The Right to a Flight - Energy Costs Up in the Air

Frances Annmarie Duffy[1]

[1]Faculty of Law, Universitas Islam Indonesia, Indonesia
234101613@uii.ac.id

Abstract. The desire for air travel is growing at an unprecedented rate raising critical questions about aviation's contribution to greenhouse gas emissions and its environmental sustainability. In 1948, air travel was still the domain of the affluent. Post-war economic growth and rising living standards over the next few decades, facilitated the democratization of air travel. Domestic vacations were gradually replaced by international trips. The globalization of business also played a large part in the accelerated growth of air travel during the 20th and 21st centuries. With flight projections indicating a substantial increase in air travel demand, especially among Indonesia's growing middle class, the resultant energy impacts warrant urgent consideration. The prospect of millions more air passengers raises concerns about achieving the aims of the Paris Agreement 2015 which seeks to abate global warming. This paper advocates for a re-evaluation of current legislation and policies promoting unrestricted air travel in Indonesia. Ultimately, it argues that, while the desire to travel by aircraft is legitimate, establishing a balance between travel aspirations and environmental responsibilities is imperative. By making air travel more expensive, we may inadvertently promote thoughtful travel decisions in an age where efficiency and sustainability must take precedence over perceived entitlements. However, in order to maintain equitable access to air travel a Personal Carbon Trading Scheme may be the answer.

Keywords: Air Travel, Greenhouse Gas Emissions, Personal Carbon Trading

1 Introduction

While the Universal Declaration of Human Rights (UDHR) 1948 enshrines the right to freedom of movement between countries, it is doubtful that the committee led by Eleanor Roosevelt envisaged the implications of global mobility on the energy demands of the transport industry. According to Article 13 of UDHR everyone has the right to travel in their own country, leave their own country and return to their own country.[1] Eleanor Roosevelt, in her role as Chairperson of the UDHR drafting committee, could not have imagined a future where vast numbers of passengers would travel both domestically and internationally via aircraft. While governments have focused on reducing greenhouse gas emissions from road transport and rail travel, air travel has flown under the radar.

The reason that air travel has not been a priority for governments attempting to

reduce CO2 emissions is that it contributes relatively less emissions than other transport sectors. According to the International Civil Aviation Organisation (ICAO) the aviation sector "accounts for under 2% of the world's annual CO2 emissions"[2]. However, this estimate is considered flawed by scientists and environmentalists who believe the figure is closer to 4% when aviation's contribution to radiative forcing from short-lived emissions such as nitrous oxides (NOx), or in the form of contrails or clouds (H2O) are taken into account. Future projections by non-governmental organisation, the Center for Biological Diversity, are concern for a call to action:

"We found that by 2050, aircraft emissions are projected to more than triple. Unchecked, between 2016 and 2050 global aviation will generate an estimated 43 gigatonnes of carbon dioxide emissions[3]."

Considering the target reduction for Greenhouse Gas Emissions by signatories to the Paris Agreement is a minimum of 1.5 % the estimated 4% is not insignificant[4]. Add to this the rate of growth in airline travel and the problem is exacerbated. Urgent action is needed now to ensure emissions from commercial aircraft do not increase but are eliminated by 2050.

Signals that the airline industry and aviation organisations are aware of the potential impacts and understand their responsibility to act now can be observed through the recent implementation of an emissions offset scheme. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) seeks to reduce aviation emissions through carbon offsetting. Currently in a "first phase", participation by States is voluntary until 2026. That said, 126 States have already signed up to participate[5].

However, the scheme has attracted widespread criticism from scientists, environmentalists and Non-Governmental Organisations (NGOs) as it does not actually reduce emissions, it simply moves responsibility for emissions to forestry or other carbon rich industries.

According to Vera Pardee, a Center for Biological Diversity attorney who has sued the U.S. federal government over aviation emissions:

"This dangerous shell game does little more than help airlines hide their rapidly growing threat to our climate. The world needs less polluting planes, not a dubious offset scheme that just passes off the industry's exploding carbon debt to someone else[6]."

