icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

MARCH 2025

Designing an equitable aviation climate levy

XINYI SOLA ZHENG, CHANG SHEN, AND ETHAN KELLOGG

ACKNOWLEDGMENTS

The authors thank ICCT colleagues André Cieplinski, Dan Rutherford, and Elise Sturrup for their reviews of an earlier draft. This study was generously supported by the Crux Alliance.

International Council on Clean Transportation
1500 K Street NW, Suite 650
Washington, DC 20005

communications@theicct.org | www.theicct.org | @TheICCT

EXECUTIVE SUMMARY

Levies on commercial aviation fuels and/or airline tickets are often discussed as policies that could help achieve the sector's 2050 net-zero climate goal. A climate levy can modulate traffic growth in mature markets to allow clean aviation technologies more time to be deployed at a large scale and help bridge the cost gap between conventional jet fuel and alternative energy sources. However, the uneven participation in air travel by household income and by country makes it crucial to assess the distributional effects of potential levy instruments to promote a just transition.

This study builds on the ICCT's prior analysis of frequent flying levies and models the distributional effects of six aviation climate levy instruments: an air passenger duty, an aviation fuel tax, a frequent flying levy, an air miles levy, a luxury aviation levy, and a ticket levy with rebates for the first two flights of the year. We use travel survey data to improve the statistical modeling of an individual's flying frequency and assess the distributional effects in terms of income level and geography, by trip purpose, seating class, and flight distances. We also quantify the emission reduction benefits of each instrument as a function of demand response.

Results show that an air miles levy would concentrate the cost burden of aviation climate taxation on those who fly the most. "Super flyers" who take more than 20 flights a year would pay 41% of the global total levy amounts. Additionally, we find that there can be a tradeoff between a levy's efficiency, equity, and complexity (Table ES1). Efficiency is measured by holding either total levy revenue or emission reduction constant. Under equity, our "access" metric quantifies the amount of air travel that would be avoided in response to higher ticket prices. Complexity is ranked based on the level of information collection required. More novel levy designs such as a luxury aviation levy or a ticket levy with rebates could achieve similar distributional effects as an air miles levy and avoid the tradeoffs among these metrics.

Table ES1

Summary of our assessment of efficiency, equity, and implementation complexity of the six levy types analyzed

Policy	Efficiency		Equity (impact on low- and middle-income households)		Complexity
	Emissions (million tonnes)	Revenue (billion US$ per year)	Burden (share of total)	Access (million flights avoided)	
Air passenger duty	-88	85	45%	-505	Low
Aviation fuel tax[a]	-62 to -82	91 to 121	39%	-296 to -395	Medium
Luxury aviation tax[b]	-50 to -59	126 to 149	33%	-335 to -343	Low
Ticket levy with rebates[c]	-75 to -91	82 to 99	21% to 28%	-214 to -260	Medium
Frequent flying levy	-82	91	20%	-146	High
Air miles levy	-77	96	16%	-147	High

Note: Green shading represents a top-performer for that metric and red shading indicates it may present serious limitation.
[a] The ranges for the aviation fuel tax depend on whether the cost pass-through rate is 0.75 or 1.
[b] The ranges depend on whether seat class substitution occurs. For the substitution case, 50% of business travel and 25% of leisure travel in premium class are substituted by economy class.
[c] The ranges are defined by assumed demand response (full versus dampened by rebate).

Additionally, a passenger duty would be most effective at modulating travel demand, and the benefit of a fuel tax can be maximized by providing a cross-subsidy for net-zero aviation technologies. While a frequent flying levy or air miles levy would be most suitable for raising funds for global climate finance in the long term, to reduce implementation complexities in the short term, a luxury aviation levy or a ticket levy with rebates could be implemented by a coalition-of-the willing to raise revenue efficiently and equitably.

TABLE OF CONTENTS

Executive summary i

Introduction 1

Collecting and using the revenue from climate taxation 2

Revenue collection 2

Aviation fuel levy and emissions charge 2

Aviation ticket levy 3

Revenue use 4

Categories and examples 4

Green spending versus rebates 5

Methodology 7

Ticket categorization 8

Demand and emissions 9

Levy design 12

Air passenger duty 13

Aviation fuel tax 13

Frequent flying levy 13

Air miles levy 13

Ticket levy with rebate 14

Luxury aviation levy 14

Results 15

Global trends 15

Trends by segment and country 19

Implications for individual travelers 21

Conclusions 23

Future research 24

References 26

Appendix A. Survey data and model validation 29

Appendix B. Distribution by country income group 30

Appendix C. Comparison of the distributional effects of the six instruments 31

LIST OF FIGURES

Figure 1 High-level modeling framework for this study 11

Figure 2 Share of population and levy burden by household income levels......15

Figure 3 Share of population and levy burden by flying frequency categories......16

Figure 4 CO_2 emissions change by instrument and household income category 17

Figure B1 Share of global total population, tickets, and levy amount by country income groups under the World Bank definition...... 30

Figure C1 Share of population and levy burden by household income levels 31

Figure C2 Share of population and levy burden by flying frequency categories......32

Figure C3 CO_2 emissions change by instrument and household income category......32

LIST OF TABLES

Table ES1 Summary of our assessment of efficiency, equity, and implementation complexity of the six levy types analyzed i

Table 1 Revenue recycling examples 5

Table 2 Travel attributes and taxation potential 7

Table 3 Distribution of tickets for trips taken by high-income, frequent flyers residing in Australia 9

Table 4 Demand-to-price elasticities used for this study 10

Table 5 Modeled frequent flying levy rates 13

Table 6 Air miles levy rates modeled 14

Table 7 Breakdown of tickets, aviation fuel tax, and air miles levy by trip purpose 17

Table 8 Summary of efficiency, equity, and implementation complexity of six levy types 18

Table 9 Share of total tickets and levy by destination type and seating class, and changes relative to ticket distribution 20

Table 10 Estimated revenue raised for top 10 aviation markets under different levy instruments 20

Table 11 Potential revenue raised from potential coalitions of the willing 21

Table 12 Average activity, emissions, and levy amount per person by flying frequency category 22

Table 13 Strengths, limitations, and applications by instrument 24

Table A1 Summary of IATA Global Passenger Survey data 29

INTRODUCTION

As governments and industry increasingly focus on reducing aviation emissions, including via country-level sustainable aviation fuel (SAF) mandates, the costs associated with cleaner aircraft and fuels are becoming a key topic for policymakers. Regulatory approaches in the form of taxes and subsidies are being considered or implemented in various aviation markets. Some mature markets with high activity, such as France, the Netherlands, and the United Kingdom, have begun taxing air travel to regulate travel demand and thus reduce emissions (CE Delft, 2019).

Increasing the cost of flying can either be a design feature or a consequence of a policy. When the goal is to reduce emissions by modulating traffic, both the tax burden and the demand impact are fully intended. When the goal is to raise revenue for climate mitigation, however, minimizing the impact on travel demand is not desirable, because less travel will mean less revenue. Additionally, demand for air travel, especially long-haul flights, is relatively inelastic to price changes (Brons et al., 2002); as this limits the emission reductions that are likely to be achieved, earmarking revenues from climate taxation for environmental measures is a common approach.

The ICCT's previous study comparing a flat ticket levy with a frequent flying levy highlighted the ability of the latter to distribute the cost burden in an equitable manner (Zheng & Rutherford, 2022). This report builds on that research and includes a wider analysis of six levy designs and their distributional effects: an air passenger duty, an aviation fuel tax, a frequent flying levy, an air miles levy, a luxury aviation levy, and a ticket levy with rebates for first two flights of the year. The comparison provides insights into ways to design a levy according to different values and to best fit the intended use of tax revenues.

COLLECTING AND USING THE REVENUE FROM CLIMATE TAXATION

Frequent flyers who take more than six flights in a year make up, at most, 2% of world population and took about 40% of the flights in 2019; the top 20% income bracket globally took about 80% of flights (Zheng & Rutherford, 2022). There are two primary equity considerations when designing an aviation climate levy: (1) Are frequent flyers wealthy enough to pay it? and (2) Would a uniform cost increase disproportionally impact those who fly infrequently, many of whom are of lower income levels? There is a strong correlation between air travel and wealth, and the lower-income group that has historically contributed the least to aviation emissions might unduly bear the cost of decarbonization if their participation in air travel increases in the coming decades, as is expected. Thus, it is important to assess the distribution of the tax burden, or distributional effects, of a levy on air travel. Distributional effects can occur through various pathways in the implementation of carbon pricing. A comprehensive review by the International Monetary Fund (Shang, 2023) identified consumption, referred to in this report more broadly as revenue collection, and revenue recycling, referred to here as revenue use, as two possible pathways.

REVENUE COLLECTION

Both fuel taxes and ticket levies have been proposed to contribute to the goal of reducing aviation's climate impacts. As airlines pass on a significant share of the increase in fuel costs to consumers (Koopmans & Lieshout, 2016), it is important to compare the distributional impacts of fuel taxes imposed on airlines with ticket levies imposed directly on consumers.

