UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Business Air Travel Emissions at UBC: Analyses and Final Recommendations

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Contents

Executive Summary

Air travel is an increasingly significant source of greenhouse gas (GHG) emissions. Currently, they account for approximately 3.5% of the total human caused warming of the planet. Estimates suggest that carbon dioxide (CO_2) emissions from air travel will increase to 22% of global CO_2 emissions by 2050. Although academic air travel has been identified as a significant contributor of aviation emissions, the University of British Columbia (UBC) does not currently regulate business-related air travel emissions, despite estimates that business-related air travel emissions account for up to 63-73% of UBC's total campus operations emissions.

The recent Declaration on the Climate Emergency, which has been endorsed by UBC President Santa Ono and the Board of Governors, demonstrates the university's strengthened commitment to develop more comprehensive emissions reduction strategies. In view of this opportunity for action, we propose a series of five policy alternatives aiming to reduce business-related air travel emissions by staff and faculty at UBC. The efficacy of these policy alternatives will be evaluated according to four main objectives: their ability to reduce aviation emissions, maximize cost efficiency, user satisfaction, and ease of policy implementation.

First, we propose requiring staff and faculty to justify the emissions associated with any upcoming flight. Second, we recommend the increased use of campus Information and Communication Technology (ICT) when travel can be avoided. Third, we call for the purchasing of voluntary carbon offsets to account for GHG emissions from all business-related air-travel at UBC. Fourth, we suggest a 500-km rule to promote the use of busses, trains, ferries, and other eco-friendly modes of ground transportation in lieu of flying. Finally, we recommend improving UBC’s current air travel booking system, Concur, to facilitate the collection of more accurate and reliable data, which is needed for identifying appropriate mitigation strategies. Substituting avoidable emissions through teleconferencing, offsetting unavoidable emissions, and gathering reliable data to track progress on mitigation and reduction strategies can form a strong and central foundation for tackling aviation emissions from different angles.

The Policy Context

Air travel is one of the fastest growing sources of greenhouse gas (GHG) emissions; roughly 3.5% of the total warming of the planet caused by human activity can be attributed to aviation emissions.[1] The continued expansion of air travel's footprint is on course to hinder efforts to avert the 2°C warming limit that has been agreed by the United Nations Framework Convention on Climate Change (UNFCCC).[2] Bows-Larkin et al. note that "over the last four decades, the number of passenger-kilometers in worldwide civil aviation increased at an average rate of 5% per year, while the corresponding carbon dioxide (CO_2) emissions have increased by 2% per year on average."[3]

Furthermore, air travel is not equally distributed: a small number of 'hypermobile' travellers like academics and business travellers have high air travel footprints.[4] Academics, who travel for conferences, fieldwork, lectures, visiting positions, etc., contribute a large portion of the CO_2 emissions that are produced by universities.[5] Air travel is responsible for one third of the total CO_2 emissions from the Ecole Polytechnique Federale de Lausanne in Switzerland[6] and in the United Kingdom, CO_2 emissions from business-related air travel rose by 3.9% at 139 universities between 2005 and 2010.[7]

Climate Policy at UBC

At UBC, Wynes and Donner estimate that business air travel emits the equivalent of roughly 63-73% of building operations emissions.[8] However, these emissions historically have not been included in UBC's GHG inventory, and thus were not included in the 2010 Climate Action Plan (CAP). This is partially because UBC's CAP followed guidelines set by the provincial government under British Columbia's Climate Change Accountability Act (CCAA), which does not require institutions to report or offset emissions from scope 3 emissions. Scope 3

emissions are those released by sources, such as airline flights, that are not directly owned or controlled by the institution itself.[9] In December of 2019 however, UBC released the President's Declaration on the Climate Emergency, which recommended broadening GHG emissions scopes through the UBC CAP and Strategic Plan "beyond UBC's current climate target, such as emissions from travel".[10]

The Policy Problem

The primary problem we have identified for this report is the high rate of emissions associated with business air travel by UBC staff and faculty, and the lack of a campus-wide policy to reduce those emissions. There are three main variables that we believe are important to better understand the nature and scope of this problem.