Data from ICAO shows passenger numbers have been increasing on average 4.6% since 1940. The number of domestic passengers increased 42% between 2013 and 2019, while the number of international passengers rose 50% (GACA)[7].

Aviation emissions are of increasing concern to governments, policymakers, and the flying public globally. From 2013 to 2018, carbon dioxide (CO2) emissions from commercial aviation increased about 70% faster than United Nations projections and they were recently on track to triple by 2050, which means they could account for one-quarter of CO2 emissions from all sectors by then[7].

Indonesia, with an estimated population exceeding 280 million people, is a country that poses a serious risk of increasing emissions from air travel[8]. Domestic air travel in Indonesia has increased by 10 % per year since 2014. It will become the fifth-largest air travel market by 2036, with an expected 355 million passengers due to the

growing demand for air travel, especially among the rising middle class[9]. The resultant energy impacts warrant urgent consideration. The prospect of millions more air passengers, raises concerns about carbon emissions and sustainable practices within the Indonesian aviation sector.

This paper advocates for a re-evaluation of current legislation and policies promoting unrestricted air travel in Indonesia. Ultimately, it argues that, while the desire to travel by plane is legitimate, establishing a balance between travel aspirations and environmental responsibilities is imperative. By making air travel more expensive, we may promote thoughtful travel decisions in an age where efficiency and sustainability must take precedence over perceived entitlements. However, this would turn the clock back to pre-war flight accessibility, making air travel the domain of the privileged only. The need to ensure equity among the Indonesian population while air fares rise could potentially be achieved through the use of a Personal Carbon Trading (PCT) scheme. This paper proposes a personal trading scheme linked to air travel on the basis of the potential for a huge increase in carbon emissions in the future due to the growth of domestic and international travel by the fourth most populous country in the world. While air travel will inevitably become more expensive due to the restriction of flights required to lower emissions, flying should remain (or become) accessible to all by a quota system administered through a PCT scheme.

To date, only one research paper has been published linking air travel to a PCT, "Personal Carbon Trading Applied to Swiss Air Travel Guaranteeing a Fair Access to Climate Ambitious Aviation," a master's thesis, published in 2024, by Marc Prébandier[10]. The context for the thesis was Switzerland, with a population of approximately nine million, a fraction of the population of Indonesia. Currently, there are no studies on the feasibility for PCT schemes in Indonesia.

2 Method

This article is primarily based on a review of trusted sources of information from the aviation industry such as ICAO and IATA and data on global emissions from the United Nations Climate Change website. It also considers innovative theories presented by authors on the use of PCT Schemes and in particular one study linked to commercial air travel; "Personal Carbon Trading Applied to Swiss Air Travel Guaranteeing a Fair Access to Climate Ambitious Aviation."

It is noted that the different empirical sources of data researched sometimes provided varying data sets and this may be attributed to different approaches in data collection, sampling sets, modelling and analysis. This review considers information from additional texts that offer insights and critiques about air travel, global emissions, potential risks and mitigations. Through this approach, the article seeks to offer a considered examination of the available literature concerning the research subject, laying the groundwork for subsequent deliberation, analysis and interpretation.

3 Result and Discussion

3.1 The Growth of Air Travel

Historical Trends and Socioeconomic Drivers of Global Air Travel Growth. In 1948, air travel was the domain of the affluent. Post-war economic growth and rising living standards over the next few decades, facilitated the democratization of air travel in the western world. Cultural changes in the 1960s and 1970s reshaped the airline industry. More people began to fly, and air travel became less exclusive. Domestic vacations were gradually replaced by international trips. The globalization of business also played a large part in the accelerated growth of air travel during the 20th and 21st centuries. Between 1955 and 1972, passenger numbers more than quadrupled. A small percentage became repeat travelers, or "frequent flyers[11]."

This shift can be seen in the chart below tracking the growth in passenger numbers worldwide from 1945 until 2021. Even allowing for major world events such as wars, financial crises and disease outbreaks, passenger numbers continued to increase. The only exception was the COVID outbreak in 2019 which resulted in a sharp decline in flights, as is clear from the sharp dip in the axis in the graph below (Figure 1). However, by the end of 2023 most airlines had recovered and flight numbers were almost back to pre-COVID levels, with 2023's yearly capacity total just 3.7% below 2019[12].