Aviation fuel levy and emissions charge

Aviation fuel taxes are imposed on the fuel used by aircraft, which is primarily kerosene. The Organization for Economic Co-operation and Development (OECD, 2021) identified three components to carbon rates for fuels: fuel excise taxes, carbon taxes, and the price of carbon dioxide (CO_2) emission permits.

Right now, aviation carbon pricing policies behave identically to fuel excise taxes; this may change in the future, though, when a sizeable amount of low-emission SAF is expected to be blended into the fuel supply.[1] Today SAF is only about 0.2% of the global fuel supply and is usually exempt from carbon pricing (International Air Transport Association [IATA], 2024). We do not distinguish between a fuel tax and a carbon price in this study.

Several countries have an aviation fuel tax, and these primarily focus on domestic flights. In 2022, the United States applied a federal tax of 6.4 cents per liter and additional state-level taxes of up to 4.5 cents per liter for domestic flights (Dama et al., 2023). In Europe, Norway and Switzerland impose a fuel tax on kerosene for domestic flights; in Norway this is €0.17 per liter of mineral oil, and in Switzerland, it is €0.45 per liter on kerosene (Transport & Environment, 2023).

Currently, two initiatives price aviation emissions: the EU Emissions Trading System (EU ETS) and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) administered by the International Civil Aviation Organization (ICAO). The EU ETS requires airlines to purchase allowances to cover their CO_2 emissions from flights within the European Economic Area. Between 2012 and 2020, allowances equivalent

1 Excise duties are indirect taxes on the sale or use of specific products or services, such as alcohol, tobacco and energy (European Commission, n.d.-a; Internal Revenue Service, n.d.).

to 82% of emissions were granted for free to airlines, but the free allowances are to be fully phased out by 2026 (European Commission, n.d.-b). The allowance price has risen considerably in recent years from about €10 in 2018 to a high of €100 in 2023 (Appunn & Wettengel, 2024). Between 2024 and 2030, the EU ETS is also setting aside 20 million allowances for airlines to cover the cost difference between SAF and conventional jet fuel (European Commission, 2023).

In the original proposal, the EU ETS covered all flights departing from and arriving in the European Union; the proposal faced resistance from non-EU countries and led ICAO to establish CORSIA. Under CORSIA, all international airlines above a certain activity threshold are required to purchase eligible emissions units (mostly carbon offsets at present) for emissions beyond 2019 levels. As CORSIA is the first global market mechanism for tackling aviation emissions, a large number of carbon offsets are priced low and the quality is difficult to verify (Transport & Environment, 2019; Wozny et al., 2022).

Aviation fuel taxes and emission charges are directly linked to flights' CO_2 emissions and the revenue generated can help to narrow the cost gap between conventional jet fuel and SAFs. However, as noted in O'Malley and Pavlenko (2022), a carbon tax at the EU ETS price level alone may not generate enough funds to substantially promote the development of SAFs. There are also potential equity issues, as the burden of the tax may fall disproportionately on lower-income groups if it is passed on to consumers in the form of higher ticket prices.

In addition, most fuel taxes, aside from the EU ETS, are only applied to domestic flights. The primary reason aviation fuel excise taxes are not commonly applied to international flights is an article of the Chicago Convention of 1944 that prohibits the taxation of aviation fuel carried on international flights, to prevent double taxation and facilitate global air travel (ICAO, n.d.). The article does not prevent the taxation of jet fuel uplifted (i.e., loaded) in one country and used on international flights, however, and there is an ongoing debate about extending these taxes to international flights to better address environmental concerns (Opportunity Green, 2024).

Aviation ticket levy

An aviation ticket levy is a tax applied to ticket purchases. This form of taxation can directly influence people's flying behaviors and generate revenue for sustainability initiatives. One common form is the frequent flying levy, which imposes additional charges on individuals who fly frequently. Recently, focus has shifted toward using a frequent flying levy to generate revenue for climate mitigation, adaptation, or loss and damage (Zheng & Rutherford, 2022; Kellogg & Zheng, 2024). The logic behind this is that those who contribute more aviation emissions should contribute more to efforts to develop new technologies. Making frequent flying more expensive could incentivize travelers to consider alternative modes of transportation or to take fewer flights.

Another concept that has been proposed is the air miles levy (Carmichael, 2019), which charges passengers based on the distance traveled during their flight, at a rate that increases the more an individual flies in a year. The primary objective of this levy is to discourage frequent flying and in particular long-haul flights. Currently, 27 countries have adopted some form of ticket levy, primarily focusing on departing flights (CE Delft, 2019; IATA, 2023a). The application of these levies varies. While some, like Australia's Passenger Movement Charge, are a flat-rate system, countries more commonly employ a progressive rate that considers factors such as distance traveled, seating class, and the aircraft's weight.

The price range for the ticket levies is remarkably wide. Portugal imposes a flat €2 levy per ticket (FCC Aviation, n.d.) and at the upper end, the United Kingdom charges from £7 (€8) up to £607 (€692) based on distance traveled and the seating class (HM Revenue & Customs, 2024). Starting in 2026, flights departing from Singapore will be required to use SAF, beginning with a target of 1% (Barrington & Goh, 2024) and increasing to 3%–5% by 2030. A ticket levy will fund this initiative, with the amount varying based on factors such as flight distance and travel class. In 2026, the additional cost for an economy-class ticket from Singapore to London is estimated to be about S$16 ($12), while flights to Bangkok and Tokyo will see increases of S$3 ($2.23) and S$6, respectively.

A 2019 survey in Europe found that the primary obstacle to widespread international implementation of these levies is concern over market distortion (CE Delft, 2019). There is concern that implementing such taxes could disadvantage domestic aviation industries in the global market. Indeed, there is only one example of internationally coordinated aviation ticket levy: the French Solidarity Levy, also known as the Chirac Levy. Under this, multiple countries including France, Chile, South Korea, and Mauritius tax domestic and international flights and use the revenue to finance health programs in the Global South (Chirac Foundation, 2013).

One advantage of ticket taxes is that implementation is straightforward. They can be introduced quickly because they are collected at the point of purchase and are easy to integrate into existing ticketing systems.

REVENUE USE

Categories and examples

We categorize the revenue use from existing climate taxation policies into two types: general funds and revenue recycling, the latter including green spending and rebates. This follows Carl and Fedor (2016). General funds refers to revenues that are allocated to the government's general budget without being earmarked for specific climate-related programs. These are used at the discretion of the government for a wide range of things that may include non-environmental projects.

Under revenue recycling, green spending includes public investment and subsidies targeted at climate-related programs, including promoting the research, development, and deployment of energy-efficiency technologies, renewable energy, and low-carbon or carbon capture technology. It also encompasses efforts to reduce greenhouse gas emissions in sectors such as agriculture, forestry, landfill management, and transport, and measures to adapt to climate change such as international climate financing, development assistance, and labor retraining.

Rebates, which are also under revenue recycling, involve returning collected revenue to taxpayers. This can take several forms. For example, Denmark allocates the majority of its carbon tax revenue to the general government budget and uses it to reduce labor taxes (Carl and Fedor, 2016). Japan focuses on green spending: It uses all revenues from its Tax for Climate Change Mitigation to promote domestic low-carbon technologies and energy-efficient projects (Cao et al., 2024). In the European Union, Member States are required to spend 100% of the revenues they receive from the EU ETS on climate and energy-related purposes that range from research on clean technologies to renewable energy projects and international climate finance. Before being distributed to Member States, a portion of the revenue is allocated to EU-wide development programs (European Environment Agency, 2023).

Rebates can be an effective tool for addressing potential regressivity associated with climate pricing, as lower-income households tend to spend a larger share of their income on energy costs (Fremstad & Paul, 2019). They can take the form of flat payments or bill credits and are often implemented in conjunction with green spending initiatives. The Canadian province of British Columbia introduced North America's first broad-based carbon tax in 2008, and it was initially revenue-neutral, with all revenues returned to businesses and individuals through tax breaks or credits (Carbon Tax Center, n.d.). Since 2018, some revenue has been allocated to green investments, but rebates for vulnerable groups remain intact.

Under California's cap-and-trade program, a portion of the revenue is allocated to green spending and utility customers benefit from revenue recycling through bill credits or rebates (Legislative Analyst's Office, 2023). This dual approach supports both climate goals and the financial well-being of residents, with Assembly Bill No.1550 ensuring that disadvantaged communities receive at least 35% of the revenues (CalEPA, 2022). The Regional Greenhouse Gas Initiative is a cap-and-trade program among multiple U.S. states; in 2022, 21% of the proceeds used for revenue recycling were in the form of direct electricity bill assistance to consumers, and the majority of the funds went to energy efficiency and clean energy investments (Regional Greenhouse Gas Initiative, n.d.). Table 1 provides a summary of these examples along with the approximate carbon tax price.

Table 1
Revenue recycling examples

Example	Revenue allocation	Note	Approximate price (source)
EU Emissions Trading System	Green spending	Investments related to climate and energy	\$61/t CO_2e in 2024 (World Bank, n.d.)
British Columbia Carbon Tax	Rebates; green spending added in 2018	Tax breaks, credits, and green investments	\$44/t CO_2e in 2024 (Carbon Tax Center, n.d.)
California AB 32 cap-and-trade	Green spending; rebates	65% pre-allocated to green spending	\$22.21/t CO_2e in 2023 (floor price; Legislative Analyst's Office, 2023)
Regional Greenhouse Gas Initiative	Green spending; rebates	~ 71% in green spending, 21% direct bill assistance	\$7.35/t CO_2e in 2024 (Regional Greenhouse Gas Initiative, n.d.)

