at these airport. As such, estimates have not be subjected to any bias correction at this stage.

6.3 ARRIVAL EMISSIONS

When deciding on the scope of the carbon impacts of the proposed airport expansion schemes, the majority of the appraisals examined here have defaulted to a form of carbon accounting that captures only the emissions relating to departing flights generated by the proposed expansion. This approach is similar to the approach to national emissions accounting promoted by the CCC, which assumes that the emissions linked to arriving flights will be accounted for in the origin country's carbon accounts.[22] It has been noted by some stakeholders – for example in Gatwick Airport's initial submission to the Planning Inspectorate – that

TABLE 6

Proportion of passengers using each airport resident in the UK and overseas.

Airport	Passengers resident in the UK (year of assessment)	Passengers resident overseas (year of assessment)
Bristol	83.7% (2015)	16.3% (2015)
Leeds Bradford	76.2% (2017)	23.8% (2017)
Southampton	No data	
Stansted	63.7% (2019)	36.3% (2019)
Heathrow	41.6% (2019)	58.4% (2019)

Source: Civil Aviation Authority Passenger Survey (2015, 2017, 2019)

there is presently no internationally agreed system for carbon accounting of air travel emissions.[23]

In effect, the CCC's approach results in both the airport, and the UK, taking responsibility for around 50% of the emissions linked to flights coming in and out of the country. It is worth noting, however, that other allocation systems are available when it comes to appraisal.

Responsibility could be allocated, for example, according to passenger residency. At the UK level, in most years over 60% of travelling passengers are UK residents.[24] Table 6 shows the proportion of passengers flying from each case study airport who are UK residents. These breakdowns highlight why an assumption of only 50% responsibility at Bristol, Leeds Bradford, and Stansted, (and likely also Southampton airport although Civil Aviation Authority data was lacking in this regard), where upwards of 80% of travellers are UK residents, is potentially conservative.

Appraisal of airport expansion is conceptually different to national carbon accounting. In this case the objective is to understand the material impacts of a proposed scheme. In some situations it is possible that the creation of additional ATM slots at an airport may effectively generate both legs of the journey. This is particularly important in the context of considering the absolute environmental impact of granting permission for a scheme, as opposed to just considering how the scheme may effect national carbon accounting balances. This is recognised by Southampton Airport's application, which is the only application to include emissions resulting from arriving flights. The Southampton application takes the worst case assumption – that the airport expansion scheme will be responsible for all departing and arriving flight emissions. The other schemes have assumed responsibility for 50% of emissions linked to incoming and outgoing flights. In most cases this seems a relatively optimistic assumption given the data presented in Table 6.

While the emissions of arriving flights are unlikely to be accounted for in UK national emissions inventories, they do still exist, and may be newly created as a result of the proposed expansion schemes. As such, analysis at least in the form of a sensitivity test, exploring the climate impact of arriving flights is appropriate. In simplified terms, assuming total responsibility for arriving flights will have the effect of doubling each scheme's net global warming potential (GWP), as demonstrated by Southampton Airport in its own submissions.

7. TOTAL CLIMATE IMPACT

In addition to emissions of CO_2 it is widely acknowledged that air travel results in emissions of other pollutants which significantly increase its total climate impact, including water vapour, nitrogen oxides and aerosols. When the total impact of these emissions is considered, aviation is understood to contribute significantly more to global warming than its CO_2 footprint alone indicates. This warming takes place through complex, interlinked processes that are the subject of ongoing scientific research. There is growing confidence in the existence of this amplifying effect, sometimes referred to as the 'non-CO_2' effect. It has usually been measured in terms of net 'radiative forcing' effect – this refers to the process by which energy from the sun is absorbed by the earth and radiated back into space. In a 2019 report the Climate Change Committee (CCC) states:

Overall, non-CO_2 effects from aviation warm the climate and approximately double the warming effect from past and present aviation CO_2 emissions.[25]

Non-CO_2 effects are also recognised by the Department for Transport (DfT) in the aviation chapter of TAG published in 2018. The DfT advises scheme appraisers on how to treat these effects stating:

…either a qualitative assessment should be made of the non-CO_2 impacts, or a quantitative assessment can be made as a sensitivity test, drawing on the latest guidance on GWP factors and BEIS guidance on valuing greenhouse gas emissions.[26]

The Department for Business Energy and Industrial Strategy (BEIS) guidance referred to gave the advice below in its July 2020 iteration – note that a more extensive discussion of the merits of different approaches to measuring non-CO_2 is contained within the referenced document and the below quote has been shortened for brevity.

It is clear that aviation imposes other effects on the climate which are greater than that implied from simply considering its CO_2 emissions alone […] A multiplier of 1.9 is recommended as a central estimate, based on the best available scientific evidence, as summarised in Table 46. […] It is important to note that the value of this 1.9 multiplier is subject to significant uncertainty.[27]

However, so rapidly is scientific research in this area progressing, that these documents may already be out-of-date. The research team cited by both BEIS and DfT in their guidance on non-CO_2 effects, led by Professor David Lee, published new research in January 2021 which provided more robust estimation of the magnitude of non-CO_2 effects of aviation.[28] This research estimates that aircraft emissions currently have a net warming impact which is three times greater than their CO_2 emissions alone would indicate. This research was then further cited by the European Commission in it 2020 research into the same topic. In relation to global warming potential (GWP) the Commission's research paper states:

A relatively new application of the GWP, referred to as 'GWP', produces a better temperature-based equivalence of short-lived non-CO_2 climate forcers than the traditional use of GWP by equating an increase in the emission rate of a Short Lived Climate Forcer with a one-off "pulse" emission of CO_2. […] The CO_2-warming-equivalent emissions based on this method indicate that aviation emissions are currently warming the climate at approximately three times the rate of that associated with aviation CO_2 emissions alone.*[29]

At present TAG guidance only binds scheme proposers to a qualitative or quantitative assessment of the likely non-CO_2 effects. This is despite other government sources, such as the BEIS worksheet for company reporting of greenhouse gases, specifically requesting quantification.[30] Nonetheless, despite ample evidence of the presence of non-CO_2, growing consensus around adequate ways to integrate these effects into appraisal, and recommendations in government guidance, only one of the evaluated airport expansion applications quantitatively assessed the potential impact of non-CO_2 effects.

TABLE 7

Treatment of non-CO_2 effects by case study airports.

Airport	Treatment of non-CO2 effects
Bristol	Qualitative assessment
Leeds Bradford	Qualitative assessment
Southampton	Quantitative assessment made
Stansted	No mention
Heathrow North West Runway	Considered qualitatively in early scoping exercises but not presented to decision makers in final appraisal documentation

Source: NEF analysis of airport appraisal documentation

8. PRICING EMISSIONS

The monetisation of emissions and their climate impact is a recommended step in the appraisal process for two primary reasons. First, monetisation provides an approximation of the overall cost to society of the carbon emitted, bringing what has historically been an externality into the appraisal in a manner that allows decision makers to weight its significance. Second, through the UK Emissions Trading System (ETS) the price associated with carbon emissions is now, at least in relation to domestic flights and flights to the European Economic Area (EEA), an internalised cost borne by aviation sector stakeholders (passengers, airlines and airports). The internalisation of emissions costs within the aviation sector means carbon prices have a dynamic relationship with demand for air travel – higher carbon prices will drive up ticket prices and reduce demand.

Carbon prices change over time. Markets adjust to the current and forecast cost of abating emissions, government policy on emissions reduction advances, and carbon pricing mechanisms develop and change. Both the fluctuating nature of carbon prices, and their dynamic relationship with demand for air travel mean carbon pricing is a critical parameter for sensitivity testing, as identified by the Department for Transport (DfT) in 2020[31]

The UK's carbon prices for appraisal are awaiting updating since the government increased its emission reduction ambition. In addition to emphasising the need for sensitivity testing of carbon prices, the DfT recently updated its guidance on the appropriate carbon prices to use in appraisal, stating:

…until updated carbon values are available, we require analysts to illustrate the potential impact of placing a higher value on GHG emissions by:

- *reporting scheme GHG impacts using the current published high carbon values series as a required sensitivity test (in addition to any use of central values)*
- *reporting the results of the high values sensitivity test in value for money advice for decision makers, noting in particular if the overall value for money assessment is sensitive to the carbon values applied.*[32]

The UK's 'high' carbon prices are currently at least 50% higher than its 'central' prices across all future years, with the 2050 non-traded carbon price rising from £231 per tonne to £346 per tonne. This significant difference could have material impacts on the overall attractiveness of airport expansion schemes, and could reduce future demand for air travel at the airports in question. For example, DfT analysis, accessed via Freedom of Information request and reported in a previous NEF report, showed that the DfT's testing of demand under a 'high' carbon price scenario resulted in an average reduction in air travel demand equivalent to 8% of passenger numbers in 2050 across all non-London and the South East regions.[33]

The assessment of the proposed third runway at Heathrow includes significant analysis of monetised carbon emissions and the implications of different carbon pricing regimes, in accordance with government guidance on appraisal. Bristol Airport has also completed a basic monetisation of carbon emissions in its latest appraisal submission – this came as a result of representations by NEF during the initial planning application process. However, Bristol Airport only considers the government's central carbon prices and in the same report rejects entirely the validity of its own monetised estimates. None of the other non-NSI airports provide any monetised estimates of the emissions associated with their schemes and, in doing so, fail to meet the government's best-practice guidelines.