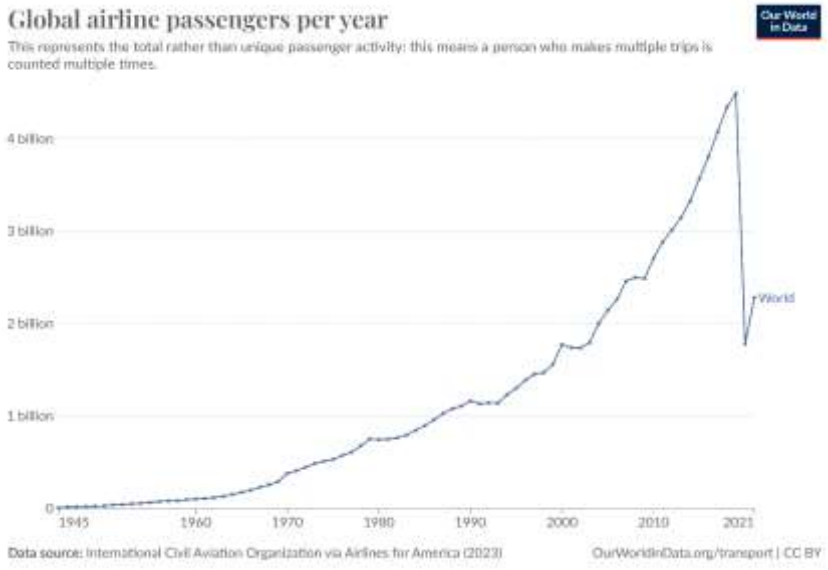

Fig. 1. Global Airline Passenger Per Year

Economic Accessibility and the Declining Cost of Air Travel Since the 1940s. Conversely, data shows that air travel has become cheaper over time. The chart below illustrates how airfares how fallen since the 1940s. Airline companies have been able

to take advantage of deregulation, economies of scale and generous energy subsidies, as more and more planes take to the skies due to soaring consumer demand. Back in post-war days, air travel was the domain of the privileged few. Certainly, my grandparents never imagined they would board an aircraft back in 1949 but they did in the 1970s. The introduction of jet passenger planes and falling prices opened airline travel to many[13].

Airfares: Then vs. Now

The table below shows a comparison of airfares between Los Angeles (LAX) and Boston (BOS).

Year	Number of stops	Flight duration	Cost	% Difference
1941	12	15 hours 15 minutes	$4,439.24	Baseline
1978	5	11 hours 50 minues	$915.82	-79%
2015	0 (nonstop)	6 hours 0 minutes	$408.89	-55% (from 1978)
2024	0 (nonstop)	5 hours 10 minutes	$119.67	-71% (from 2015)

In the 1940s, the average domestic ticket within the continental United States cost thousands and took nearly an entire day to complete. That is because the aircraft were smaller and short-ranged, requiring multiple stops along the way. In the 1970s, the deregulation act significantly brought domestic airfares down to hundreds of dollars. However, the aircraft and technology limitations still require higher airfares than today.

Fig. 2. Airfares: Then Vs. Now

Air Travel Inequality and Emissions Disparity. Results from a study conducted in 2020 suggest that 11% of the world's population travelled by air in 2018, with an estimated 4% taking international flights. Of note is the study's finding that only 1% of air travelers is responsible for a large share of warming: "The percentile of the most frequent fliers – at most 1% of the world population - likely accounts for more than half of the total emissions from passenger air travel" (this figure includes private aircraft which are not considered in this article)[14]. Despite public perception that air travel is comprised of jet setting businessmen and women, air travel is mainly used by tourism and leisure travelers[10]. While this has been the case since the 1970s when air travel first became accessible to the middle and working classes in the developed western world, the east is catching up.