Green spending versus rebates

Surveys reviewed by Carl and Fedor (2016) showed that green subsides are more popular than rebates, likely because of perceptions of an environmental tax. If revenues go toward projects that reduce the impacts of climate change, people are more likely to see the tax as genuinely environmental. However, if revenue goes to general government spending or rebates, the tax may be perceived as just another broad fiscal instrument.

Tying green spending to specific projects with clear guidelines and accountability measures is important, and if not achieved, there is a risk that funds intended for environmental purposes could be misallocated or used ineffectively. A WWF report highlighted that while the EU ETS Directive lists spending for "climate and energy-related purposes," the descriptions for what would qualify are vague (WWF, 2021). For instance, revenues are often not earmarked for specific projects and the quality of reporting from Member States is low, making it difficult to assess compliance. It is also challenging to determine whether the spending represents additional climate actions or if Member States simply labeled already committed funds as ETS revenues to meet the requirements.

Green spending also primarily focuses on domestic development rather than international climate efforts. The EU ETS does not earmark any portion of revenues for international climate financing or development assistance. The WWF (2021) report found that only a small proportion of the total revenue—7.5% between 2013 and 2019—was allocated to international climate actions.

Note, too, that instead of addressing distributional effects, green spending often focuses on initiatives with broader, long-term benefits. Consequently, some countries opt for lower tax rates to minimize the economic impact. Revenue recycling can support a higher carbon tax rate while minimizing its cost burden on lower-income households.

The World Bank (2017) modeled the effective carbon rates needed to meet Paris Agreement goals and found rates would need to reach $40–$80 per tonne of CO_2 by 2020 and $50–$100 per tonne by 2030. These rates are substantially higher than many existing national carbon prices. Japan, the first Asian country to introduce a carbon tax, designed the tax with a low rate to minimize its economic impact. In 2012, the rate was set at ¥289 ($2.60) per tonne of CO_2 (Nakano & Yamagishi, 2021). Revenue recycling mechanisms that relieve burden on lower-income households can enable governments to introduce a higher tax rate while containing the economic impacts.

METHODOLOGY

To model the effect of different levy instruments on global commercial air travel, purchased plane tickets were grouped based on eight characteristics: distance, seating class, emissions per passenger (varied by seating class), average fare, annual flying frequency, trip purpose (business or leisure), the traveler's country of residence, and household income. The first four are attributes of the ticket, and the latter four are social attributes of the traveler. These characteristics are outlined in Table 2.

Table 2
Travel attributes and taxation potential

Associated with	Attributes	Potential target of taxation	Complexity to collect information[a]	Data source
Ticket	Distance	Yes	Low	GACA model
	Seating class	Yes	Low	GACA model
	Emissions	Yes	Medium	GACA model
	Fare	No	Low	RDC data
Traveler	Country of residence	No	Medium	Survey
	Flying frequency	Yes	High	Survey and modeling
	Household income	No	High	Survey
Both	**Purpose[b]**	**Maybe**	**High**	**Survey**

[a] Low = directly shown on booking confirmation; Medium = calculable/collectible without involving traveler; High = need to survey traveler.
[b] The "Both" category reflects how each itinerary, or purchased ticket, is associated with a specific purpose, and at the same time, an individual traveler can make multiple trips with different purposes.

Ticket attributes were quantified using the ICCT's Global Aviation Carbon Assessment (GACA) model and supplemented with 2019 economy-class fare data purchased from RDC Aviation Ltd. (n.d.). The premium-class fare is assumed to be 4x the economy-class fare, based on the Airline Origin and Destination Survey data from the U.S. Department of Transportation (2023). In 2020, the ICCT published a tank-to-wake carbon emissions inventory for each unique route-airline-aircraft combination of 2019 commercial aviation using the GACA model (Graver et al., 2020). The 2019 operations closely resemble those in 2023, as global passenger air travel recovered from COVID-19 and reached 94% of 2019 total revenue passenger-km (IATA, 2023b).

The analysis year for this study is 2030. We assumed a global average annual traffic growth of 3% from 2024 to 2030 and an emissions intensity reduction of 18% in 2030 compared with 2019. These parameters are drawn from the Action Case of the ICCT's aviation decarbonization roadmap (Graver et al., 2022); a 6% SAF blending is modeled for 2031, largely consistent with the announced ICAO-level goal of achieving 5% emissions reduction from SAF on international flights by 2030 (ICAO, 2023). We assume that the routes flown do not change substantially between 2019 and 2030. The total number of passengers carried in 2030 is estimated to be 5.6 billion. Airfares were adjusted to reflect the 14% improvement in fuel efficiency compared with the 2019 level, and we assumed fuel cost was 24% of total operating cost (IATA, 2019). All fares were modeled in real 2019 U.S. dollars[2].

2 Fare data of 2019 commercial flights were purchased from RDC Aviation Ltd. (n.d.).

For each country, tickets sold in 2019 were categorized into four groups: domestic economy, domestic premium, international economy, and international premium. Economy-class tickets include basic economy, regular economy, and premium economy. Premium-class tickets include both business class and first class. The average carbon emissions per passenger for each group was calculated using the GACA model, which allocates total flight emissions to different seating classes based on the floor area of each seat. Premium-class seating was estimated to be 2.6 to 4.3 times more carbon intensive than economy class seating, depending on aircraft class.

The average emissions would be closer to real-world emissions if the tickets were categorized by distance bands (regional, short-, medium-, and long-haul), as carbon intensities are similar within each band, but the granularity of the activity survey data does not enable modeling on the level of distance band. Instead, we used domestic versus international as a proxy for distance, and that also allows an assessment of domestic versus global policies. The traveler attributes were assigned based on the statistical modeling of flying frequency based on income described in Zheng and Rutherford (2022), and 2019 Global Passenger Survey data (IATA, n.d.).

The statistical modeling estimates the average number of flights taken by each income decile of each country (World Inequality Database, n.d.), based on income elasticity of air travel (Zheng & Rutherford, 2022). Populations within each income decile were then assigned to different flying frequency bins by assuming a normal distribution of flying frequency around the mean. The modeled results were validated against publicly available traveler surveys from 24 countries, including most of the 10 largest aviation markets in the world. For countries with income-bracket travel survey data, the curve of cumulative flights versus cumulative population from modeling closely aligns with the survey. For countries with flying frequency surveys, the modeled distribution of flying frequency among population closely aligns. Details are in the appendices of Zheng and Rutherford (2022).

To align with the analysis year of 2030, we projected each country's population to 2030 by assuming a global population of 8.5 billion, per the United Nations (2023). We assumed an annual per capita income growth rate of 2.8% to 2030, based on projections by the International Monetary Fund (2024).

The IATA Global Passenger Survey data includes responses from 11,000 unique travelers who took at least one flight in 2019. Travel behavior and socio-economic data were collected through the survey, including the number of leisure and business trips, typical seating class, destination type (domestic or international), total airfare expense, annual household income, and country of residence. As many survey respondents were frequent flyers, the survey was used to validate the distribution of flying frequency within income brackets in the statistical model and not used to estimate number of flights taken by a population group. Survey data processing and validation details are in Appendix A.

TICKET CATEGORIZATION

Based on the statistical modeling, tickets purchased in 2019 were assigned to unique country-income-frequency groups. Infrequent flyers are defined here as those who took one or two flights, occasional flyers took between three and six flights, frequent flyers took more than six flights, and super flyers took more than 20 flights.

Using survey data, the tickets in each group were then further broken down by business or leisure purposes, domestic or international destination, and economy or premium seating class. Survey responses of each country income group, as defined by the World Bank (n.d.), were divided into income brackets and frequency bands to calculate the share of tickets that fall into each purpose-domestic/international-seat segment within each group. The share was then applied to the total number of flights assigned to each group by statistical modeling. The domestic-to-international flight ratios and economy-to-premium ratios for each country were calculated based on inventory data, to facilitate assigning the responses that selected "mixed" for destination type or seating class.

After the ticket assignment, the distribution of each country's tickets between domestic and international flights were calibrated so that the total number of economy-domestic, premium-domestic, economy-international, and premium-international tickets matched the inventory data. This step was taken to ensure that the data aligns with real-world flight operations while still preserving the distribution of tickets by social attributes.

Table 3 shows the outcome of the ticket categorization process using high-income Australian frequent flyers as an example. The same type of breakdown was conducted for all other country-income-flying frequency groupings.

Table 3
Distribution of tickets for trips taken by high-income, frequent flyers residing in Australia

Purpose	Domestic/ international	Seat class	Tickets (million)	Average flight distance (km)	Average fare (US$)	Avg elasticity[a]
Leisure	Domestic	Economy	21	854	111	-0.94
		Premium	0.6		445	-0.47
	International	Economy	6.3	5,420	258	-0.73
		Premium	1.1		1,032	-0.24
Business	Domestic	Economy	13	854	111	-0.67
		Premium	0.4		445	-0.34
	International	Economy	4.0	5,420	258	-0.28
		Premium	0.7		1,032	-0.09
Total			**47**	—	—	—

[a] Values from InterVISTAS (2007).