9. THE DISCOUNT RATE

TAG guidance requires the estimation of the net present value (NPV) of a scheme's monetised costs and benefits. This value calculates a single figure from a series of costs and benefits occurring in future years. To derive this value a 'discount rate' is applied to future values which represents the 'time preference' for near term benefits, and the greater uncertainties and risks associated with distant future benefits. While the discount rate forms a core part of current UK government appraisal guidance, it is a hotly debated topic in scientific circles. Climate economist, William Nordhaus, describes the discount rate as "perhaps the most important conceptual issue facing current climate policy".[34]

Researchers have shown that Integrated Assessment Models (IAMs), which often form the basis of present-day climate policy and economics, are extremely sensitive to the chosen discount rate. For example, small changes in the chosen discount rate can lead to significant changes in the recommended present-day carbon price.[35] In general, there is a strong consensus among scientists and economists that decision makers should be using lower discount rates for environmental impacts than are currently applied in policy appraisal. One survey of experts conducted in 2018 stated:

Despite disagreement on discounting procedures and point values, we obtain a surprising degree of consensus among experts, with more than three-quarters finding the median risk-free SDR [social discount rate] of 2 percent acceptable[36]

A 2% discount rate would represent a significant reduction on the current primary rate recommended by HM Treasury of 3.5%. While the Treasury does recommend lower rates in certain circumstances relating to impacts on health (Table 8), these are not currently applied to environmental impacts such as carbon emissions. However, in light of the emerging academic consensus, the government have announced that they are considering making a change to discounting policy. Specifically, the government are considering reducing the discount rate applied to environmental valuation (including carbon costs) from the currently used 3.5% per year, to the value used for life and health effects, 1.5% per year. This announcement came in response to a 2020 review of the Green Book. The government states its intention to commission an expert review into the application of the discount rate for environmental impacts. Specifically:

This will scrutinise the current guidance on environmental valuation and discounting and investigate the case for using the same discount rate as currently applied to the valuation of life and health effects.[37]

Given both the potential imminent change to government discounting policy, and the significant body of academic research highlighting the extreme sensitivity of carbon models to the chosen discount rate, application of a sensitivity test on the discount rate parameter to the carbon costs of airport expansion seems appropriate. None of the case study airports have performed such a test in their appraisal documentation.

TABLE 8

Summary of 2020 Green Book discount rates.

	Year 0 to 30	Year 31 to 75	Year 76 to 125
STPR (standard)	3.50%	3.00%	2.50%
Value of life and health	1.50%	1.29%	1.07%
Intergenerational Impacts	3%		
Intergenerational Impacts (Health)	1%		

Source: HM Treasury Green Book

10. THE CLIMATE COST

In the following figures and tables NEF demonstrates the impact of different assumptions and sensitivities in the modelling process on final emissions estimates. The data below represents reworking of modelling initially presented by applicant airports in their appraisal documentation. Notably, we facilitate comparison between schemes by focusing on an assessment period from 2025–2050, derived from linear interpolation between time slices. The following estimates should not be viewed as the 'final word' on the schemes in question. Other commentators may identify areas in our methods and those of the applicant airports that can be improved using the latest science.

All of the estimates which follow should be understood as airport-level emissions and costs, not system-level changes. It is likely that each scheme will result in a degree of displacement of flights and passengers between airports in the UK. Although this effect is likely to be modest, it will likely reduce the net impact on UK carbon budgets of each scheme and as such we return to this process in the second part in this report series.

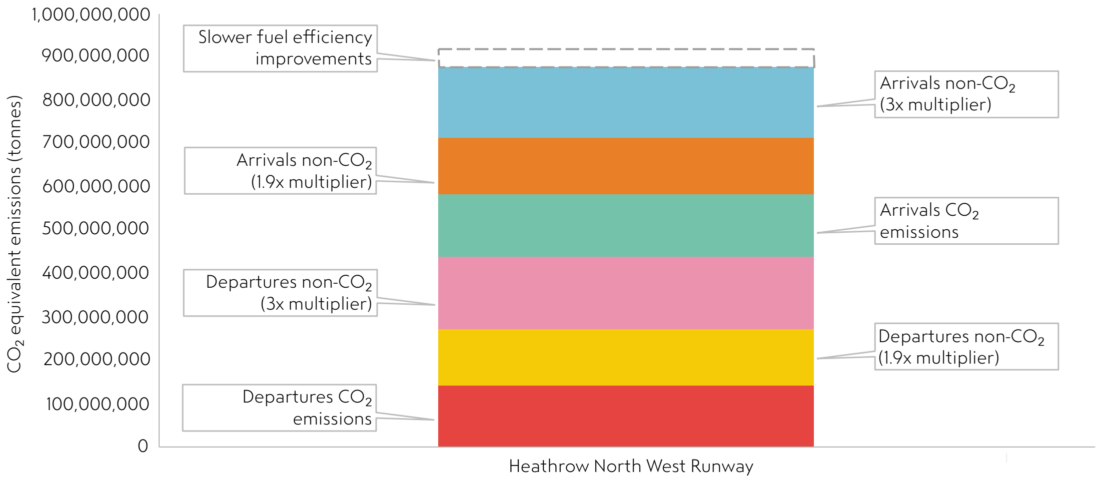
10.1 EMISSIONS SENSITIVITIES

Figure 1 illustrates the different components that make up a 'maximum climate-impact scenario', in this case illustrated using the proposed Heathrow North West Runway expansion. As shown, inclusion of arrival (inbound) flight emissions can have a very significant amplifying effect on the scheme's total climate impact. Nonetheless, including the more conservative estimate of non-CO_2 effects almost doubles the scheme's impact. Also shown is the potential impact of lower future rates of fuel efficiency improvement, an issue considered by two out of four of the airports in their appraisal documentation.

Table 9 focuses on the emissions and climate impact of the four non-NSI schemes evaluated. This table highlights a significant gap between the emissions estimate put to decision makers by applicants, and what would seem to be a reasonable minimum and maximum climate impact range. In this case, the minimum potential is treated as the scheme's departure emissions and the lower estimate of non-CO_2 effects. A scheme's maximum impact, which should also be presented to decision makers as a worst-case-scenario, includes arrival (inbound) emissions, and utilises the higher end non-CO_2 effect multiplier. Both scenarios utilise each applicant's central fuel efficiency improvement assumption.

FIGURE 1

Presenting only the CO_2 emitted by departing flights potentially hides very significant wider climate impacts of airport expansion schemes.
Breakdown of the different sources of cumulative climate impact at the airport level resulting from Heathrow's North West Runway over the period 2025–2050.



Source: NEF remodelling of airport appraisal documentation

TABLE 9

In 3/4 of the airport expansion proposals reviewed, decision makers were not presented with climate impact estimates representative of the true likely range of impacts.
Climate impacts of four expansion schemes shown as annual averages over the period 2025–2050 based on different sets of assumptions.

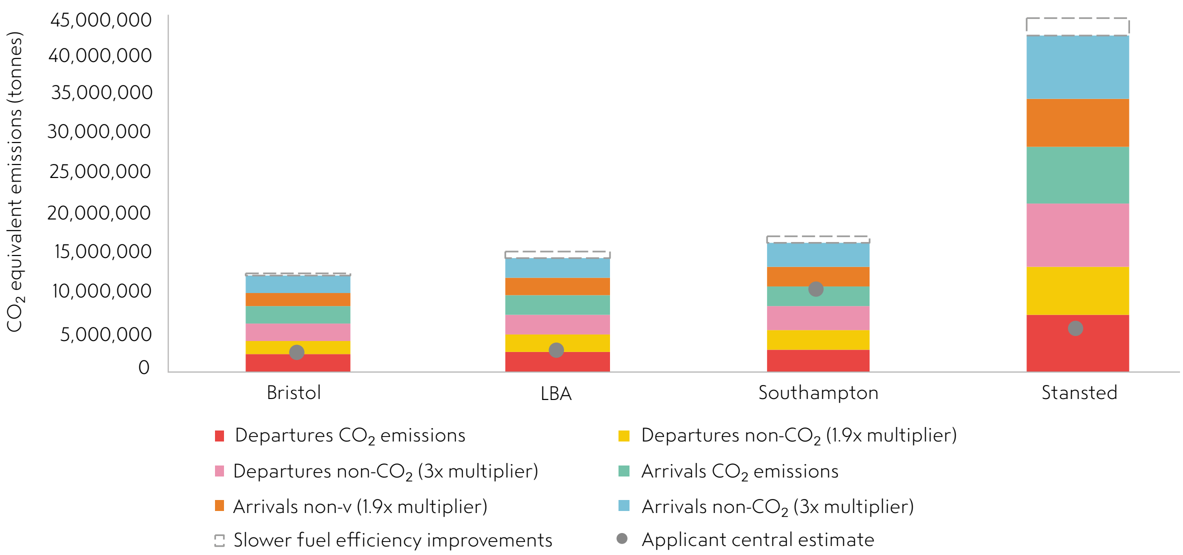
	Assumptions	Bristol	LBA	Southampton	Stansted Airport
Climate impact as presented by applicant airport (tonnes CO_2 equivalent/year)	As per airport appraisal documents	80,000	95,000	403,000	209,000
CO_2 impact (tonnes/year)	Departing flights only	80,000	95,000	107,000	281,000
Minimum climate impact (tonnes CO_2 equivalent/year)	Departing flights + lower non-CO_2 multiplier	151,000	179,000	202,000	530,000
Maximum climate impact (tonnes CO_2 equivalent/year)	Departing + arriving flights + higher non-CO_2 multiplier	484,000	574,000	645,000	1,697,000
Applicant figures as a proportion of maximum climate impact (%)		16.5%	16.5%	62.5%	12.3%

Source: NEF remodelling of airport appraisal documentation

While three of the four schemes (Bristol, LBA and Southampton) are of relatively similar size and impact, decision makers were presented with notably different quantifications of climate impact potential. Documentation relating to Southampton airport takes a significantly more conservative approach to presenting the scheme's potential climate impact (Figure 2).

FIGURE 2

There was significant variation between airports in the approach taken to presenting total potential climate impact, with Southampton Airport considerably more conservative.
Breakdown of the different components of cumulative climate impact for the non-NSI airports over the period 2025-2050, compared with the central emissions estimate put forward in the applicant's appraisal documents.



Source: NEF remodelling of airport appraisal documentation

TABLE 10

Three out of four non-NSI airports have presented central climate impact estimates at the airport-level which are significantly lower than even the most optimistic reasonable forecast.
Airport-level cumulative climate impact estimates of four expansion schemes over the period 2025–2050 based on different sets of assumptions.

	Assumptions	Bristol	LBA	Southampton	Stansted Airport
Climate impact as presented by applicant airport (tonnes CO_2 equivalent)	As per airport appraisal documents	2.0 million	2.4 million	10.1 million	5.2 million
CO_2 emissions impact (tonnes)	Departing flights only	2.0 million	2.4 million	2.7 million	7.0 million
Minimum climate impact (tonnes CO_2 equivalent)	Departing flights + lower non-CO_2 multiplier	3.8 million	4.5 million	5.0 million	13.3 million
Maximum climate impact (tonnes CO_2 equivalent)	Departing + arriving flights + higher non-CO_2 multiplier	12.1 million	14.3 million	16.1 million	42.4 million

Source: NEF remodelling of airport appraisal documentation

Viewing each airport's cumulative emissions over the period 2025–2050, as shown in Table 10, underscores the importance of appraising these schemes alongside the UK's national decarbonisation ambitions. It is important to note that these are airport-level rather than system-scale changes in emissions (an issue that will be discussed further in part two of this series). Nonetheless the expected changes are of significant magnitude, and are likely material to the achieving of the nation's climate targets and indeed the UK's international credibility on climate change.

Emissions of this magnitude additionally raise issues regarding the fair distribution of the UK's remaining carbon budget. In a carbon capped world, higher emissions in one sector or location will inevitably lead to greater pressure to cut emissions in other areas, potentially bringing cost penalties and unintended impacts on disadvantaged groups. These issues were discussed further in NEF's 2020 report on the regional impacts of the proposed third runway at Heathrow.[38]

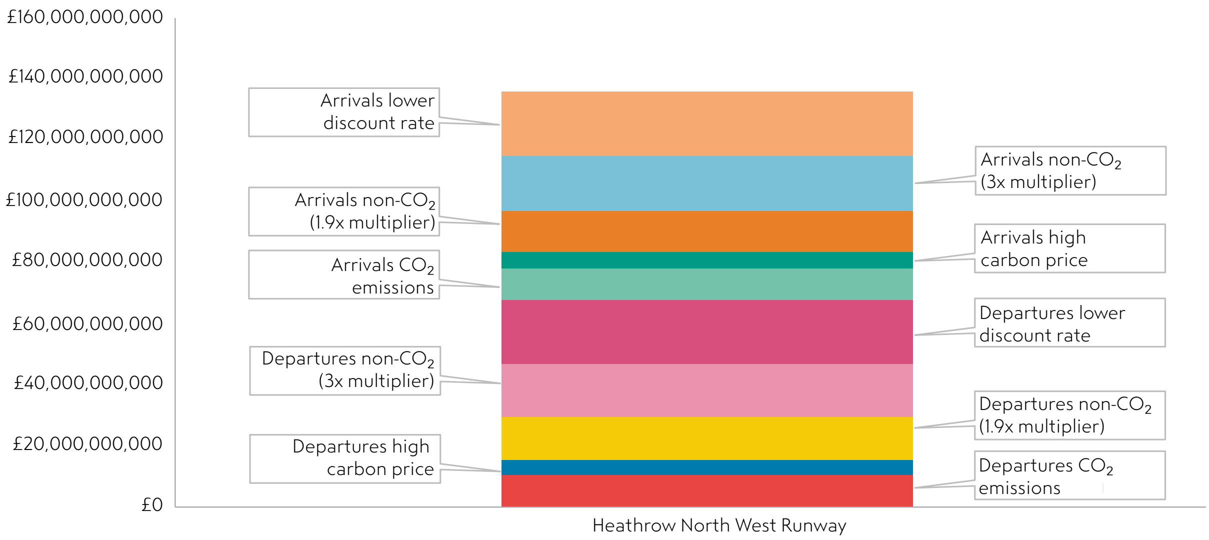
10.2 Cost sensitivities

When establishing a scheme's monetised carbon cost the same parameters as above – fuel efficiency assumptions, CO_2 emissions, non-CO_2 effect and treatment of arriving flights – play a key role in determining its net present value (i.e. cumulative discounted value over the period 2025–2050). However, the final value is also highly sensitive to the chosen discounting approach and the carbon pricing schedule applied. The breakdown of costs in a maximum impact, or worst-case scenario is shown in Figure 3.

The accumulation of costs is shown for the non-NSI airports in Table 11. Three of the four airports have declined to monetise climate impacts in their appraisal documentation. Table 11 highlights that even a more conservative estimate of net present value leads to costs in the hundreds of millions of pounds over the 2025–2050 period. These estimates, and particularly the higher-end, more precautionary estimates, are likely to be material when compared with a robust assessment of each scheme's economic benefits.

FIGURE 3

Very significant monetised costs of climate impacts quickly accumulate, particularly if future changes to carbon prices and discount rates materialise.
Accumulation of carbon costs (net present value) over 2025–2050 associated with Heathrow expansion under each given assumption. Baseline emission costs assume the central traded carbon price and the Green Book standard discount rate.



Source: NEF remodelling of airport appraisal documentation

TABLE 11

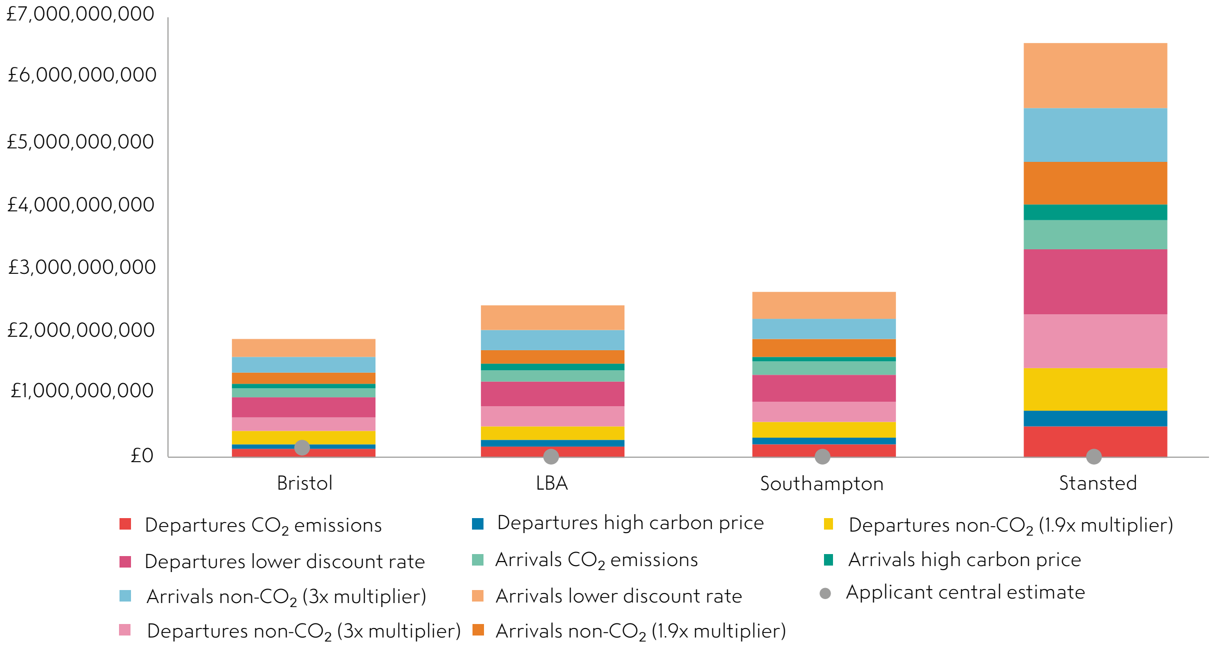
In combination, the four non-NSI schemes result in airport-level climate impacts over 2025–2050 worth a minimum of £2.4 billion and a maximum of £13.4 billion.
Summary of the net present value (2025-2050) of each scheme's total climate impact at the airport-level under different sets of assumptions.

	Assumptions	Bristol	LBA	Southampton	Stansted Airport
Value presented by applicant airport	As per airport appraisal documents	£142.1 million	None presented	None presented	None presented
Value of CO_2 emissions only	Departing flights only. Central carbon prices + high discount rate	£142.1 million	£177.6 million	£194.1 million	£495.3 million
Minimum cost for appraisal	As above + lower non-CO_2 multiplier	£332.4 million	£415.0 million	£453.8 million	£1,158.4 million
Maximum cost for appraisal	Departing + arriving flights + higher non-CO_2 multiplier + high carbon prices + low discount rate	£1,886.3 million	£2,406.5 million	£2,625.8 million	£6,563.6 million

Source: NEF remodelling of airport appraisal documentation

FIGURE 4

All four non-NSI airports have significantly overstated the economic case for their schemes by ignoring material monetised climate costs.
Accumulation of carbon costs (net present value) over 2025–2050 associated with non-NSI airport expansion schemes under each given assumption. Baseline emission costs assume the central traded carbon price and the Green Book standard discount rate.



Source: NEF remodelling of airport appraisal documentation

11. INTERNAL AND EXTERNAL COSTS

The Department for Transport (DfT) is clear in its guidance that the monetised value of carbon should be disaggregated between the internalised costs, e.g. those capture by the UK Emissions Trading System (UK ETS), and the externalised costs, i.e. those not currently captured by any carbon taxation mechanism. TAG states:

When carrying out monetary valuation, it is important to distinguish between the emissions from those sectors that are included within the EU Emissions Trading System (EU ETS) – the 'traded sector' – and those that are not – the 'non-traded sector.[39]

The recently legislated UK ETS currently functions much the same as its EU counterpart. A cap-and-trade system is operated whereby domestic flights and flights departing from the UK to the European Economic Area (EEA) must own carbon credits equivalent to their direct CO_2 emissions in order to fly. The non-CO_2 effects of aviation are not covered, nor are flights travelling to outside the EEA. However, at the time of writing airlines were provided with a free allocation of credits each year. This allocation was equivalent to 82% of the emissions cap over the period 2013–2020. From 2021 the free allocation began reducing at 2.2% per year.[40] At the present rate 16% of the overall emissions cap would be given away for free by 2050.

As a result of the free allocation of credits, the exemption for flights to non-EEA countries, and the lack of accounting for non-CO_2 effects, the majority of the climate impact of airport expansion is not internalised within the sector. It will be borne by society at-large as opposed to passengers and aviation businesses. However, it remains useful to test and understand the relative size of the internalised and externalised climate costs of each scheme. None of the case study airports have presented this information.

Some additional internalisation of international aviation emissions is expected to be provided by the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of the International Civil Aviation Organization (ICAO).[41] However, as this scheme is currently only designed to internalise emissions above the average emissions in 2019 it is largely redundant in the UK context.[42] This is because the efficiency of UK aviation is expected to improve over time, resulting in overall declines in future emissions. Only a very significant airport expansion (such as the proposed North West Runway at Heathrow) is likely to be sufficient to push UK aviation emissions back above the 2019 baseline after efficiency gains are accounted for. It is unlikely that any of the emissions resulting from smaller expansions (e.g. those resulting from non-NSI expansions) will be sufficient to be captured by the CORSIA scheme.

NEF modelled the carbon costs of expansion, applying the declining annual free allocation of emissions each year to the eligible carbon costs (assumed to be all costs barring non-CO_2 effects at non-NSI airports). This modelling suggested that when examining just the CO_2 emissions over the period up to 2050, around 65% of the costs of carbon are recouped within the sector by the UK ETS scheme. However, when considering non-CO_2 effects over the period up to 2050, only 35% of the total climate impact costs are internalised across the case study non-NSI airports. For example, of the total maximum climate impact cost of the four non-NSI expansion schemes, estimated at £13.4 billion over 2025-2050, only £4.7 billion would be internalised within the aviation sector; an estimated £8.7 billion would be borne by wider society.

12. WHERE NEXT FOR AIRPORT EXPANSION APPRAISAL?

Four non-NSI airport expansion schemes were evaluated. These schemes are relatively well progressed and in all cases decision makers in UK local authorities have already been presented with appraisal evidence. This analysis highlights that scheme proponents (and the consultants working on their behalf) have failed to take a precautionary approach to their scheme assessment. Appraisals have failed to take a comprehensive and robust approach to sensitivity analysis of uncertain model parameters (Table 12) and have presented an overly-optimistic vision of the future climate impact of the proposed expansion schemes (Table 13).

Questions are raised by this assessment regarding the extent to which decision makers had access to a complete, robust, and precautionary set of evidence upon which to base their determination. While council officers were able to commission external support to help them in interpreting submitted evidence, and requesting further clarification, there remains cause for concern. Not only are local authorities ill-equipped to handle appraisal of highly complex, far reaching, and high risk schemes (particularly in the midst of a global pandemic) but there are key questions regarding whether local authorities are the appropriate stakeholder to appraise the climate cost of expansion. Climate costs are national concerns which impact on all communities and emissions obligations are international. Airport appraisal stacks national

TABLE 12

Sensitivity testing report card.

Airport	Fuel efficiency	Sustainable aviation fuels	Arrivals	Non-CO_2 effects	Carbon price	Discount rate
Bristol	Sensitivity tested	Sensitivity tested	Not tested	Qualitative only	Priced not tested	Not tested
Leeds Bradford	Tested but only on the optimistic side	Tested but only on the optimistic side	Not tested	Qualitative only	Not priced	Not tested
Southampton	Not tested	Not tested	Included not tested	Included not tested	Not priced	Not tested
Stansted	Sensitivity tested	Not tested	Not tested	Not mentioned	Not priced	Not tested

TABLE 13

Assumptions report card

Airport	Fuel efficiency	Sustainable aviation fuels	Non-CO_2 effects	Arrivals	Carbon price	Discount rate
Bristol	Conservative	Moderate	Optimistic	Optimistic	Moderate	Moderate
Leeds Bradford	Optimistic	Moderate	Optimistic	Optimistic	Not modelled	Not modelled
Southampton	Moderate	Conservative	Moderate	Conservative	Not modelled	Not modelled
Stansted	Moderate	Optimistic	Optimistic	Optimistic	Not modelled	Not modelled

and international emissions costs against local and regional economic benefits creating an imbalance and potentially leading to what economists describe as a 'tragedy of the commons' – where individual stakeholders, seeking to maximise their own returns from a public resource which is not effectively governed, contribute to the collapse of that resource (or in this case climate breakdown) to the detriment of all stakeholders.

At the time of writing the central government had an inconsistent level of involvement in each non-NSI scheme, with the Secretary of State able to make a final determination on those schemes going to a planning inquiry (Bristol and Stansted) but not on those approved by the local council (Southampton and Leeds Bradford). This inconsistency, as well as the concerns both about the evidence base upon which decisions were being made, can be addressed by the Secretary of State actively calling in all four applications and re-appraising them alongside a new national aviation decarbonisation strategy.

The need for a central government appraisal took on new importance when the government committed to including international aviation emissions in national emissions accounting, and set a new 2035 emissions reduction target of a -78% reduction in greenhouse gas emissions compared to the 1990 baseline. NEF modelling suggests the four non-NSI schemes currently moving through planning processes are likely to account for an increase in airport-level emissions of around 600,000 tonnes of CO_2 in 2035 according to current national accounting protocols. When considering total climate impact, an increase in airport-level CO_2 equivalent emissions of up to 3.7 million tonnes (maximum impact) is possible (Table 14). However, to fully understand the combined impacts of the proposed schemes on the UK's national carbon accounts, system modelling, factoring in displacement of demand between airports is required. This analysis should be overseen by the Department for Transport (DfT).

In addition to reviewing the further progressed non-NSI applications, lessons can be taken from this evaluation for the larger NSI-level applications expected in coming months and years. Heathrow, Gatwick, and Luton have signalled their intent to submit applications resulting in a combined 72 million passengers per year, and millions of tonnes of carbon equivalent emissions. It is imperative that the highest standards of appraisal are adhered to, and a precautionary approach applied to the significant climate risks implied, particularly when the potential impact of these schemes on the UK's climate commitments is considered (Table 15).

TABLE 14

Airport level responsibility for climate impacts will grow significantly at all four case study airports in the UK's 2035 emissions reduction target year.
Climate impacts at the airport level of four non-NSI expansion schemes in the year 2035 under different sets of assumptions.

	Assumptions	Bristol	LBA	Southampton	Stansted Airport	Total
2035 CO_2 emissions (tonnes)	Departing flights only	85,000	130,000	108,000	290,000	614,000
2035 minimum climate impact (tonnes CO_2 equivalent)	Departing flights + lower non-CO_2 multiplier	161,000	246,000	204,000	548,000	1,160,000
2035 maximum climate impact (tonnes CO_2 equivalent)	Departing + arriving flights + higher non-CO_2 multiplier	516,000	787,000	654,000	1,754,000	3,711,000

Source: NEF remodelling of airport appraisal documentation

Recommendations

- The Secretary of State should call in all of the currently active airport planning applications and assemble a more robust and precautionary evidence base on climate change issues. This evidence can be measured against the forthcoming aviation decarbonisation strategy and the government's new 2035 emissions target, which is expected to include international aviation emissions. In addition, the government will need to demonstrate how the proposed expansions can be reconciled with the Climate Change Committee's recommendation of a no-net-expansion policy on airports.
- The DfT should ensure a more robust evidence base is assembled for the appraisal of future airport expansions, including in the case of future NSI proposals, all of which are expected to involve significant climate impacts. This should include tighter guidelines and expectations on the integration of non-CO_2 climate impacts, and the monetisation of said impacts.

TABLE 15

In combination the three proposed NSI schemes could be responsible for airport-level climate impacts equivalent to the emission of over one billion tonnes of CO_2 between 2025 and 2050.
Cumulative climate impact estimates at the airport level of three NSI expansion schemes over the period 2025–2050 under different sets of assumptions.

	Assumptions	Heathrow North West Runway	Gatwick	Luton
CO_2 emissions impact (tonnes CO_2)	Departing flights only	144.8 million	13.3 million	14.7 million
Minimum climate impact (tonnes CO_2 equivalent)	Departing flights + lower non-CO_2 multiplier	268.8 million	24.9 million	27.5 million
Maximum climate impact (tonnes CO_2 equivalent)	Departing + arrving flights + higher non-CO_2 multiplier	859.9 million	79.8 million	88.0 million

Source: NEF modelling based on DfT 2017 aviation forecasts data and EIA scoping reports submitted by applicant airports to the Planning Inspectorate

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42 CORSIA was initially designed with the average of 2019 and 2020 as its baseline years, but following the significantly depressed rates of travel in 2020 as a result of the Covid-19 pandemic, a decision was taken by ICAO to use 2019 as the baseline. See: https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-and-Covid-19.aspx

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