Indonesia's Air Travel Growth and CO_2 Emissions Challenge. In 2023, 62.55 million Indonesians took domestic flights and 15.63 million took international flights. By comparison pre-pandemic figures (2019) for Indonesian air travel show that 76.69

million people took domestic flights and 18.86 million people took international flights[8]. Indonesia ranked 7th in the world for CO2 emissions from domestic flights in 2019 (Figure 3). While its emissions for international flights are not insignificant, 8 million tonnes of CO2, Indonesia does not feature in the top 10 for international flights. With all the evidence pointing to increased domestic and international flights demand, Indonesia must develop a sense of urgency to limit CO2 from aircraft[7].

Rank	Departure country	CO_2 [Mt]	% of total global CO_2	RPKs [billions]	% of total global RPKs	CO_2 intensity [g CO_2 / RPK]
1	United States[a]	117	15	1,222	14	96
2	China[b]	68.4	8.7	770	8.8	89
3	India	12.1	1.5	140	1.6	86
4	Russian Federation	10.2	1.3	113	1.3	90
5	Japan	9.92	1.3	87.5	1.0	113
6	Brazil	9.49	1.2	96.4	1.1	98
7	Indonesia	8.08	1.0	81.7	0.9	99
8	Australia[c]	7.05	0.9	72.2	0.8	98
9	Canada	6.28	0.8	62.5	0.7	100
10	Mexico	5.51	0.7	57.5	0.7	96

[a] Includes American Samoa, Guam, Johnston Island, Kingman's Reef, Midway, Palmyra, Puerto Rico, Saipan (Mariana Islands), Wake Island, U.S. Virgin Islands
[b] Includes Hong Kong SAR and Macau SAR
[c] Includes Christmas Island, Coco Islands, Norfolk Island

Fig. 3. Passenger CO2 emissions from domestic operations in 2019 Top 10 departure countries

3.2 Pathway to Climate Neutrality

The Paris Agreement was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris in 2015. Its overarching goal is to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels[4]." Effectively, this climate ambitious goal advocates for net-zero global CO2 emissions by roughly mid-century and net-zero greenhouse gas emissions by the end of the century. A study by Bergero, C et Al states that "among the most difficult emissions to avoid will be those from aviation given the industry's need for energy-dense liquid fuels that lack commercially competitive substitutes and the difficult-to-abate non-CO2 radiative forcing[15]."

According to the International Civil Aviation Organisation (ICAO) the aviation sector 'accounts for under 2% of the world's annual CO2 emissions. However, this does not account for non-CO2 enforcers "which currently warm the climate at twice the rate of CO2 emissions." Non-CO2 enforcers include water vapor (H2O), sulfur dioxide (SO2) and nitrogen oxides (Nox) which combined with other contributions create a direct radiative effect at high altitudes, bringing the actual figure closer to 4%[2].

In 2016, the ICAO's 191 Member States decided to implement the Carbon Offsetting and Reduction Scheme for International Aviation that uses carbon

offsetting as the main tool to reduce aviation carbon emissions. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) seeks to reduce aviation emissions through carbon offsetting. Currently in a "first phase", participation by States is voluntary until 2026. That said, 126 States have already signed up to participate[16].

The efficiency of carbon offsetting is subject to debate and the scheme has attracted widespread criticism from scientists, environmentalists and Non-Governmental Organisations (NGOs). The basis for their criticism is that carbon offsetting does not actually reduce emissions, it simply moves responsibility for emissions to forestry or other carbon rich industries[3].

Sustainable aviation fuels (SAFs) may offer substantial opportunities to the aviation sector as a means of reducing GHG emissions by 80% compared with fossil fuels. Despite steady improvements in fuel efficiency in Europe and the United States, mainly achieved by new aircraft entering the fleet, decarbonizing aviation remains a challenging task, due to rapid growth of the sector and the challenges of developing new fuel sources. While hybrid and electric vehicles have become popular alternatives to fuel powered vehicles in the bid to reduce GHG emissions, electrifying an airplane is not as simple as converting a bus from diesel to electric fuel due to the high energy requirements of aircraft. SAFS are made from used cooking oil, agricultural residue and even carbon dioxide from industrial gas effluents or the atmosphere. The technology and process used is very expensive. Pertamina in Indonesia has successfully produced SAF at its refinery in Cilacap from palm oil derivatives called Bioavtur. While trials have begun with Garuda Air there are many issues that need to be resolved including sourcing suitable feedstock from used oil and collection procedures. Research is expensive and needs a lot of investment from the government[17]. Transitioning to alternative fuel like hydrogen also poses technical and financial hurdles. Aviation would require "a dramatic leap in technology" to mitigate its reliance on fossil liquid hydrocarbon fuels in the short to mid-term[18].