DEMAND AND EMISSIONS

The increase in ticket price was calculated first (Equation 1) and then translated into demand response and emissions reduction. An aviation fuel tax increases fuel costs for airlines, while ticket levies are in most cases directly added to the airfare paid by consumers. All calculations were conducted on the segment level; segment is defined by unique combinations of country of residence, household income, flying frequency category, destination type, seating class, and trip purpose.

$$\text{Change in ticket price (\%)} = \text{climate levy per ticket (\$)} / \text{segment-average fare (\$)} \quad (1)$$

Travel demand elasticities to price change were obtained from a meta-analysis (InterVISTAS, 2007) and the elasticities vary based on market, short haul versus long haul, trip purpose, seat class, and household income. While the first three factors are extensively studied and summarized in the InterVISTAS report, the variations of price elasticity by household income are not included there or in any other available literature. As demand for air travel correlates with income (Gallet & Doucouliagos, 2014), we modeled less elastic demand (i.e., lower price sensitivity) from premium class travelers and higher-income travelers using adjustment factors. An adjustment factor of 0.8 was applied to the average elasticity for a trip segment for high-income travelers, and factors of 1.1 and 1.2 were applied to mid-income and low-income travelers, respectively. These adjustment factors are based on how much the upper and lower bounds of elasticities vary from the median elasticity, as summarized in the InterVISTAS report, and serve as proxies for how much demand elasticities of different travelers within the same distance-purpose segment can vary. Additionally, seating class elasticity adjustment factors of 0.5 for business class and 0.3 for first class were applied based on European data detailed in CE Delft (2019). Since all instruments modeled are global, elasticities for global-level price change are used rather than regional or route-level price changes. The global average elasticities are summarized below. An elasticity value of 0.6 means that a 10% increase in price would lead to a 6% decrease in demand, all other factors being held constant.

Table 4
Demand-to-price elasticities used for this study

Trip purpose	Seat class	Flight segment	Household income level[a]	Average elasticity
Business	Economy	Domestic	Low	-0.70
			Mid	-0.74
			High	-0.78
		International	Low	-0.33
			Mid	-0.35
			High	-0.36
	Premium	Domestic	Low	-0.35
			Mid	-0.37
			High	-0.39
		International	Low	-0.11
			Mid	-0.12
			High	-0.12
Leisure	Economy	Domestic	Low	-1.47
			Mid	-1.43
			High	-1.10
		International	Low	-1.27
			Mid	-1.22
			High	-0.93
	Premium	Domestic	Low	-0.74
			Mid	-0.71
			High	-0.55
		International	Low	-0.42
			Mid	-0.41
			High	-0.31

Notes: Business travel's elasticities are higher for the high- and medium-income brackets. This is a function of the underlying route-group distributions; regions like Africa and Asia generally have lower elasticity than Europe and North America. The adjustment factor for income was only applied to leisure trips.
[a] Low-income is less than $20,000 annual income; mid-income is $20,000–$50,000 annually; and high-income is more than $50,000 annually.

For the aviation fuel tax only, a fuel cost pass-through rate of 75% was applied when calculating the change in ticket price; this assumes that airlines absorb 25% of fuel cost increases to remain competitive and pass the remaining 75% on to consumers (Albers et al., 2009; Koopmans & Lieshout, 2016; Wang et al., 2017). For ticket levies, Wozny (2024) observed an immediate and full pass-through from airlines to consumers. The calculation of demand response calculation for each segment is summarized in Equation 2.

Change in number of tickets purchased (%) = % change in ticket price * demand elasticity (2)

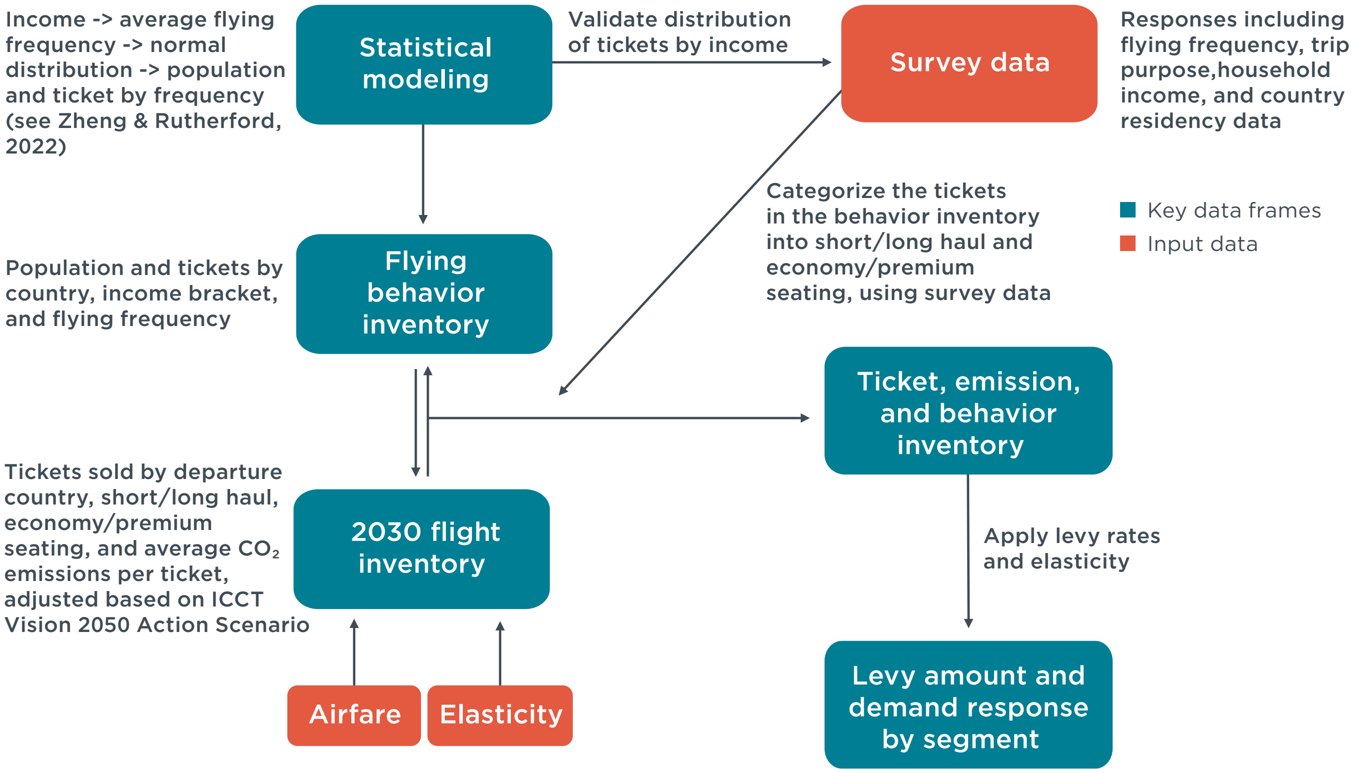
Lastly, the reduction in demand was translated into the reduction in emissions using Equation 3.

Emissions reduction (t CO_2) = total number of passengers in a year (in absence of a climate tax) × change in tickets purchased (%) × segment-average per-passenger flight CO_2 emissions (t CO_2) (3)

We assume that the decrease in emissions is proportional to the decrease in the number of passengers because airlines need to achieve a breakeven load factor on a given route to maintain profitability (IATA, 2020b). Therefore, when the number of passengers on a route decreases significantly, airlines would operate fewer flights to maintain a profitable load factor.[3]

The calculations above are summarized into a high-level modeling framework in Figure 1.

Figure 1
High-level modeling framework for this study



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

3 A reduction in passenger flights is likely to lower the capacity of belly cargo transport and therefore lead to an increase in dedicated freighter flights. This effect is not modeled, as this study focuses on passenger transport.

LEVY DESIGN

Zheng (2023) estimated that, of the $4 trillion of net investment needed for net-zero international aviation between 2020 and 2050, government spending could cover about $0.8 to $1.4 trillion, and about $3 trillion could come from industry investments through the price effects of a fuel tax or carbon price. Counting domestic operations, which account for about 40% of all aviation activity, net-zero aviation requires about $6.5 trillion in net investment, with at least $5 trillion coming from the industry.4 The industry's investment needs increase gradually from an average of $30 billion a year between 2026 and 2030 to an average of over $450 billion a year between 2045 and 2050 This is because net-zero technologies take time to mature and scale.

The split of government and private investment assumes that governments subsidize emerging technologies until commercialization and gradually shift the cost burden for mature technologies to the private sector.[5] Aviation is a special case in the sense that SAF is unlikely to ever reach cost parity with fossil jet fuel, and a large amount of financing (in this case from tax revenues) would be needed even in later years, if there is a desire to bridge the price differential.