1. *Emissions Rate:* UBC has not tracked emissions associated with business air travel to date, and the exact figure is thus uncertain. A 2019 study by Wynes and Donner estimates this to be between 26,333 and 31, 685 tonnes of CO_2 per year, while the 2018 UBC Carbon Neutral Action Report (CNAR) estimates the number to be 15,710 tonnes.[11] This discrepancy stems from a difference in measuring methodology. The CNAR's estimate is based on the cost of travel booked through UBC's bookings tool, Concur, although many individuals do not book through Concur, and cost is not an accurate measure of GHG emissions.[12] Donner and Wynes, on the other hand, take a mix-methods approach by combining data from Concur with "bottom-up" data on independently booked flights from eight administrative units, scaled to the rate of the university's total expenditures.[13] As there are no official UBC emissions measures, we will be relying on the qualitative data provided by Donner and Wynes' article in our policy analyses and recommendations, as their method is more rigorous than that used by the CAP.

2. *Who is Flying:* UBC's GHG inventory and Wynes and Donner's article include all emissions from business-related air travel purchased by or through UBC by graduate students, staff, staff, faculty.[14] Business-related flights taken by UBC staff or faculty that were paid by external institutions were not included in this count, but flights by guests whose travel expenses were paid by or billed to UBC are included.
3. *Purpose of Flight:* Most flights were taken by faculty; 55% for conferences, 19% for fieldwork, and 5% for lectures.[15]

The Policy Objectives

The primary objective is to **reduce carbon emissions from business-related air travel**. A policy alternative that does not satisfy this objective does not address the central problem, and therefore will not be considered in this report.

Secondly, we aim to **maximize cost effectiveness**. Any recommended policy will be assessed on its total costs in terms of its overall successfulness in reducing GHG emissions. High total cost alternatives will only be considered if they drastically contribute to the primary objective.

Thirdly, we want to ensure **staff and faculty satisfaction**. We recognize that controlling the frequency at which faculty and other university employees can fly is likely to be met with a degree of displeasure, and we aim to minimize this as much as possible, so long as it does not obstruct the primary objective. This will be done principally through avoiding policies that encroach on staff and faculty freedoms as much as possible, so long as they can be substituted with policies that contribute towards the primary objective to a similar extent.

Our final objective is **ease of implementation.** With the expected release of an updated Climate Action Plan, in which the scope of carbon emission sources being confronted will be extended (among others, to business-related air travel), we seek policy alternatives that can be quickly and easily implemented. In the absence of any current policies concerning air travel emissions, we believe that the first order of action is to establish an initial policy that can tackle the most easily corrected factors contributing to emissions. In this way, we ensure there exists a background policy at work which allows the focus to shift towards more ambitious, long-term strategies for emissions reduction.

Policy Alternatives and Analyses

Alternative 1: Emissions Justification

Requiring staff and faculty to justify the emissions associated with each proposed flight to department heads holds potential for reducing emissions from business-related air travel. Naturally, departments vary in the quantity of flights taken by their respective staff and faculty. Staff and faculty in departments belonging to the harder sciences may necessarily be required to travel more often to complete field or lab work to fulfil the requirements of their academic work. These departments may have less opportunities to conduct their work effectively through information and communication technologies (ICT). In contrast, there are departments—such as those belonging to the Faculty of Arts—that can more often take advantage of campus ICT options as their academic work does not require the same degree of travel to be successfully accomplished. For these departments, ICT options can be effective alternatives for conducting conferences, lectures, etc., in potentially more cases than they can be for departments whose work necessitates face-to-face interactions and on-site analyses for success. Wynes and Donner

found that reducing flights that are taken solely for conducting lectures can be a simple and cost-saving measure for reducing business-related air travel emissions.[16] This is a measure that can be adopted by most, if not all, departments.

In recognition of the varying travel needs of different departments and that some departments can potentially avoid travel more often than others, it is important for the department heads to collaborate in developing departmentally appropriate criteria for determining allowable emissions limits for the different types of travel undertaken by staff and faculty. Having clear criteria for allowable emissions limits for different types of travel, such as field work, conferences, lectures, etc., can help department units to identify which types of work responsibilities necessitate travel and which can be accomplished through ICT. Having such criteria and requiring staff and faculty to justify their travel with these emissions limits in mind can reduce the number of flights taken by each department, which can contribute to the reduction of emissions arising from business-related air travel.