The costs of investigating and transitioning to SAFs should be borne by the aviation industry and would of course make flights more expensive. Increasing airfares would be one way of eliminating the increasing demand for flights, reducing commercial aircraft in the skies and ultimately reducing CO2 emissions. This seems unlikely, Tourism and Creative Economy Minister, Sandiago Uno, wants to reduce the prices of airline tickets to get more people flying[19]. If the Indonesian government lacks the impetus to reduce flights, given the benefits of tourism to the government revenue, other ways of reducing flights to eliminate CO2 must be considered.

One solution is the use of a Personal Carbon Trading (PCT) scheme that could provide the national framework for delivering emissions reductions over the mid-to-long term. PCT is a general term used to describe a variety of downstream cap-and-trade policies, which locate rights and responsibilities for the carbon emissions from household energy use and/or personal travel at the individual level. The characteristics of PCT schemes are depicted in Figure 4.

All PCT schemes share common features: the scheme is mandatory for all residents (this provides greater scope than just applying the scheme to citizens); individuals periodically receive a carbon quota for free in a capped carbon market; for every activity that involves carbon use within the scope of the scheme, allowances are

surrendered; the allowances are tradable, enabling a market in allowances to deal with the different requirements of above-average and below-average carbon consumers; allowances are reduced over time in line with national carbon reduction commitments which reduce the cap progressively[20].