The total levy amount of each instrument analyzed in this study was calibrated to sum up to $100 billion a year, which is the assumed average annual industry investment between 2026 and 2040. The four core levy types described in detail below were modeled, and two additional levy designs, a ticket levy with rebate and a luxury aviation levy, were analyzed to investigate if distributional effects similar to a frequent flying levy or an air miles levy can be achieved with fewer implementation challenges. We do not discuss the case of a flat ticket levy but, for reference, a flat levy of $18 would be required to raise the desired revenue.

The revenues generated from each instrument would be affected by the decrease in ticket sales as a response to higher prices. Wherever revenues are presented in this paper, they are the estimated final revenue after taking into account the demand response.

The modeled levy instruments were only applied to passenger operations, as that is the focus of ticket levies. It would be reasonable to apply a fuel tax or carbon tax to freight operations, as well, and these accounted for 15% of the global commercial aviation emissions in 2019 (Graver et al., 2020). The potential revenues from a fuel or carbon tax would increase accordingly.

While the global implementation of these levies is the focus of this study, we also modeled potential coalitions-of-the-willing that could introduce an aviation climate levy for all departing flights from member states or all flights within member states. The coalitions considered are existing economic forums—G7, G20, and the Organization for Economic Co-operation and Development (OECD)—and a geographic coalition of the transatlantic market.

4 The International Civil Aviation Organization modeled the decarbonization cost for international aviation in detail, as that is their regulatory purview, and it provided broad estimates for how the cost scales when including domestic aviation. See Appendix 1 in Zheng (2023) for an explanation of the calculation of the global decarbonization cost using ICAO estimations. The modeled government spending does not scale accordingly, as the investments in maturing technologies and infrastructure for international flights are assumed to benefit domestic flights at the same time.

5 The private sector may underinvest in new technologies due to the knowledge spillover effect and uncertainty of return. The spillover effect refers to how innovation by one company tends to benefit other companies without receiving proper return, leading to suboptimal levels of innovation. Targeted policy support is therefore needed to spur innovation.

Air passenger duty

This instrument is modeled after the air passenger duty in the United Kingdom (HM Revenue & Customs, 2024), which varies by flight distance and seating class. For this study, we used a base rate and multipliers for international flights and premium class tickets to mimic the stratification of the UK air passenger duty while matching the data granularity of our modeling. The base levy is $10 per ticket, with a 2.5x multiplier for long-haul flights (longer than 1,500 km) and a 3x multiplier for first and business class tickets. The two multipliers stack on top of each other, so that an international business class ticket would be assessed a tax of $75.

Aviation fuel tax

Global flights modeled in this study burned about 227 million tonnes (Mt) of conventional jet fuel and emitted an estimated 752 Mt of CO_2, including emissions from SAF. A fuel tax of $0.35 per liter, or a carbon price of $140 per tonne, to reach $100 billion in a year, was modeled. The tax is applied to a base jet fuel price of $0.6 per liter. Sensitivities of the results to airlines' rate of passing increased fuel costs to consumers were also analyzed. This fuel tax is higher than the existing carbon prices in policies such as the EU ETS and the Canadian Carbon Pricing System. The modeled fuel tax is not applied to SAFs blended into the system. Similarly, a near-term aviation carbon price would likely exempt SAFs to encourage its adoption, even though their life-cycle carbon emissions are not zero. Emissions trading systems were not modeled separately; when no free allowances are issued, the function of an ETS is identical to that of a carbon tax.

Frequent flying levy

A frequent flying levy is a tax that escalates as a traveler takes more flights throughout the year. In most of the existing proposals, the policy exempts the first one or two flights and linearly increases with each subsequent flight. The exemption builds on the assumption that if only one roundtrip is made in a year, it is likely to be essential or made by travelers with limited financial resources. Implementing such escalating rates requires a database of flying frequency with a real-time link to ticket price at point of purchase. The complexity of information collection and privacy concerns both pose serious implementation challenges. This study assumes the frequent flying levy would be charged at the end of the year, when a person's total number of flights are known. Each traveler would be charged the average/effective levy per flight times the total number of flights. A long-haul multiplier of 2.5x is also applied in this case.

Table 5
Modeled frequent flying levy rates

Flying frequency	Frequent flying levy rate	
	US$ per ticket (short/long haul)	Average annual US$ per passenger
Infrequent flyer (1–2 flights a year)	0	
Occasional flyer (3–6 flights a year)	9/22	55
Frequent flyer (7–19 flights a year)	18/44	279
Super flyer (20 or more flights a year)	27/68	1,338

Air miles levy

To enable comparison with a frequent flying levy, the first 5,000 km of flying in a year is fully exempt from the air miles levy modeled in this study. The air miles levy rate starts at $0.011 per km for travelers who fly 5,000–10,000 km a year and then increases with subsequent mileage bands. Both the frequent flying levy and the air miles levy were modeled assuming the total number of flights or mileage in a year is already known, and the effective levy rate is applied onto each flight or kilometer. This approach would exert the same total levy amount as per-flight or per-kilometer escalating levy schedules but simplifies the modeling and the potential implementation. The method was first used in an earlier ICCT study (Zheng, 2024).

Table 6
Air miles levy rates modeled

Activity bands	Air miles levy rate	
	Rate per km	Average annual cost per passenger
Less than 5,000 km a year	$0	$0
5,000 to 9,999 km a year	$0.011	$74
10,000 to 49,999 km a year	$0.017	$302
More than 50,000 km a year	$0.025	1,761

Ticket levy with rebate

We modeled an air passenger duty with rebates equivalent to the base levy of two tickets. Through this design, those who fly infrequently would pay no or minimal net cost under the levy, depending on whether they took short-haul or long-haul flights. The only information that needs to be collected is whether a taxpayer flew at least once in the past year, and that could be proved to tax agencies via a receipt in the event of an audit. Sensitivities of results to the perceived levy amount (i.e., whether a consumer takes into account the rebates that will come later) were also analyzed. However, the flat levy rate would need to be higher, $20 per ticket, to sum up to the same $100 billion total as a regular air passenger duty without rebates.

This levy also differs from other instruments in terms of modeling. The rebates can only be modeled at the country-income-flying frequency level, and not the purpose-destination-seating level, as the latter is not unique to individuals; only a breakdown of all tickets in the same country-income-flying frequency grouping is possible.

Luxury aviation levy

A luxury aviation tax was proposed in the United States in 2023 to charge both private jet fuel uptake and commercial first class and business class ticket booking (AIR FAIR Act, 2023). This study analyzes only commercial air travel, and the luxury aviation levy modeled is a flat charge on premium class tickets.6 If $100 billion of revenue were to be raised from a luxury aviation levy, the levy rate would need to be extremely high compared with other instruments analyzed in this report, at $360 for each ticket in first class or business class. Therefore, we modeled a 9x multiplier on a purely flat ticket tax for all premium-class tickets, at $165, and half of the flat tax for all economy-class tickets, at $9. These rates add up to $95 billion a year, and we assume that the remaining $5 billion could be collected in the form of a private jet tax. Sensitivities of results to the cross elasticity of premium and economy class air travel were also analyzed.

6 The potential for consumers to shift to a lower seating class in response to a luxury aviation levy has not been well studied and is thus not modeled here. The demand response to a luxury aviation levy may be overestimated for this reason.

RESULTS

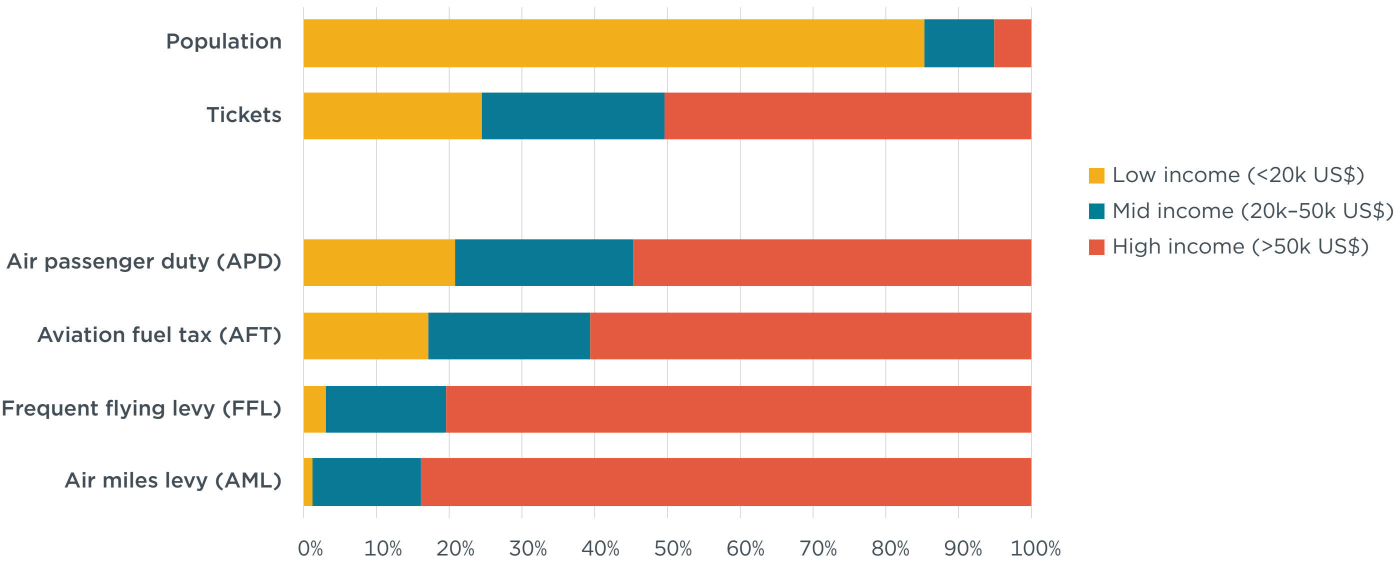
To understand the distribution of the source of tax revenues, the results were broken down by household income, flying frequency, resident country development status, trip purpose, and ticket attributes (destination type and seating class).7 The distribution of demand and emissions response was also analyzed, and we compare the four core levy types based on efficiency, equity, and logistical complexity, each of which is defined below. We conclude with analyses of alternative levy designs that can potentially combine the strengths of the four core levy types.