Analysis

Reducing Emissions	This option holds great potential for reducing emissions from business-related air travel. Having clear criteria for determining the types of work responsibilities that necessitate travel and which can be accomplished virtually through online communication platforms can drastically decrease the number of flights taken by staff and faculty.
Cost Efficiency	The costs that can be incurred with this policy option are minimal and largely non-monetary. Staff and faculty may incur costs associated with the limits that are imposed on them in terms of their ability to travel. There may also be minor costs associated with the time required to complete the paperwork needed to determine the necessity

	of proposed travelling.
User Satisfaction	As it imposes limits on the amount of travelling that staff and faculty can undertake and limits their capacity for choice, there is a high likelihood of some opposition to this policy. Department heads may oppose the policy as it entails more work for them and more consequentially, opposition may arise due to issues of equity between departments in terms of the imposed emissions limits.
Implementation	Implementing this policy alternative could be accomplished in the medium to long term. Outlining the criteria for justifiable emissions limits for each type of travel—a process that may engender tensions within and between departments—can be potentially done in the medium term with the right level of commitment from and collaboration between department heads.

Alternative 2: Developing Information and Communication Technology

Information and Communication Technology (ICT) has the potential to reduce business-related air travel emissions at UBC to a significant degree. **By way of substituting certain events that would otherwise require an element of air travel to attend them with ICT options, a portion of carbon emissions can be completely eliminated**. However, for these emissions reductions to take place, further integration and implementation of ICT options into UBC's academic framework must be explored. When asked about their position on ICT at the university, 46% of respondents replied that the enhancement of video and teleconferencing would reduce the frequency at which they fly. Our team feels that this fraction is significant enough to represent a serious demand for increased ICT options.

Available ICT Options at UBC

UBC has three official ICT software recommendations: Skype for Business, Collaborate Ultra and Zoom Video Conferencing. All three platforms have their strengths and weaknesses, the examination of which our team will not pursue in this proposal, and yet they are not being employed on a level that significantly reduces air travel emissions. Consequently, our recommended actions aim at increasing the frequency at which ICT is used, and presume that this increase will translate to a substitution of air travel for distance communications options.

ICT Development Opportunities at UBC

Preserving Current Recommended ICT Options

The first group of policy actions is centered around increasing the usage of the current recommended software. This would mean increasing the availability of Information Technology (IT) support so that troubleshooting becomes a quicker and less distressing process, and organizing (perhaps even mandating) seminars to teach the basics of the software.

One step further would be to invest in ICT hardware that supports the current software. Examples of this can be high-definition televisions, smartboards, higher quality microphones and speakers, better webcams, or avoiding that and instead opting for whole-room hardware packages. We believe this option should be centrally funded, leaving it up to the university to decide the intensity and distribution with which it is applied.

Replacing Current ICT Options

The alternative to preserving the current recommended software is to abandon it for new ICT software that is more in line with the university's needs. This will entail a thorough assessment of which of the many ICT software models available will best suit the

university's needs, and therefore be the most effective at reducing business-related air travel emissions.

Analysis

Reducing Emissions	The capacity to reduce GHG emissions through ICT options is highly variable. It is dependent on both the intensity of investment into ICT facilities on campus, but more importantly on the receptivity of staff and faculty to their use. So far, frequency of use has been relatively low (only 61% of staff are aware ICT options even exist), so addressing this is the primary concern for reducing emissions.[17] As every interaction held over ICT produces 80% less emissions than if it were done face-to-face, the more successful UBC is in transitioning towards ICT options, the less emissions will be produced from flying.[18]
Cost Effectiveness	It is difficult to predict how much each additional dollar invested in ICT options will reduce emissions. Because there is a significant portion of staff and faculty not currently using ICT facilities, this number can be reduced through relatively low-cost alternatives such as an awareness campaign or even a campus-wide email. Only after this is done would it make sense to begin investing in the improvement of hardware on campus, which can cost up to $200 000, depending on the size of the room being equipped.[19]
User satisfaction	We do not foresee a negative impact on user satisfaction.
Implementation	The implementation and operation of policies aimed at raising the frequency of use of current ICT options available is expected to be achieved in the short to medium term. Because of their low-cost nature, not much resistance is anticipated. The subsequent investment in hardware will likely be predicated on how successful the previous attempt at raising frequency of use was, since it is doubtful that significant investment will occur without high rates of use. Because of this, the implementation and operation of investment in the enhancement

	of both the quality and quantity of ICT hardware available on campus is expected to range from the medium to long term.

Alternative 3: Purchasing Carbon Offsets

While recognizing the limits of carbon offsets in combating climate-change (see Appendix A), we also must acknowledge that halting all business-related air travel at UBC is infeasible, at least in the short term. The best existing solution to mitigate remaining GHG emissions is through purchasing reliable carbon offsets. Therefore, **our team recommends purchasing voluntary carbon offsets to account for GHG emissions from *all* business-related air-travel at UBC.**

Not all Offsets are Created Equal

As UBC is not legally required to offset scope 3 emissions, any offsets it purchases will be in the voluntary market. Unlike the compliance offset market in which there is little differentiation in products and competitive pricing is the primary concern, the voluntary offset market is much more varied in both quality and price.[20] Buyers are faced with a slew of options, and cost can fluctuate depending on factors such as the location of the offset, whether there are local jobs created in the process, or whether the offsets have been endorsed by certification bodies.[21] **We recommend purchasing offsets from either reputable sources such as The Gold Standard, or pursuing local community-based offset options.** To that extent, **we further recommend conducting and publishing a preliminary investigation to ensure both the quality of the offsets purchased and a high level of accountability and transparency to the UBC community.**

Revenue and Implementation

Based on revenue models from similar programs at the University of Maryland, **our team recommends paying centrally through university funds**, rather than individually by department. This bypasses several constraints, such as the administrative cost of individual departmental purchases, budgetary constraints due to federal grants, and equity issues between departments. To that extent, **we further emphasize the importance of coordinating all travel booking through a centralized system,** such as Concur, to ease the administrative burden of coordinating receipt submissions from office to office.

Analysis

Reducing Emissions	The biggest strength by far of this alternative is its high potential for emissions reductions. Assuming a high-quality offset scheme, there is a potential for total carbon neutrality. This highlights the necessity of a rigorous investigation process to ensure the reliability of whatever offset choices are pursued.
Cost Efficiency	The average cost for voluntary offsets in 2018 was $4.37 CAD/tonne. UBC should therefore expect a yearly cost between $114, 300 - $137, 500. While the cost of voluntary offsets has decreased yearly since 2011 from $6.20 to the current $3.10 per tonne, UBC should remain prepared for rising costs, especially considering the increasing demand for such offsets. At a projected growth rate of 5%/year, the average price of offsets could reach $6.11 CAD/tonne by 2025, bringing the total yearly cost between $160, 810.78 to $193, 494.46 CAD.
User Satisfaction	There is a distinct concern that staff and faculty will be critical and unsupportive of an offset scheme due to the generally negative perception of offsets (Appendix A). To that end, we expect pursuing local community-based offsets that offer higher levels of transparency and engaging in and publishing a rigorous investigation can mitigate some of these concerns. Similarly, it is important to address concerns raised by user communities when raised.

Implementation	The implementation process of this alternative should *not* be highly intensive or cumbersome. Although the time taken to initiate the policy will depend on the administrative route taken (ie. whether offsets are purchased centrally or by individual units), we do not anticipate the process taking longer than half a year, making this alternative a more immediate solution.

Alternative 4: The 500-KM Rule

Both the University of Santa Clara and Maryland in the U.S. have proposed the implementation of a 300-mile (roughly 480-km) rule, in which travelers who choose to fly within a 300 mile radius of the university are not eligible to have their travel reimbursed by university funds.[22] Alternately, those who choose other modes of transportation may have their travel costs reimbursed. Another option would be for **UBC to adopt a similar policy to promote the use of busses, trains, ferries, and other eco-friendlier modes of ground transportation as opposed to flying.**

UBC's 500 KM Radius

There are several large cities within a 500 km radius of Vancouver, including Victoria, Kelowna, Kamloops, Portland, and Seattle. While available local transportation to each varies, options are available and relatively convenient. Bearing that in mind, we also must acknowledge the possibility that ground transportation may not be feasible or available in some instances, even within the radius. **Therefore, in such instances where there are no ground transport options, or available options are unreasonable, we suggest including a proviso to reimburse travel expenses as usual**. As with the previous alternative, **we endorse centralizing booking and travel reimbursements** to reduce the administrative burden on individual university units.

Analysis

Reducing Emissions	The largest opportunity for emissions reductions using this alternative is in reducing air travel between UBC's Vancouver and Okanagan campuses. According to Wynes and Donner, there were a total of 807 such flights in the 2016 calendar year, emitting a total of 139.7 tonnes of CO_2.[23]
Cost Efficiency	This policy will likely be costly in terms of administrative effort required to implement and enforce. Otherwise, we can anticipate a cost of between $55-$75 per bus trip, roughly $74-$277 cheaper than a roundtrip flight. Based on an 800 flights/year calculation, UBC may save between $59, 200 to $221, 600 on travel between campuses and even more than that factoring in travel to other nearby cities.
User Satisfaction	In restricting the availability of flying as a travel option, we anticipate this policy will generate some unhappiness or backlash among staff and faculty. That being said, a more restrictive policy like this may indicate that UBC is serious in its commitment to pursuing a greener campus, and may garner support from those invested in climate policy.
Implementation	This alternative should be considered a short to medium term solution.

Alternative 5: Improve UBC's Current Centralized Booking System

We suggest improving UBC's current air travel booking system to facilitate the collection of more accurate and reliable data, which is needed for identifying appropriate mitigation strategies. Access to accurate and complete data on business-related air travel emissions by staff and faculty is necessary for setting informed emissions reduction targets, tracking progress towards those targets and effectively evaluating reduction and mitigation strategies. To that end, Wynes and Donner have noted the difficulty of conducting an accurate and complete assessment of business-related air travel emissions at UBC due to the challenges associated with the university's current booking system, Concur.[24]

Although Concur provides the most comprehensive data for UBC's air travel emissions at this point, the data does not represent a complete assessment of aviation emissions at UBC, as the data tends to be biased towards air travel by administrators.[25] One option, therefore, is to **make Concur's service more user friendly**, as this could enhance UBC's capacity to determine the full extent of the campus' business-related air travel emissions. To further facilitate the enhanced collection of data on business-related air travel emissions by staff and faculty, **we recommend that in the short term, UBC mandates that all University-related air travel be booked through Concur in order to qualify for reimbursement.** This can be done even as the feasibility of the suggested software improvements is being examined. An alternative short-term measure is to **require that faculty and staff determine and report the CO_2 emissions associated with each flight as a condition for reimbursement.** In the long term, **we recommend adding an interface that displays the total GHG emissions of each flight option on Concur's webpage**, an addition that can both raise awareness of the carbon burden of flying among travellers and aid the centralized purchasing of carbon offsets if that option is undertaken. The same can be said for managing travel reimbursements as well.

Analysis

Reducing Emissions	UBC's capacity to reduce emissions depends on the availability of accurate and complete aviation emissions data, which is necessary to set informed reduction targets, track progress, and effectively evaluate reduction and mitigation strategies. Improving data collection is therefore an integral cornerstone to any successful emissions reduction scheme.
Cost Efficiency	We have not been able to determine either the amounts that the university spends to use Concur, nor the costs that UBC would incur to undertake the improvements this alternative proposes. We estimate that the highest

	costs associated with this policy option would arise if UBC chooses to abandon Concur in favour of an alternative software. Such a decision could be costly due to the potentially high administrative overhead from the costs of installing the new software and training staff, faculty and administrators on its use.
User Satisfaction	The enhanced usability of Concur for staff and faculty is likely to have a positive impact, as an improvement would ease and/or eliminate the current challenges associated with booking and managing air travel through the system. University mandates requiring staff and faculty to use Concur to book air travel and those requiring them to report CO_2 emissions associated with each flight, however, may engender strong opposition. This is especially so in the case Concur's usability is not improved in the long term.
Implementation	The recommended software improvements may only be feasible in the long-term as UBC may be locked into a multi-year contract with Concur and may not have the leverage to request the suggested improvements. If UBC can acquire an alternative software for managing air travel that permits the suggested improvements, this alternative is feasible in the medium to long-term. Measures that are possible in the shorter term include the mandate requiring staff and faculty to use Concur to book their travel and the mandate requiring them to report the CO_2 emissions associated with flights.

Final Recommendations

Our team strongly believes that any comprehensive emissions reduction scheme adopted by UBC must incorporate a host of policy alternatives that work in tandem; one single option will, quite frankly, be insufficient to address such a large and multi-faceted problem. We recommend UBC begin by **requiring all faculty members include GHG emissions in their travel reimbursements** alongside an **investigation into the viability of improving Concur to**

allow for GHG tracking, with the goal of **onboarding UBC to a centralized flight booking system that tracks aviation emissions centrally**. Comprehensive and high-quality data is a vital component of any emissions reduction scheme; long term carbon savings will justify any cost or staff and faculty dissatisfaction that may arise from this alternative. While UBC improves data collection and centralized booking, it should simultaneously **promote the use of existing ICT option**s**.** This is an opportune time to do so, as most staff and faculty will be familiar with using videoconferencing technology and will likely be less averse to its continued use in the future, and require less training and support to do so after working remotely due to the COVID-19 pandemic. As ICT use increases, we recommend UBC begin **investing in more facilities and IT support staff** as a long-term measure to maintain and grow rates of ICT use at UBC. Similarly, this is the time for UBC to **launch a preliminary investigation into the viability of a local carbon offset scheme, publish their findings, and begin offsetting flights.** Despite the comparatively high cost and staff/faculty dissatisfaction associated with carbon offsetting, our team believes offsetting is a strong option that has the highest potential to mitigate aviation emissions. That said, we strongly emphasize the need for transparency if UBC plans on pursuing this option, something that can be facilitated by a rigorous investigation that acknowledges and addresses the problems associated with carbon offsetting (Appendix A). It is also for transparency and accountability purposes that we recommend UBC pursue local offset options.

Together, these three alternatives form a strong foundation that tackle aviation emissions from different angles: substituting avoidable emissions through teleconferencing, offsetting unavoidable emissions, and gathering reliable data to track the progress. In the short and medium terms, offsetting carbon emissions and increasing the frequency of use of current ICT options is the most feasible and effective method for emissions reduction. Furthermore, reforming the flight

booking system to improve data collection and investing in the enhancement of ICT facilities, both of which are long term strategies, are necessary steps to build a resilient, effective, and reliable air-travel emissions reduction scheme.

Appendix A

In recommending offsetting as an alternative, it is important to recognize that carbon offsetting is a highly controversial practice; many critics question both the scientific legitimacy and ethicality of offsetting schemes. Critics of their legitimacy often cite additionality as the main issue. Essentially, the question is whether the emissions reductions achieved by the offset would have been achieved anyways without the investment.[26] If the answer is yes, then the offset is null, and no carbon has been mitigated, and any carbon accounting factoring in the value of the offset is inaccurate. On the other hand, critics of their ethicality contest the act of paying another party to offset one's own emissions.[27] Furthermore, reports like *An Even More Inconvenient Truth* by Propublica reporter Lisa Song highlight failed or ineffective offset schemes, many of which are purchased from highly accredited sources like the Clean Development Mechanism, which came out of the 1997 Kyoto Protocol. To this extent, organizations that employ offsets as a part of their carbon mitigation strategies are often accused of greenwashing, or paying to emit.

Notes

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[4] Ciers et al., 2

[5] Nursey-Bray, Melissa, Robert Palmer, Bridie Meyer-Mclean, Thomas Wanner, and Cris Birzer. "The Fear of Not Flying: Achieving Sustainable Academic Plane Travel in Higher Education Based on Insights from South Australia." Sustainability 11, no. 9 (2019): 2694

[6] Ciers et al., 1

[7] Nursey-Bray et al., 1

[8] Wynes and Donner, "Greenhouse Gas Emissions." 4

[9] Greenhouse Gas Reduction Targets Act, B.C. Reg. 392/2008, s. 4

[10] UBC President's Declaration on the Climate Emergency, 2

[11] Wynes and Donner, 4; *CNAR*, 16

[12] Ibid., 7

[13] Ibid., 7

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[19] Wynes and Donner

[20] Olivia et al., 8

[21] Ibid., p. 8

[22] Ibid., pg. 29

[23] Wynes and Donner, 14

[24] Wynes and Donner, 21

[25] Ibid., 21

[26] Hyams, Keith, and Tina Fawcett. "The Ethics of Carbon Offsetting." *Wiley Interdisciplinary Reviews: Climate Change* 4, no. 2 (2013): 91–98. https://doi.org/10.1002/wcc.207., 93

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