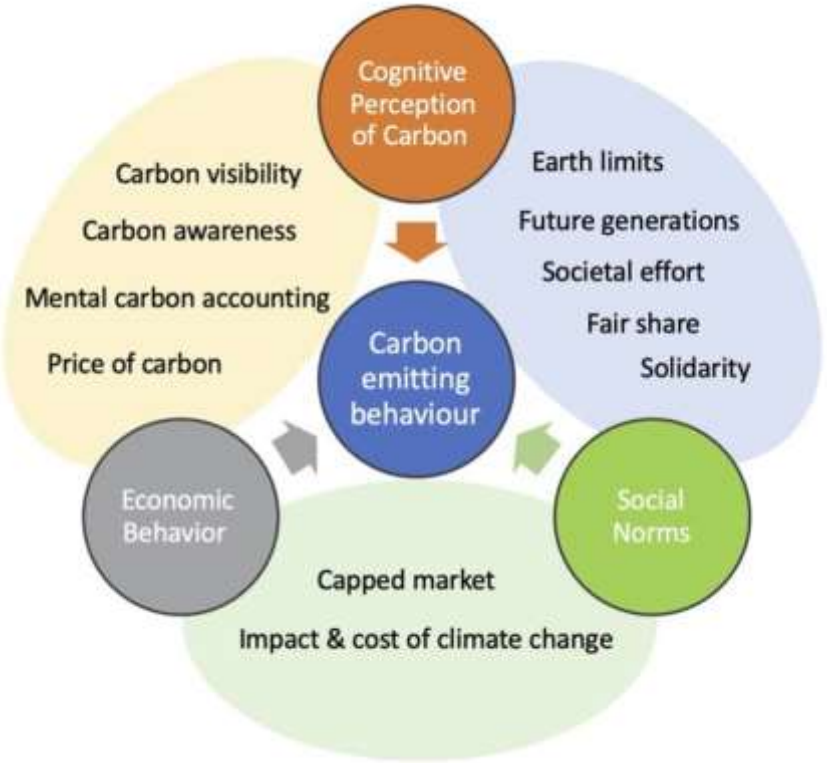

Fig. 4. Characteristics of PCT

There are limited studies on the efficacy of PCT schemes available. The concept of a PCT scheme gained traction in the UK as the 21st century dawned but it was never developed due to technology and administration costs as well as concerns around public acceptability. It was described by the Department for Environment, Food and Rural Affairs (Defra) as a "scheme ahead of its time"[20]. That may have been the case back in 2006 when Defra was appointed to research the feasibility of a PCT scheme in the UK. However, almost twenty years later, technology has advanced with the "APP Age" providing applications that can easily be downloaded onto personal mobile phones, enabling more efficient means of data collection, analysis and administration. Public acceptability may also have changed as people have become more educated and aware of the impacts of climate change and the necessity to reduce greenhouse gas emissions.

Lahti in Finland was the first city to pilot PCT in a mobility study by using a mobile phone application. However, this study focused only on land travel and did not consider air or sea travel. Mobility data was collected in Lahti using Android enabled mobile phones. A mobility application which could track walking, bicycle, passenger car, bus, metro, train and tram mobility, was downloaded onto personal mobile phones. The application also used GPS data to calculate distances covered with different mobility modes. Users were required to keep their mobile phones with them at all times so mobility could be accurately recorded, much in the same way that fitness followers record daily 'steps' using an APP, to track their exercise. There were no other tasks allocated to participants which facilitated the seamless introduction of the PCT scheme into daily life. The data collection took place over a period of six months from 5 October 2018 to 5 April 2019. Data collection aimed to measure current mobility of test users. The results of the study showed that "lower income users are mostly winners with low carbon emissions." Higher-income levels tend to be 'larger emitters' and have to reduce their mobility emissions or purchase additional emission allowances from other users. Mobility emissions of low-income levels are much closer to the amounts of their allowances and their reduction or allowance purchase needs are lower[21].

To date, only one study has been published linking air travel to a PCT scheme: Personal Carbon Trading Applied to Swiss Air Travel Guaranteeing a Fair Access to Climate Ambitious Aviation by Marc Prébandier assesses the possibility of introducing a Personal Carbon Trading (PCT) scheme for air travel, by developing a case study centered on Switzerland[10]. In Switzerland, a 90% reduction of the emissions by 2050 compared to 1990 levels is proposed, with the remaining 10% to be mitigated through carbon direct removal (CDR). The cap-and-trade scheme allocates individuals free flight quotas each year, distributing the emissions budget equitably among residents of Switzerland. An exchange market is established to bring flexibility in the quota scheme. To keep the policy as a quantity-based mechanism with certainty in emission reductions, a hard cap must be maintained. At the policy start, the vast majority of Swiss residents in the two lowest income brackets would receive more flight quotas than necessary, while individuals within the two highest income groups would either have to purchase additional quotas or fly less.

"Given the unequal nature of air travel consumption across income groups, introducing a flight quota scheme should not be perceived as a restrictive policy, but as a guarantee of fair access for all individuals of society to climate ambitious aviation." (Marc Prébandier, 2024)

The scenario-based case study addressed the full impact of air travel including non-CO2 enforcers. While the author acknowledged barriers to the success of the scheme such as the legal implications of allocating PCT schemes to international travel and the potential costs, there is no doubt of its plausibility in reducing emissions. Aiming for climate neutrality, it guarantees emission reductions by setting a capped emissions budget which is progressively reduced over the defined period.

While PCT schemes are complex and require consistent application and use by all involved, the outcome is guaranteed. Perhaps the only way to truly test the efficacy of a PCT Scheme linked to travel, is to pilot a real case study. Indonesia is ideally suited due to the large population, the growth of domestic air travel in particular and its

reputation for the rapid development, implementation and early adoption of new technologies. Developing and trialing a PCT scheme based on domestic air travel would eliminate the potential legal barriers for linking a PCT Scheme to international air travel. Successful results from the pilot study could provide the catalyst for a coordinated international approach to developing and implementing a PCT Scheme for international travel.

4 Conclusion

With flight projections indicating a substantial increase in air travel demand, especially among Indonesia's growing middle class, the resultant energy impacts warrant urgent consideration. The prospect of millions more air passengers, raises concerns about carbon emissions and sustainable practices within the aviation sector.

According to the International Civil Aviation Organisation (ICAO) the aviation sector "accounts for under 2% of the world's annual CO2 emissions" but the figure is closer to 4% when non-CO2 enforcers "which are warming the climate at twice the rate of CO2 emissions" are taken into account.

Considering the target reduction for Greenhouse Gas Emissions by signatories to the Paris Agreement is a minimum of 1.5 %, the estimated 4% is not insignificant. Add to this the rate of growth in airline travel and the problem is exacerbated. Urgent action is needed now to ensure emissions from commercial aircraft do not increase but are eliminated by 2050.

Current climate change mitigations used by the aviation industry rest on The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). However, the scheme has attracted widespread criticism from scientists, environmentalists and Non-Governmental Organisations (NGOs) as it does not actually reduce emissions, it simply moves responsibility for emissions to forestry or other carbon rich industries.

This paper advocates for a personal trading scheme linked to air travel on the basis of the potential for a huge increase in carbon emissions in the future due to the growth of domestic and international travel by the fourth most populous country in the world. Indonesia, with an estimated population exceeding 280 million people, is a country that poses a serious risk of increasing emissions from air travel. Domestic air travel in Indonesia has increased by 10 % per year since 2014. It is touted to become the fifth-largest air travel market by 2036, with an expected 355 million passengers due to the growing demand for air travel.

To reduce emissions flights must decrease which means airfares will rise due to the laws of supply and demand. A PCT scheme may address any inequities that result from higher fares ensuring flights are still accessible to all. PCT describes a variety of downstream cap-and-trade policies, which locate rights and responsibilities for the carbon emissions from household energy use and/or personal travel at the individual level. There are limited studies on the efficacy of PCT schemes available. To date, only one study has been published linking air travel to a PCT scheme: Personal Carbon Trading Applied to Swiss Air Travel Guaranteeing a Fair Access to Climate Ambitious Aviation by Marc Prébandier, assesses the possibility of introducing a PCT scheme for air travel, by developing a case study centered on Switzerland.

While PCT schemes are complex and require consistent application and use by all involved, the outcome of emissions reduction is guaranteed. Perhaps the only way to truly test the efficacy of a PCT Scheme linked to travel, is to pilot a real case study. Indonesia is ideally suited due to the large population, the growth of domestic air travel in particular and its reputation for the rapid development, implementation and early adoption of new technologies.

References

[1] United Nations General Assembly, *Universal Declaration of Human Rights*. United Nations, 1948. [Online]. Available: https://www.un.org/en/about-us/universal-declaration-of-human-rights

[2] International Civil Aviation Organization, 'ICAO Environmental Report 2016', International Civil Aviation Organization, Montreal, Canada, 2016. [Online]. Available: https://www.icao.int/environmental-protection/documents/ICAO%20Environmental%20Report%202016.pdf

[3] Center for Biological Diversity, 'Up in the Air: How Airplane Carbon Pollution Jeopardizes Global Climate Goals', Tucson, Arizona, Dec. 2015. [Online]. Available: https://www.biologicaldiversity.org/programs/climate_law_institute/transportation_and_global_warming/airplane_emissions/pdfs/Airplane_Pollution_Report_December2015.pdf

[4] United Nations Framework Convention on Climate Change, *Paris Agreement*. 2015. [Online]. Available: https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[5] International Civil Aviation Organization, 'Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)', Montreal, Canada, 2016. [Online]. Available: https://www.icao.int/environmental-protection/Pages/CORSIA.aspx

[6] Center for Biological Diversity, 'Airlines Will Pay Just Pennies on Dollar for Climate Pollution Under New Global "Offset" Scheme'. [Online]. Available: https://www.biologicaldiversity.org/news/press_releases/2016/airplane-emissions-10-06-2016.html

[7] B. Graver, D. Rutherford, and S. Zheng, 'CO_2 Emissions from Commercial Aviation: 2013, 2018, and 2019', International Council on Clean Transportation, Washington, D.C., Oct. 2020. [Online]. Available: https://theicct.org/wp-content/uploads/2021/06/CO2-commercial-aviation-oct2020.pdf

[8] Badan Pusat Statistik (BPS-Statistics Indonesia), 'Mid-Year Population (Thousand People), 2022-2024', Badan Pusat Statistik, Jakarta, Indonesia, 2024. [Online]. Available: https://www.bps.go.id/en/statistics-table/2/MTk3NSMy/mid-year-population--thousand-people-.html

[9] C. Slocum, 'How Low-cost Carriers are Changing the Growing East Asian Travel Market', *Int. J. Aviat. Aeronaut. Aerosp.*, vol. 5, no. 5, Jan. 2018, doi: 10.58940/2374-6793.1270.

[10] M. Prébandier, 'Personal Carbon Trading Applied to Swiss Air Travel: Guaranteeing a Fair Access to Climate Ambitious Aviation', Master's Thesis, Laboratory of Environmental and Urban Economics (LEURE), Swiss Federal Institute of Technology of Lausanne (EPFL), Swiss Federal Institute of Technology of Zürich (ETH Zürich), 2024. [Online]. Available: https://infoscience.epfl.ch/handle/20.500.14299/207768

[11] National Air and Space Museum, 'The Evolution of the Commercial Flying Experience', airandspace.si.edu. [Online]. Available: https://airandspace.si.edu/explore/stories/evolution-commercial-flying-experience

[12] OAG Aviation Worldwide, 'COVID-19 Impact on Aviation Industry: Airline

Recovery', oag.com. [Online]. Available: https://www.oag.com/coronavirus-airline-schedules-data
[13] S. F. Staff and O. Memon, '50 Years of Airfares: The Evolution of Price and What You Got In 1970 VS Now', simpleflying.com. [Online]. Available: https://simpleflying.com/50-years-airfares/
[14] S. Gössling and A. Humpe, 'The Global Scale, Distribution and Growth of Aviation: Implications for Climate Change', *Glob. Environ. Change*, vol. 65, pp. 102–194, Nov. 2020, doi: 10.1016/j.gloenvcha.2020.102194.
[15] C. Bergero, G. Gosnell, D. Gielen, S. Kang, M. Bazilian, and S. J. Davis, 'Pathways to Net-zero Emissions from Aviation', *Nat. Sustain.*, vol. 6, no. 4, pp. 404–414, Jan. 2023, doi: 10.1038/s41893-022-01046-9.
[16] International Civil Aviation Organization (ICAO), 'Destination Green: The Next Chapter', International Civil Aviation Organization, Montreal, Canada, 2019. [Online]. Available: https://www.icao.int/environmental-protection/Documents/ICAO-ENV-Report2019-F1-WEB%20(1).pdf
[17] Denny Gunawan, 'Indonesia Can Become a Major SAF Producer', *The Jakarta Post*, Sydney, Australia, May 21, 2024. [Online]. Available: https://www.thejakartapost.com/opinion/2024/05/21/indonesia-can-become-a-major-saf-producer.html
[18] M. Prussi, A. O'Connell, and L. Lonza, 'Analysis of Current Aviation Biofuel Technical Production Potential in EU28', *Biomass Bioenergy*, vol. 130, p. 105371, Nov. 2019, doi: 10.1016/j.biombioe.2019.105371.
[19] Y. Belinda, 'Tourism Minister Backs Proposal to Eliminate Tax on Flight Tickets', *The Jakarta Post*, Jakarta, Aug. 08, 2024. [Online]. Available: https://www.thejakartapost.com/business/2024/08/08/tourism-minister-backs-proposal-to-eliminate-tax-on-flight-tickets.html
[20] T. Fawcett and Y. Parag, 'An Introduction to Personal Carbon Trading', *Clim. Policy*, vol. 10, no. 4, pp. 329–338, Jan. 2010, doi: 10.3763/cpol.2010.0649.
[21] V. Uusitalo *et al.*, 'Using Personal Carbon Trading to Reduce Mobility Emissions: A Pilot in the Finnish City of Lahti', *Transp. Policy*, vol. 126, pp. 177–187, Sep. 2022, doi: 10.1016/j.tranpol.2022.07.022.