GLOBAL TRENDS

The vast majority (85%) of world's population earns less than $20,000 a year and falls into the category of low-income households in this study. The low-income group would shoulder 17%–21% of the tax burden under global taxation policies such as an air passenger duty and an aviation fuel tax but would have minimal (1%–2%) exposure to a frequent flying levy or an air miles levy because low-income households are typically not frequent fliers (Figure 2).

High-income households with an annual income greater than $50,000 make up only 5% of the world's population and are responsible for 61% of the passenger air travel CO_2 emissions and associated carbon charges. The use of a frequent flying levy or an air miles levy would concentrate the burden on these households, at 80% and 84% of total levy charges, respectively. An air miles levy would shift about $30 billion more, or 30% of the total levy burden, from low- and mid- income households to high-income households compared with an air passenger duty.

Figure 2
Share of population and levy burden by household income levels



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

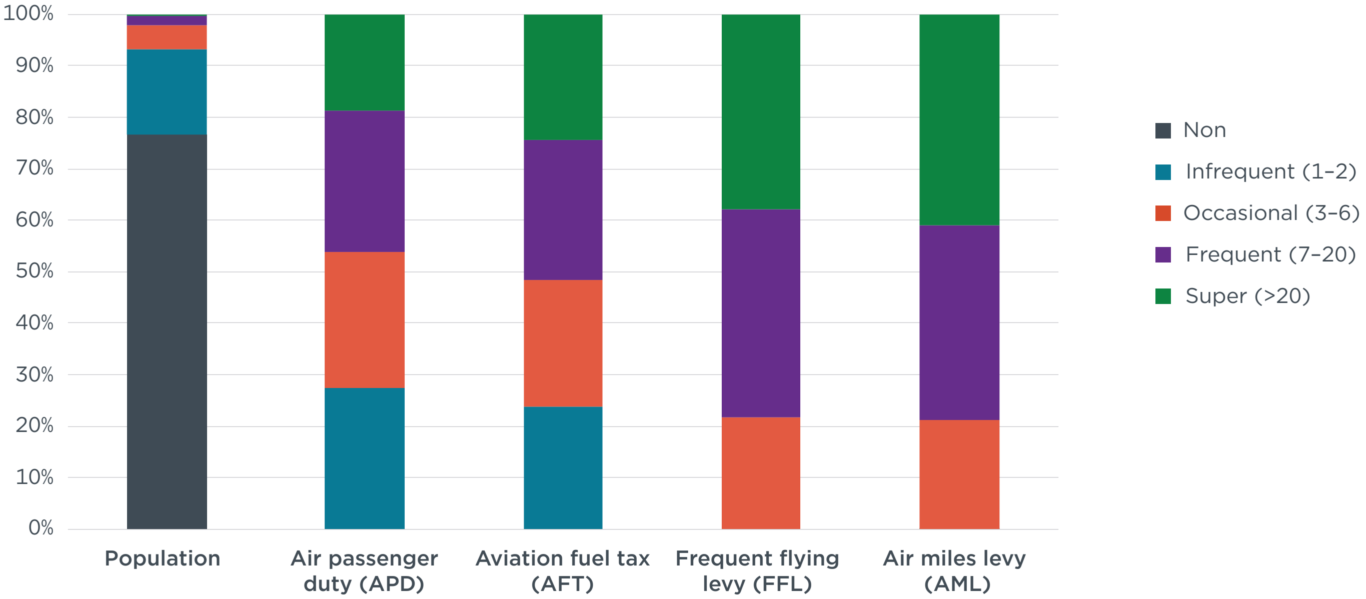
The concentration of levy burden by annual flying frequency is even more pronounced, as at least 77% of the world's population is estimated to take zero flights per year. For an air passenger duty and an aviation fuel tax, the shares are fairly even across frequency categories even though frequent flyers and super flyers are only a small

7 Carbon price results represent both share of emissions and share of tax burden, and air passenger duty results closely resemble the distribution of tickets.

subset of global population, 2% and 0.3%, respectively. Super flyers' share of a frequent flying levy and an air miles levy are larger as a proportion of their population share: 41% of the air miles levy burden could be concentrated on 0.3% of the population (Figure 3). For infrequent and occasional flyers, the levy burden would decrease from over half in the case of an air passenger duty and an aviation fuel tax to only 22% under a frequent flying levy and 21% under an air miles levy.

Figure 3

Share of population and levy burden by flying frequency categories (measured by number of flights in a year)

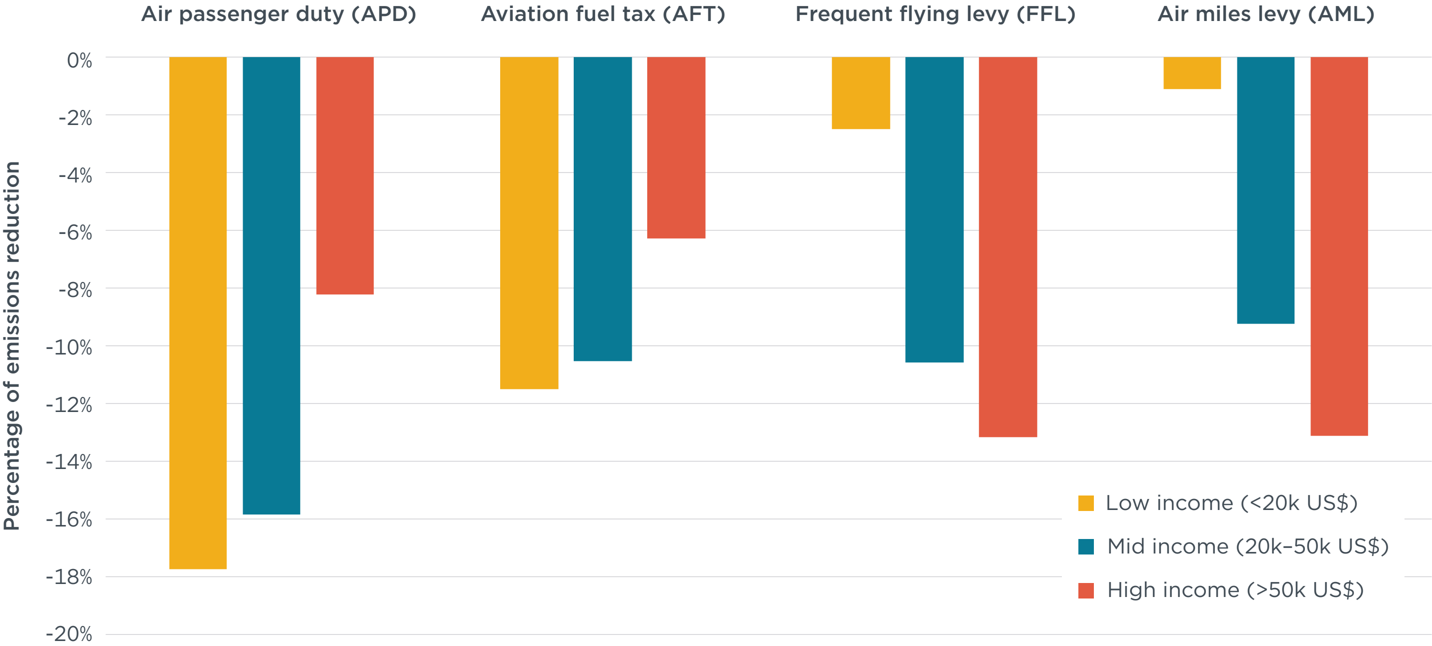


THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

While all instruments are modeled to incur $100 billion of levy burden and generate about $90 billion in revenue each year, the demand response and emission reductions vary greatly (Figure 4). An aviation fuel tax is the only instrument that directly affects airline operating costs, and some of the cost increase is expected to be absorbed as reduced profits rather than a ticket price increase; its demand impact would therefore be somewhat mediated. Total emission reductions under the modeled $0.35/liter aviation fuel tax would be 62 Mt CO_2 (8% of global total), while air passenger duty would reduce 88 Mt (12% of global total).

Emission reductions from a frequent flying levy and an air miles levy are 77 and 81 Mt, respectively, both less than from the air passenger duty. The concentration of the frequent flying and air miles levies on less price-sensitive, high-income households dampens the overall demand and emissions response. This feature helps protect trips made by lower-income, infrequent flyers, whose one or two trips per year would have been more costly under an air passenger duty and an aviation fuel tax.

Figure 4
CO_2 emissions change by instrument and household income category



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

Another distinction in the demand and emissions response lies between business and leisure travelers, as the former are less sensitive to price change and tend to fly premium class more often. An aviation fuel tax is estimated to trigger a 10% reduction in leisure trips but only a 5% reduction in business trips (Table 7). An air miles levy, which concentrates levy burden on high-mileage individuals, could help neutralize this effect, with both business and leisure demand projected to drop by 11%. For business travel, both the levy burden and the magnitude of demand change under an air miles levy are almost 1.5 times those of an aviation fuel tax. However, due to the amount of leisure travel (79% of all tickets purchased), leisure travel is still most of the reduced flights.

Table 7
Breakdown of tickets, aviation fuel tax (AFT), and air miles levy (AML) by trip purpose

Trip purpose	Tickets (million)		Total AFT (billion US$)		AFT demand change (million reduced flights)		Total AML (billion US$)		AML demand change (million reduced flights)	
	Value	%	Value	%	Value	%	Value	%	Value	%
Business	1,195	21%	25	25%	(56)	-5%	36	36%	(132)	-11%
Leisure	4,450	79%	75	75%	(444)	-10%	64	64%	(468)	-11%
Total	**5,645**	**100%**	**100**	**100%**	**(500)**	**-9%**	**100**	**100%**	**(600)**	**-11%**

Table 8 compares the different levy instruments based on the criteria of efficiency, equity, and complexity. Efficiency is measured by holding either total levy revenues constant at US$100 billion, or emission reduction constant at 30% from 2019 global total carbon emissions. The access metric quantifies the amount of air travel activity that would be avoided as a response to higher ticket price due to taxation. Complexity is ranked based on the level of information collection required. Green shadings denote the top-performing instrument by each metric, and red shadings mark where equity or complexity may be a serious limitation of an instrument. The rest are yellow shadings, which denote average performance.

When total revenue is held constant across levies, an air passenger levy reduces emissions the most, as it is directly imposed on tickets and may increase ticket price for shorter flights more noticeably than an aviation fuel tax, which generally scales with distance. On the other hand, an aviation fuel tax would raise the most amount of revenue if the demand impact is held constant under a 0.75 cost pass-through rate. If airlines do not absorb any of the cost increase, an air miles levy would have advantages in generating revenue compared with an aviation fuel tax. Neither a frequent flying levy nor an air miles levy would be the leading instrument if the goal is to maximize emission reductions.

When considering equity, we see that the more efficient policies could unduly burden lower-income, less frequent flyers, as exemplified by the emissions response shown in Figure 3. An air passenger duty would impose the highest tax burden on low- and middle- income households, while an air miles levy appears to be the most equitable design of the four primary types. Higher tax burden also translates into more flights reduced by lower-income travelers, raising the concern of pricing individuals out of crucial travel.

Given the strengths and limitations of the four primary instruments, we investigated two alternative levy designs that could better balance efficiency, equity, and complexity. The principal objectives were to add equity safeguards to the more efficient instruments (air passenger duty and aviation fuel tax) and reduce implementation complexity of the more equitable instruments (frequent flying levy and air miles levy). The result was a ticket levy with rebate and a luxury aviation levy, both described above. The distribution of levy burden and emissions reduction by income brackets with all six levy instruments is in Appendix C.

Table 8
Summary of efficiency, equity, and implementation complexity of six levy types

Policy	Efficiency		Equity: Impact on low- and middle-income population		Complexity
	Emission (million tonnes)	Revenue (billion US$ per year)	Burden (share of total)	Access (million flights)	
Air passenger duty	-88	85	45%	-505	Low
Aviation fuel tax[a]	-62 to -82	91 to 121	39%	-296 to -395	Medium
Luxury aviation tax[b]	-50 to -59	126 to 149	33%	-335 to -343	Low
Ticket levy with rebates[c]	-75 to -91	82 to 99	21%–28%	-214 to -260	Medium
Frequent flying levy	-82	91	20%	-146	High
Air miles levy	-77	96	16%	-147	High

[a] The range of values for an aviation fuel tax depends on whether the cost pass-through rate is 0.75 or 1.
[b] The range is defined by whether seat class substitution occurs. For the substitution case, 50% of business travel and 25% of leisure travel in premium class are substituted by economy class.
[c] The range is defined by the assumed demand response (full versus dampened by rebate).

Both the ticket levy with rebates and the luxury aviation levy reduce lower-income households' share of levy burden compared with an air passenger duty and an aviation fuel tax (Table 8). They also lead to lower demand and emissions response compared with an air passenger duty, but for different reasons. The rebates under a ticket levy with rebates would theoretically zero out the burden on infrequent flyers and reduce the tax burden of the first two flights for all others. The 9x rate on premium-class booking under a luxury aviation tax affects a very small number of people who generally have low demand elasticity to price change. Both options are much easier to implement than a frequent flying levy and an air miles levy, especially a luxury aviation tax.

A luxury aviation tax that targets the demand-inelastic premium seating travelers is the least efficient as an emissions-reduction lever. However, it could generate more revenue than any other, if all instruments were to incur the same amount of emissions reduction. It corrects some of the disproportional equity impacts of an air passenger duty or an aviation fuel tax, as the economy-class levy rates are lower under a luxury aviation tax, but it does not differentiate rates based on flying frequency.

The results for a ticket levy with rebates are sensitive to consumers' perception of the effective tax rate (i.e., whether they take rebates into account when paying the levies upfront). We modeled a dampened demand case where a reduction in levy burden for two flights in a year is mostly perceived (90%) for infrequent flyers, somewhat perceived by occasional (70%) and frequent (40%) flyers, and completely ignored by super flyers. The emissions reduction and demand response would increase by about 20% under these assumptions and increase low- and middle-income households' share of the tax burden from 21% to 28%. Nevertheless, a ticket levy with rebates would still be more equitable than an air passenger duty, an aviation fuel tax, and a luxury aviation tax. If the rebates are not fully considered during ticket purchase, it would raise less revenue.

There is also a noticeable tradeoff between equity and complexity. Both a frequent flying levy and an air miles levy require timely collection and accurate accounting of travel behavior data that are not currently being done. National governments and airlines are limited in their ability to collect frequency and mileage data for all passengers, and complex coordination and robust privacy safeguards would need to be in place. An air passenger duty and an aviation fuel tax are easier to implement.

TRENDS BY SEGMENT AND COUNTRY

To determine segment and country trends, we first analyzed the ability of a levy instrument to raise revenues from international flights. If the revenues were to be earmarked for assisting least developed countries and small island states with climate adaptation or recovery from climate-related loss and damage, it makes sense to only tax international flights. As shown in Table 9Table 9, the instruments that best correlate with distance, the aviation fuel tax and air miles levy, raise more of their revenues from international flights (67% and 64%, respectively), while the ticket-based air passenger duty and frequent flying levy raised 61% and 62%, respectively, of revenue from such flights. Although the frequency of domestic flights is higher than that of international flights, the 2.5x multiplier for international flights included in the ticket taxes boosts the revenue collected.

While all four instruments analyzed shift costs toward premium-class traveling to some extent, an aviation fuel tax would raise a higher share of revenue from premium-class tickets on international flights than others, as a result of accurately accounting for per-passenger emissions by seat class.

Table 9

Share of total tickets and levy by destination type and seating class, and changes relative to ticket distribution

Segment	Share of tickets	Share of revenue			
		Air passenger duty	Aviation fuel tax	Frequent flying levy	Air miles levy
Domestic	60%	38% (-22%)	33% (-27%)	39% (-21%)	36% (-24%)
Economy	58%	34% (-24%)	28% (-30%)	36% (-22%)	34% (-24%)
Premium	2%	4% (+2%)	5% (+3%)	3% (+0.4%)	3% (+0.5%)
International	40%	62% (+22%)	67% (+27%)	61% (+21%)	64% (+24%)
Economy	37%	51% (+13%)	49% (+12%)	54% (+17%)	56% (+19%)
Premium	3%	11% (+9%)	18% (+16%)	7% (+4%)	8% (+5%)
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Patterns emerge when tallying levy revenues by the top 10 aviation markets (Table 10Table 10), after taking into account revenue loss due to demand reduction. The total levy amount applied to these 10 countries ranges from $52 to $59 billion a year, which is more than half of the global total, and does not vary greatly among instruments. However, there are distinctly different results for China and the United States. That the revenue from U.S. residents increases from $16 billion under an air passenger duty to $28 billion under an air miles levy highlights the large presence of frequent flyers and international travelers in the United States; the difference also reflects a shift of 13% of the levy burden away from other countries toward the United States. Levy revenue raised from China's population, meanwhile, decreases from $11 billion under an air passenger duty to $6 billion under a frequent flying levy. This can also be observed for India. A breakdown by country income groups is in Appendix B.

Table 10

Estimated revenue raised for top 10 aviation markets under different levy instruments

Country	Air passenger duty		Aviation fuel tax		Frequent flying levy		Air miles levy	
	Revenue (billion US$)	Share of global total	Revenue (billion US$)	Share of global total	Revenue (billion US$)	Share of global total	Revenue (billion US$)	Share of global total
United States	16	19%	23	25%	20	23%	28	32%
China	11	13%	10	11%	6	7%	8	9%
United Kingdom	6	7%	6	6%	8	10%	8	9%
Germany	5	6%	4	4%	5	6%	4	4%
Russia	3	3%	3	3%	2	3%	2	3%
Australia	2	2%	3	3%	2	2%	3	4%
Japan	3	3%	3	3%	2	3%	2	2%
France	3	3%	2	3%	3	3%	2	2%
India	3	3%	2	3%	1	1%	1	1%
Brazil	2	2%	2	2%	2	2%	2	2%
Total	**52**	**61%**	**58**	**63%**	**52**	**60%**	**59**	**66%**

Note: Revenue varies across countries in part because of revenue loss due to demand reduction.

We also analyzed a case where a coalition of the willing implements an aviation climate levy, for either all departing flights from member countries or all flights in between the member countries (Table 11). The "flights within" scenario is particularly relevant for introducing a fuel tax or carbon tax, as those require changes to bilateral air service agreements, while a ticket tax can be applied on all departing flights unilaterally. No coalition version of a frequent flying levy or an air miles levy was modeled, because the accounting of flying frequency or annual cumulative mileage was conducted based on all flights.

Table 11
Potential revenue raised from potential coalitions of the willing

Coalition	Coverage	Potential revenue raised each instrument (billion US$ annually)			
		Air passenger duty	Aviation fuel tax	Luxury aviation levy	Ticket levy with rebate
G7	All departing flights	38	42	39	43
	Flights within	21	24	26	24
G20	All departing flights	64	71	66	64
	Flights within	62	62	62	68
OECD	All departing flights	51	56	52	58
	Flights within	37	38	44	42
Transatlantic[a]	All departing flights	42	46	43	49
	Flights within	30	28	37	34

Note: Revenue varies across countries in part because of revenue loss due to demand reduction.
[a] Our hypothetical transatlantic coalition includes member states of the European Economic Area (EEA), Switzerland, Canada, the United States, and Mexico.

A coalition of G20 countries could raise the most revenue under both coverage scenarios, as it includes almost all the largest aviation markets in the world. An aviation fuel tax applied to all flights departing G20 countries could generate the highest amount of revenue, $71 billion a year. G20 countries, however, are geographically scattered and face challenges related to emission leakages if neighboring countries do not have an aviation climate levy in place. If applied to all departing flights, OECD totals come close to those of the G20 case.

A transatlantic coalition of North American and European countries could be very effective at raising revenues through a levy while minimizing the risk of leakage. An air passenger duty within the transatlantic coalition could raise $30 billion a year, and the coalition could raise even more with a luxury aviation levy or a ticket levy with rebate.

IMPLICATIONS FOR INDIVIDUAL TRAVELERS

The contrast between super flyers and infrequent flyers is extreme: a super flyer typically emits 40 times more than an infrequent flyer in a year. This is reflected in the average air passenger duty or aviation fuel tax a super flyer would need to pay, at $660–$870 a year compared with $17–$19 a year for an infrequent flyer. The average levy per flight, however, is the same for each group, as an air passenger duty and an aviation fuel tax only scale with the number of tickets purchased or the amount of emissions.

Under a frequent flying levy or air miles levy, there is a noticeable shift of cost from infrequent and occasional flyers to super flyers. The per-person levy amount increases to roughly $1,340 (frequent flying levy) and $1,450 (air miles levy) annually for super flyers and averages $43 (frequent flying levy) and $47 (air miles levy) per ticket. Occasional flyers, meanwhile, would only pay half the levy amount compared with the air passenger duty and aviation fuel tax scenarios. The average cost for frequent flyers does not vary as much by instrument.

Table 12
Average activity, emissions, and levy amount per person by flying frequency category

Flying frequency category	Average flights per year	Average mileage (km)	Average emissions (tonnes)	Air passenger duty		Aviation fuel tax		Frequent flying levy		Air miles levy	
				Average levy (US$)	Share of income	Average levy (US$)	Share of income	Average levy (US$)	Share of income	Average levy (US$)	Share of income
Infrequent	1	1,812	0.1	19	0.1%	17	0.1%	0	0.0%	0	0.0%
Occasional	4	6,047	0.5	68	0.1%	63	0.1%	55	0.1%	54	0.1%
Frequent	10	15,697	1	189	0.2%	188	0.2%	279	0.2%	261	0.2%
Super	31	61,781	6	662	0.2%	867	0.2%	1,338	0.4%	1,452	0.4%

Notably, the levy burden's share of household income shows that all instruments, even an air passenger duty or an aviation fuel tax, are considered progressive taxes. This is due to aviation's nature as a luxury good; the spending positively correlates with income. The more complex instruments, such as a frequent flying levy or an air miles levy, further differentiate the levy burden as a share of income: Infrequent flyers are completely exempt and super flyers shoulder double the burden.

CONCLUSIONS

An aviation climate levy can help tackle climate change in a variety of ways, including by moderating air travel demand, incentivizing or directly supporting zero-emission technologies, and financing climate change adaptation and damage-control measures in vulnerable communities. As both the contribution to historical emissions and the susceptibility to climate change-related damages are highly uneven, it is important to consider the distributional effects of such a levy, regardless of whether the purpose of the levy is to reduce emissions or to raise revenue.

We assessed levy collection by examining the distribution of tax burden by income level and flying frequency and found that **an air miles levy most equitably distributes the cost burden of aviation climate taxation**; super flyers who take more than 20 flights a year would pay $41 billion, or 41% of the global total, and high-income households would shoulder 84% of the total. Results show that aviation fuel taxes and air passenger duties are also progressive, as flying frequency highly correlates with wealth. **An air passenger duty with distance and seating class multipliers is similar to a fuel tax**; the only major difference is that an air passenger duty would likely result in higher demand cuts, as the duties are directly imposed on travelers rather than airlines.

Another key metric of distributional effects is the impact on air travel demand, as an equitable distribution of tax burden would shift demand impacts away from price-sensitive infrequent travelers. When raising the same amount of total revenue, we found comparable demand reductions from an aviation fuel tax as we did from a frequent flying levy and an air miles levy, but only the frequent flying levy and air miles levy concentrate the impact on high-income and frequent flyers. The demand impact on low-income households (earning less than $20,000 a year) is estimated to be less than 1% reduction in ticket purchase, compared with a 19% reduction under an aviation fuel tax.

Most infrequent flyers are traveling for leisure rather than business, and leisure travel demand is more elastic to price change than business travel. Under uniformly applied instruments like an air passenger duty and an aviation fuel tax, we found leisure travel demand would decrease twice as much as business travel. We also found that **instruments that exempt infrequent flying (the frequent flying levy, the ticket levy with rebate, and the air miles levy to an extent) would minimize the impact on once-a-year non-business trips.** Frequent business travel, on the other hand, correlates with frequent leisure travel (Rutherford, 2023). Despite the noticeable strengths of a frequent flying levy or an air miles levy, the flying frequency or mileage data required to implement such taxes are not readily available to governments. Policy proposals for a frequent flying levy have been made in the United Kingdom and the European Union, but difficulties with implementation have been cited as a key hindering factor to applying the levy.

We also modeled a ticket levy with rebates, where the equivalent of two flights' flat levy amount would be returned to each air passenger regardless of their overall flying frequency. **A ticket levy with rebates achieves similar distributional effects as a frequent flying levy or an air miles levy and would likely to be easier to implement.** Even though the distribution of rebates depends on self-reporting by taxpayers, it is much easier to audit whether a taxpayer has flown in a year than to verify the exact number of flights they have taken, such as would be necessary for a frequent flying levy or an air miles levy. As the rebates go through a national tax system, however, global implementation could be challenging.

A frequent flying levy or an air miles levy would be most suitable for raising funds for global climate finance, as these collect revenues mostly from wealthy, frequent flyers and can level out the demand impact on leisure versus business travel. However, these are complex, and a luxury aviation levy could be an efficient near-term option; it would be the easiest to implement and amplify the levy burden on premium-class tickets, which are typically booked by wealthy, frequent flyers. More details on the strengths, limitations, and suitable application of the six instruments are in the table below.

Table 13
Strengths, limitations, and applications by instrument

Instrument	Strengths	Limitations	Suitable application
Air passenger duty	• Easy to implement • Policy precedent • Emissions/demand reduction	• Burden on low-income/infrequent/leisure flyers	Demand management
Aviation fuel tax	• Directly tied to emissions • Revenue from international flights	• Burden on low-income/infrequent/leisure flyers • Smaller tax base as decarbonization progresses	Cross subsidy for zero-emission technologies
Ticket levy with rebates	• Easy to implement • Equitable (income)	• Inefficiency (need to rebate frequent flyers) • Perceived upfront tax rate is uncertain	Revenue generation (short term)
Luxury aviation levy	• Easy to implement	• