Aviation Emissions at Imperial College, London:

Current Status and Policy Recommendations

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Executive Summary

Significant change is required in the way the earth's resources are utilised if we are to avoid dangerous levels of climate change. While the UK government aims to reach net-zero greenhouse gas emissions by 2050, a significant share of total emissions are embedded in air travel, which will be very difficult to decarbonise through technological innovation alone. Therefore, technological improvements in aviation should be accompanied by policies shifting demand from aviation towards alternative options such as rail and video-conferencing. This is of particular importance for universities, where aviation is responsible for a greater share of total emissions than the national average. In response to this, many universities have attempted to develop strategies to monitor and reduce aviation emissions. Imperial College, London should now attempt to fulfil its environmental responsibilities regarding aviation emissions.

This report evaluates the current state of aviation at Imperial College, London by analysing data that captures all flights booked through Imperial's central booking agency for flights, Egencia. This dataset captures approximately 60% of all flights taken by Imperial College staff and students in the academic year 2017/18.

Our analysis demonstrates that emissions due to aviation are comparable to those associated with the electricity and gas consumption at the university, accounting for as much as 9% of the university's total emissions in the 2017/18 academic year. Around 15% of the total users in the Egencia dataset are responsible for 50% of total emissions recorded in these data. These represent members of staff who fly much more frequently and longer distances than other, more occasional fliers, therefore demonstrating an opportunity for significant emissions reductions if the correct groups of people are targeted. Furthermore, our analysis demonstrates that guests, people not counting as members of staff of the college, are responsible for about 25% of total aviation emissions, indicating another group of users who should be looked at closely. This work also explores how emissions vary per department, showing that the Faculty of Engineering is responsible for the highest share of emissions, but also that the Business School displays significantly higher emissions per capita compared to other schools.

This report summarises some actions taken by other universities in an effort to reduce the environmental impacts of aviation and organizes the different policies into four main areas of action: i) improved data gathering; ii) carbon pricing; iii) video conferencing and iv) departmental action.

The report concludes with two central recommendations, which are as follows:

- Imperial should improve data collection around the number of flights taken at the college, to better understand the extent of aviation emissions at the college and design appropriate policies to reduce these emissions.
- Imperial should create a sustainable travel team, tasked with the design and implementation of a sustainable travel policy which deals appropriately with the issue of aviation. Such a team should consider policy options including pricing carbon emissions from flying and promoting videoconferencing as an alternative to aviation.

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1. Introduction

In December 2015 the global community negotiated the Paris Agreement, which committed the world to limiting warming to 'well below 2°C' and pursuing efforts to limit warming to 1.5°C above pre-industrial levels[1]. The UN's Intergovernmental Panel on Climate Change has stated global CO_2 emissions must halve by 2030 if we are to have a chance of achieving the 1.5°C target[2]. This will require drastic changes in all aspects of society. In the UK, the Government has responded to the issue of the climate crisis by legislating for the UK to become net-zero greenhouse gas emissions by 2050 at the latest[3].

Awareness of the scale and urgency of climate change has also brought a renewed focus on the environmental impact of aviation. Flying is a very carbon intensive activity – with a return trip from London to New York responsible for over 1.1 tonnes of CO_2.[4] By comparison, the average yearly carbon emissions for someone living in the UK is around 5.4 tonnes of CO_2.[5] The emissions impact of flying can be over ten times greater than that of low-carbon alternatives such as rail[6]. Emissions from flying are also unequally distributed across society – with 15% of people taking 70% of flights in the UK[7]. Furthermore, the environmental impact of aviation is increased by nitrous oxide emissions and the formation of clouds at high altitudes, which increases the warming effect of flying by a factor of between two and five[8].

Aviation is not only a highly emitting activity, but one of the hardest sectors to decarbonise via new technologies. Improving the efficiency of aeroplanes can only provide an emissions reduction of 0.8% per annum[9], and other alternatives such as biofuels or hydrogen are not yet ready for commercial deployment. Therefore, curbing demand for aviation and replacing flights with low-carbon travel where possible will be an essential part of the solution alongside technological innovation[10].

In the 2017/18 academic year, flights taken by Imperial College staff and guests resulted in over 23,000 tonnes of CO_2 emissions. This represents 8.9% of Imperial's emissions in 2017/18, making aviation the sixth largest source of emissions for the college[11]. This share is also higher than the UK average, where aviation accounts for approximately 6% of national emissions[12]. As Imperial takes action to reduce its emissions and respond appropriately to the climate crisis, it is essential that the problem of aviation emissions is not ignored. Imperial should provide a set of targets and policies which ensure that the environmental impact of aviation at the college is consistent with the Paris Agreement.

This report aims to provide an understanding of the current state of aviation at Imperial, explore what actions other universities have taken to reduce emissions from aviation and promote low-carbon travel, and provide recommendations for how Imperial could reduce emissions from flights. It has been compiled by Ph.D. students affiliated with the Grantham Institute for Climate Change and the Environment at Imperial College, London.

The report is organised as follows. Section 2 assesses the current state of aviation at Imperial, using data from Imperial's central booking agency. It seeks to understand how emissions from flying differs across departments and between individuals. Section 3 presents a series of case studies, assessing what actions other universities have taken to reduce emissions from flying.

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Finally, Section 4 concludes by providing some recommendations on actions the college could take to reduce aviation emissions.

2. Aviation at Imperial: Current Status

2.1. Data Assumptions and Limitations

The data for the analysis of Imperial's aviation emissions was provided by Judge Singh, the Category Manager for Business Services. The data captures all flights booked through Egencia, Imperial's central flight booking agency. In 2017/18, this represented approximately 60% of all flights taken by Imperial staff, as a significant proportion of flights are not booked through Egencia. The proceeding analysis is all based on the data provided by Egencia. Tables 1 and 2 provide the main assumptions that are used in this analysis. Table 1 presents the amount of CO_2 per passenger mile for each type of flight, which was provided alongside the data by Egencia. Then, Table 2 demonstrates how all flights are classified into different segments according to the distance they cover, as advised by the Department for Environment, Food & Rural Affairs (DEFRA). A central assumption of this work is that the flights booked through Egencia are representative of the all the flights taken by the College.

Table 1: Amount of CO_2 per passenger kilometre for each type of flight.

Segment Distance with Cabin Type	kgCO$_2$/ passenger-km
Long Distance – First	1.56
Long Distance – Business	1.13
Long Distance – Other	0.51
Long Distance – Premium	0.62
Long Distance – Economy	0.39
Medium Distance – Business	0.61
Medium Distance – Economy	0.41
Medium Distance – Other	0.42
Short Distance – All	0.69

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Table 2: Flight classifications according to DEFRA

Segment Haul Distance	Distance (miles)
Short Distance	≤ 287.7
Medium Distance	> 287.7 and ≤ 2299.1
Long Distance	> 2299.1

The dataset also has a set of limitations. The first is the limited share of flights that are booked through Egencia. In 2017/18, this was estimated at around 60% of all flights. We have assumed that the distribution of flights booked through Egencia is representative of all flights booked by staff at Imperial. In reality, the distribution of flights booked through Egencia could differ to the distribution of flights booked without Egencia – for example more short-haul flights could be booked without Egencia, with staff instead booking their own flights and claiming back on expenses. This possibility would mean that while Egencia data represents 60% of all flights, it represents more than 60% of all emissions (as it covers more of the long-haul flights taken by College staff and, students and less of the short-haul flights). This means our estimate of Imperial's aviation emissions at 23,000 tonnes of CO_2 in the 2017/18 academic year is an upper estimate. This potential for bias in the data can only be fully resolved by improved data gathering e.g. with all flights being booked through Egencia or with aviation data being adequately captured through the College expenses system.

Another potential limitation is the lack of separation of flight bookings done as group bookings (all counted as flights for the person who booked) and flights only for the individual doing the booking. This appears to be an especially important distinction when understanding the distribution of flights among more and less frequent fliers.

2.2 Data Analysis

In the 2017/18 academic year, flights booked through Egencia were responsible for just over 14,000 tonnes of CO_2. If we scale this number to account for the fact that the Egencia data captures only 60% of all flights, this suggests that in the 2017/18 academic year aviation emissions were around 23,000 tonnes of CO_2 (see above for a discussion of the limitations in this approach). This represents 8.9% of the College's total emissions, as shown in Figure 1. The share of emissions from aviation is thus comparable to that from electricity or gas consumption, as well as the emissions from services at Imperial.

Figure 2 shows how aviation emissions at Imperial are distributed across staff members within the Egencia data. It shows that there is a large discrepancy within the staff body relating to their responsibility for emissions. 15% of fliers in the Egencia data are responsible for 50% of all

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emissions in the dataset. These are members of staff who are flying frequently and flying long distances, compared to fliers who take occasional flights over shorter distances. The discrepancy between frequent and far vs. occasional and near fliers indicates that strong potential gains could be made by targeting the most frequent of fliers and providing incentives for them to reduce the amount of flights they take. Another interesting finding is that guests appear to make up a significant (~25%) contribution of the total flights, suggesting that these are another group to consider targeting to reduce aviation emissions.
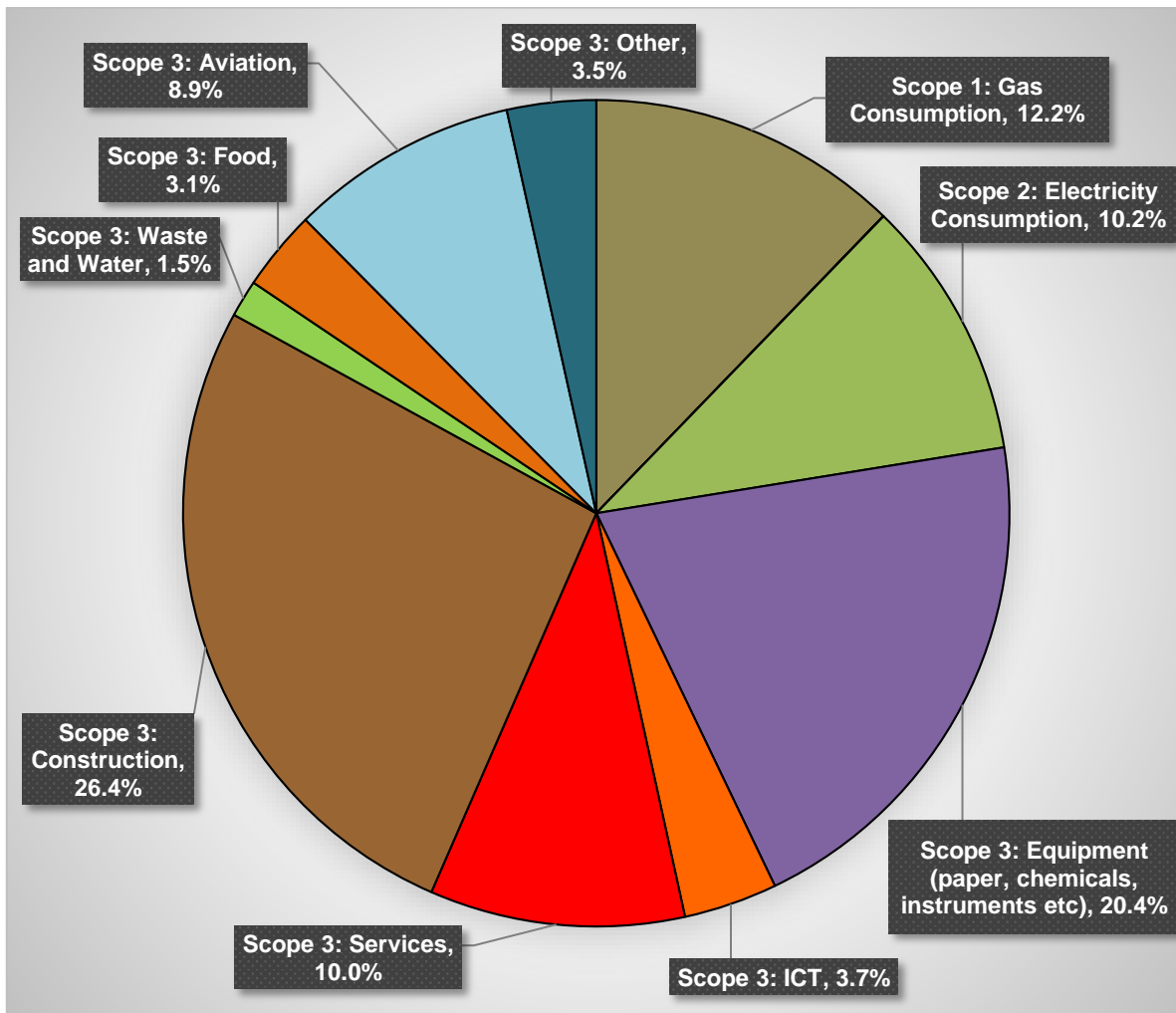
Figure 1. Greenhouse gas emissions by source for Imperial College, London in 2017/18. Data from (HESA, 2018) combined with Egencia data on flight emissions (scaled by 60% factor to account for gaps in data). Scope 3 emissions from other travel forms (rail, road, sea travel) are lacking.
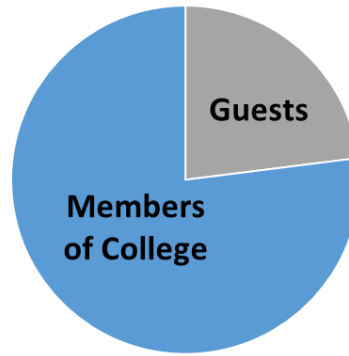
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Who's Responsible for Aviation Emissions at Imperial?

Emissions: Frequent and far vs. occasional and near fliers

bottom 85%   top 15%
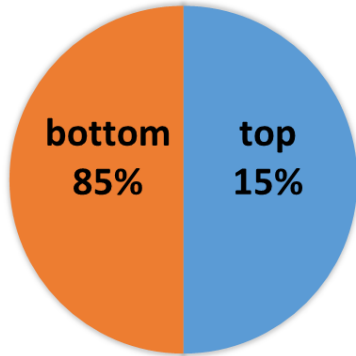
Frequent and far fliers are responsible for far more aviation emissions than those who fly less often and less far
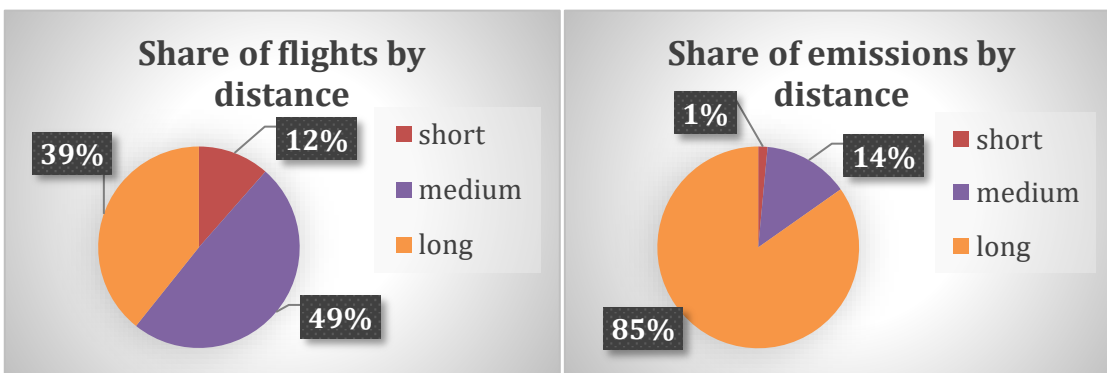
Emissions: Guests vs. members of college

Guests

Members of College

Guests account for a significant 23% of aviation emissions for Imperial.

Figure 2. Distribution of aviation emissions at Imperial across staff members, and the distribution of emissions between staff members to 'guest' bookings.

Figure 3 indicates how the share of flights and resulting aviation emissions at Imperial vary by distance. As shown, the flights booked through Egencia are predominantly medium- or long-haul flights, with short-haul flights representing only 12% of all flights booked through Egencia. However, given that short-haul flights are affordable and feasible for academics with many research centres nearby within Europe, staff may not be booking short-haul flights through Egencia. Figure 3 also illustrates that most aviation emissions at Imperial are due to long-haul flights. Short-haul flights are responsible for only 1% of all emissions in the data, while long-haul flights represent 85% of aviation emissions at Imperial. This suggests that reducing the amount of long-haul flights is an essential part of a sustainable travel policy for Imperial.

Share of flights by distance

39%   12%   49%

- short
- medium
- long

Share of emissions by distance

1%   14%   85%

- short
- medium
- long

Figure 3. Distribution of flight distance categories (according to DEFRA) by share of total segments and share of emissions over the period 2013-2018, demonstrative of the greater share of emissions from long-haul flights despite them being in the minority of flights

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Figure 4 shows how per-capita emissions from aviation varies across departments, taking data from 2018. The average per-capita emissions from aviation in 2018 was around two tonnes of CO_2 per staff member at Imperial. There are, however, significant departmental differences. Some of these may be down to differences in how travel is arranged and booked, despite the same college policy applying across the board. However, assuming that the college travel policy is roughly applied consistently and that there are no significant differences in how departments report travel, it is clear that certain departments bear the responsibility for far more aviation emissions than others. The Business School has the highest per-capita emissions, at over six tonnes of CO_2 per person. It is important to acknowledge that the Business School is the smallest of the analysed departments and as such only ever makes up a small proportion of total college emissions (see Figure 7). The Business School also has a low number of research post-graduate students (who are less likely to travel) compared to the number of academic and research staff, who are more likely to travel[13].
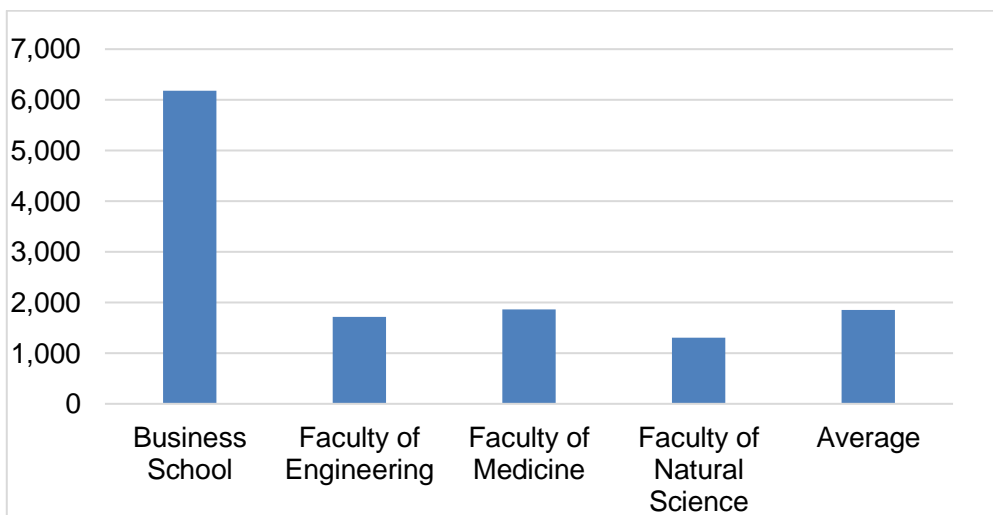
Figure 4. Emissions per-capita of flights according to the Egencia data with populations of each department derived from the Imperial Statistical Pocketbooks. Average emissions per capita across the entirety of college. Support and Admin not included for lack of staff number data.

Focusing on the other departments then reveals a markedly lower quantity of emissions from the Faculty of Natural Sciences (FONS) when compared to the Faculties of Engineering and of Medicine. This may suggest that the FONS has a more environmentally friendly approach to academic travel. However, it is more likely that the need/capacity to travel is less so in certain departments in FONS, e.g. the Mathematics department may have less money for travel in comparison to departments in the Buisness School. These notions are supported by the data presented in Figure 5**Figure** which displays the lower number of tickets purchased by FONS compared to the similarly sized departments of Engineering and Medicine.

FONS also books proportionately fewer non-economy flights than the Faculty of Engineering or Medicine, which have a higher proportion of flights booked as business, premium or first class (Figure 6). Non-economy flights are responsible for more emissions than equivalent economy class bookings, as each passenger takes up more space[4]. The fact that FONS takes fewer flights

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than other comparable departments, and books fewer non-economy flights than other departments means that per-capita aviation emissions in FONS are 25% lower than per-capita emissions in the Faculty of Engineering or Medicine. By contrast, the high proportion of business class flights adds to the disproportionate share of emissions from the Business School. Support staff / Administration also takes a very high share of non-economy flights, which appears to be an obvious target for action.
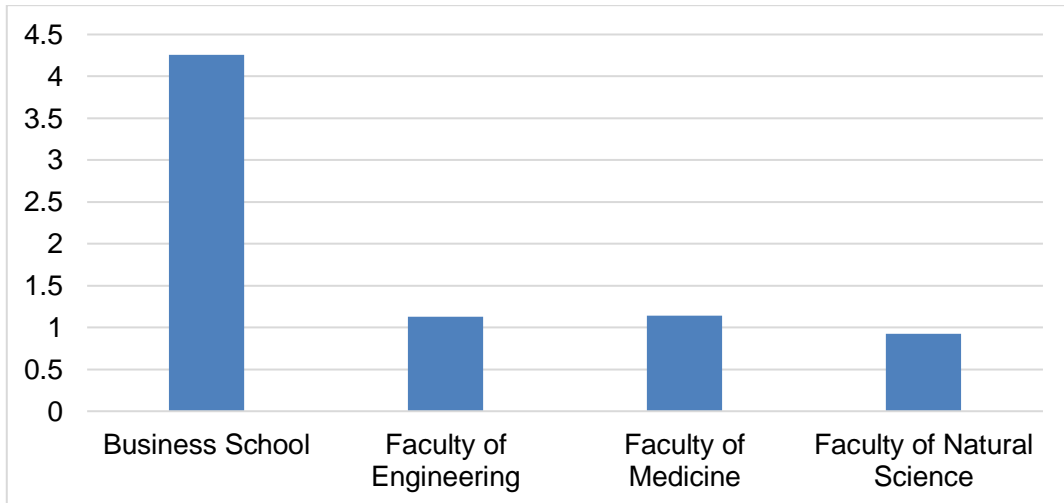

Figure 5. Average number of tickets purchased through Egencia by each department in 2018.
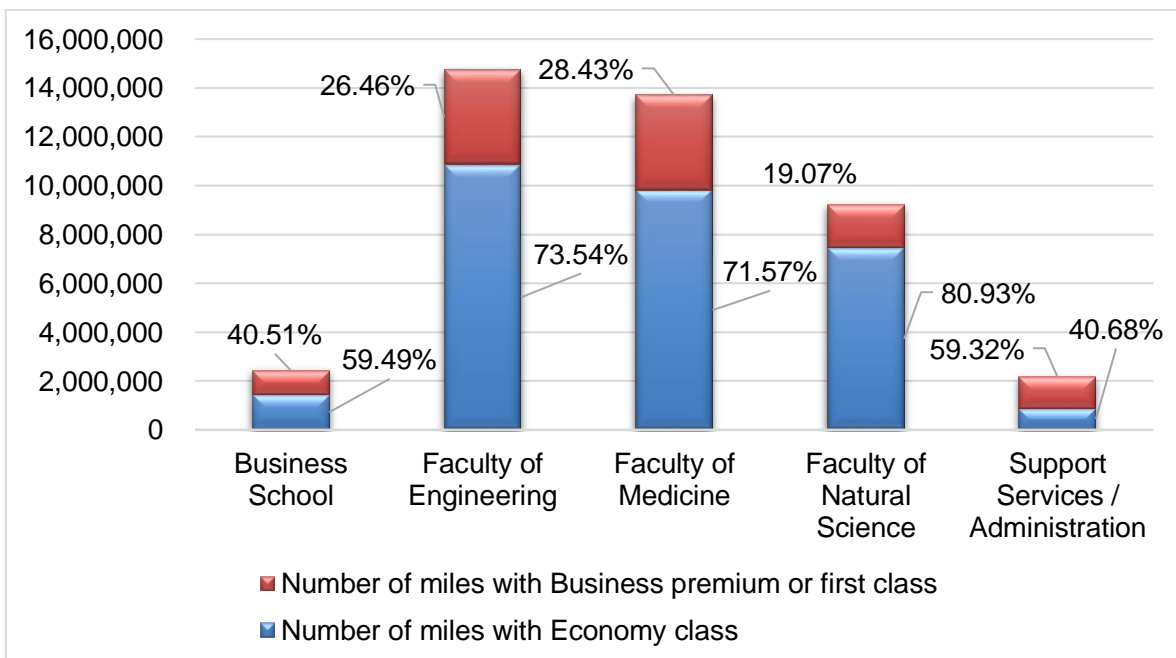

Figure 6. Comparison of miles per department showing the relative share of miles travelled by each flight class. Notable is the low level of non-economy flights taken by FONS, and the high proportion of non-economy flights taken by the Business School and Support Services.

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Lastly, Figure 7 demonstrates that the share of emissions from the groups with higher emissions per flight (and per-capita, as shown for the Business School) fortunately make up a small proportion of the overall aviation emissions. This does not mean that it is not important to target these groups for reducing aviation, but rather that these groups should not be targeted alone for reducing aviation emissions.
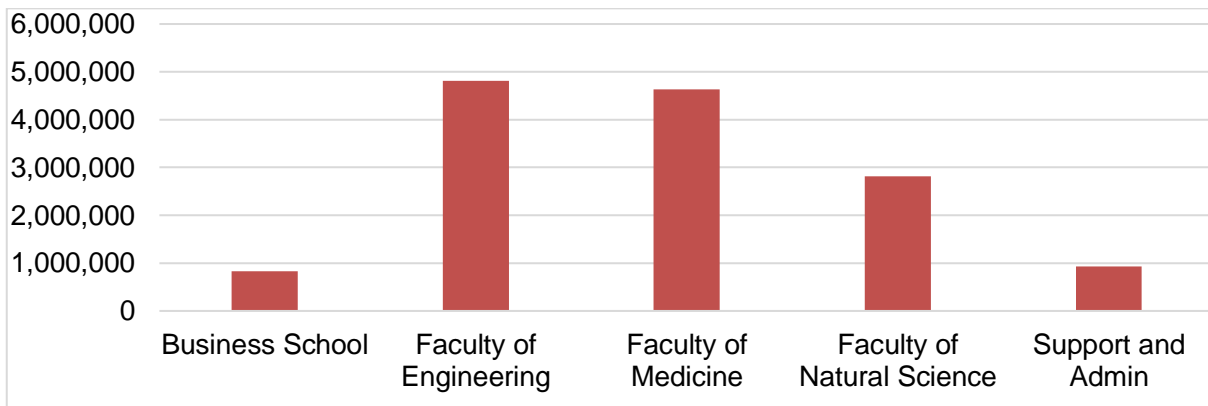
Figure 7. Total emissions per department in kg CO_2, as recorded by Egencia for 2018.

3. Case Studies

3.1. Data Assumptions and Limitations

Table 3 summarises some of the actions being taken by a sample of universities on emissions from aviation.

As seen in Table 3, there are many universities who are taking steps to monitor and reduce their emissions from aviation. A variety of strategies are available to Imperial College as it attempts to fulfil its environmental responsibilities pertaining to aviation. Below, we summarise four central options for action on aviation emissions.

3.1.1 Improved Data Gathering

Multiple universities have implemented policies to improve aviation data gathering as an initial step to determine the scale of the problem faced and how best to address it. The University of Exeter have included continued monitoring of aviation emissions in their Sustainable Travel Plan[14]. One of the University of Cambridge's Carbon Reduction Strategy pillars is to improve the understanding of Scope 3 air business travel emissions, including modifications to the financial systems to record business travel, particularly air travel. ETH Zurich have used their monitoring system to quantitatively define their emissions targets with respect to a baseline (a per-capita reduction of 11% between 2019 and 2025 compared to the average for 2016-2018). In 2019, ETH Zurich introduced a central monitoring system, recording flight number, travel class and date, with a monthly summary of aviation emissions sent out to each department[15].

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Table 3. *Actions taken by other universities aiming at monitoring/reducing aviation emissions*

	Numerical Target for Reducing Air Travel	Carbon Price on Flying	Incentivising low-carbon travel	Promotion of Video Conferencing	Improving data collection around flying	Providing departmental reports	Carbon Offsets
Cambridge	✔						
Oxford					✔		
Manchester	✔						
UCL			✔	✔			✔
Edinburgh							
Bristol				✔			
Kings College London				✔	✔		
Warwick					✔		
Exeter			✔	✔	✔		
University of Gothenburg		✔	✔				
University of Helsinki				✔			✔
University of Copenhagen						✔	
NTNU					✔		
ETH Zurich	✔	✔ *	✔	✔	✔	✔	
University of Washington				✔	✔		✔

3.1.2 Carbon Pricing/ Polluter Pays

Several universities have adopted 'polluter pays' strategies to reduce the number of business flights. UCLA adopted a trial scheme in 2018 which applied a flat fee of $8 to internal flights and $25 to international flights. This money is placed into an Air travel mitigation fund which is used to fund projects on campus that provide 'lasting, measurable carbon reduction in order to mitigate air travel'. The scheme is part of the UCLA Climate Action Plan, which aims to reduce staff/faculty air travel by 5% by 2020[16]. A review of the scheme is scheduled for 2020. A similar scheme has been adopted by The University of Neuchâtel in Switzerland, who place a surcharge on a flight that is calculated based on the amount of carbon emitted by the traveller and the price of carbon at the European Emission Allowances Auction[17]. As these schemes are relatively new initiatives, it is difficult to evaluate their effectiveness. However, a carbon pricing scheme at Imperial, based on the 2018 data figures and a £10/tCO2 charge, would raise ~£230,000 annually. This could be

used to subsidise low-carbon forms of transport such as trains, as well as fund environmental initiatives on campus.

3.1.3 Promoting Video-Conferencing

A survey conducted by the University of Washington found that over half of staff and faculty would be open to video-conferencing as an alternative to flying[18]. As a result, they have been promoting video-conferencing facilities. Similar promotion of video-conferencing facilities as an alternative to travel are being promoted at ETH Zurich. At UCLA, an evaluation and augmentation of their teleconferencing facilities was implemented as part of an educational initiative to "promote individual behaviour change"[16]. At Imperial, promotion of the available video-conferencing facilities, followed by an increase of these facilities would be a straightforward initial step to reduce aviation emissions.

3.1.4 Central Action Vs. Departmental Action

Some universities have a central travel policy e.g. The University of Exeter. In others, like ETH Zurich, each department has been given control over their travel policy, and they choose how to reduce per-capita emissions. The ETH Zurich goal to reduce per-capita aviation emissions was arrived at through a "participatory process of the departments, Executive Board and administrative units"[15]. With continuous monitoring of each department and monthly reports, each department is held accountable to the specific, measurable, time-based targets that the university as a whole has agreed upon. However, the specific policies that each department seeks to implement to reduce their per-capita emissions has been left to their discretion.

The Egencia data shows that there are significant differences between the emissions of each department. This suggests that following the ETH Zurich model could be a good option to provide for the College, as it would give each department the opportunity to learn from the best practise in other departments and give departments flexibility around how to take action on aviation emissions.

In addition to implementing the ETH Zurich model, aspects of the UK Met Office's flight travel policy could be used. "[Met Office] staff must go through a rigorous justification process in order to determine whether air travel is essential, which includes signing off air travel at high management levels." [19,20] Staff are encouraged to use alternatives, such as video- and telephone- conferencing to reduce the amount of air travel. Applied at a departmental level, implementing this policy may prove to be equally beneficial as the ETH Zurich model.

4. Policy Recommendations

4.1 Improved Data Gathering

We estimate that Imperial's emissions from aviation in the 2017/18 academic year were just over 23,000 tonnes of CO_2, or 8.9% of the college's total emissions. This is the first estimate of aviation emissions at Imperial College, London, to the knowledge of the authors. However, as detailed in Section 2, the current data on aviation at Imperial from Egencia does not capture all flights, and so the results in this report used a scaling factor to estimate the total emissions from aviation at Imperial.

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A sustainable travel policy dealing with aviation would benefit from higher data coverage. This would provide a clearer picture of the total emissions from aviation at Imperial, allowing numerical targets for the reduction of aviation emissions to be set with greater confidence and accuracy.

This improved data coverage could come through a simple section on the expenses form which captures relevant data for aviation emissions (flight class, origin, destination and reason for travel). This would allow data from expenses clams and Egencia data to be combined, providing a full picture of the level of aviation emissions at Imperial College. The additional administrational expenses for such a scheme would be small (as the data collected would be minimal), and this could significantly improve our knowledge of the current status of aviation at Imperial.

However, a lack of total data coverage should not be used as an excuse for inaction – as seen in Section 3, there are many universities who are acting on aviation emissions in the absence of complete datasets.

4.2 Creation of a Sustainable Travel Team

As seen in Section 3, a wide range of universities are taking action on the issue of emissions from staff travel. Many of these (e.g. Exeter, ETH Zurich, Gothenburg and more) have created a sustainable travel team, in which members of staff have some of their time allocated to designing and implementing sustainable travel policies.

Currently, Imperial's active travel policy is the responsibility of Ethos Gym. This may be adequate for the promotion of healthy travelling practises such as walking and cycling but is wholly inadequate for the design of a sustainable travel policy which is commensurate with the urgency of action on the climate crisis. It is essential that Imperial College provides the necessary resources to design such a plan. The appointment of Prof Paul Lickiss as Academic Leader in sustainability is a welcome development, but one staff member working part-time on the issue of sustainability will not be sufficient. We strongly recommend that the college creates a sustainable travel team to tackle the issue of aviation directly.

This group could be formed of a mix of academic and support staff, covering both central college administration and the faculties. It would be responsible for designing and implementing a sustainable travel policy that addresses the issue of aviation emissions. This report has covered a variety of possible policies that are worth consideration. These include:

- Putting a price on aviation emissions could reduce emissions. The revenue raised could be recycled in a variety of ways – for example, subsidising low-carbon travel such as rail or providing funding for environmental initiatives on campus. With 15% of flyers responsible for 50% of emissions in the Egencia database, a frequent flyer levy could potentially be an effective policy. A frequency flyer levy means the carbon price applied to flights increases with the number of flights taken by an individual. This could be an effective way to target the individuals most responsible for aviation emissions.
- Promoting video-conferencing to reduce the number of long-haul flights taken. As seen in Section 2, long-haul flights are responsible for 85% of emissions at Imperial. These flights will be hard to replace with alternative travel arrangements, and so it is essential that policies are put in place to promote the use of video-conferencing as a sustainable alternative to long-haul flights.

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- Perhaps the most interesting, some universities have taken a devolved approach to the issue of aviation emissions. This would involve allowing departments to set their own targets for emissions reductions and giving them flexibility around the policies used to achieve these goals. Given the significant differences between faculties at Imperial, this could provide some valuable flexibility in the creation of a sustainable travel policy.

Another policy which has not been discussed in detail in the report is a slow-travel policy, in which members of staff who choose environmentally friendly alternatives to aviation could have their travel days counted as workdays rather than holiday. This could also be considered by the sustainable travel team.

The authors of this report would be willing to support the operation of such a sustainable travel team in whatever ways deemed appropriate. This could include providing supporting analysis and expertise, serving as part of the team or other options. The sustainable travel team could also be supported by the Greening Imperial initiative.

5. Conclusions

Imperial is a world-leading academic institution, whose research has a significant societal impact. Imperial should be proud of the pioneering research into sustainable futures undertaken by institutes such as the Grantham Institute, the Energy Futures Lab and the Centre for Environmental Policy. However, the College could do much more to improve its own environmental footprint, as it is still ranked as 'failing' by People and Planet's University League[21].Given the significant proportion of Imperial's emissions that come from aviation, it is essential that Imperial takes action to reduce the amount of flights taken by college staff. There are a variety of clear policy options available to reduce aviation emissions, which we have presented in this report.

There may be a perception that flying is an essential part of academia – that it allows individuals to network and make new academic collaborations that are essential for academic success. There is, however, very limited evidence that flying has an impact on professional success[22]. Imperial College can therefore act on aviation emissions while remaining a world-leading academic institution. In doing so it will join other major universities who are taking the lead in responding to the issue of emissions from academic travel. We strongly urge Imperial to join these universities and act to reduce aviation emissions at the college.

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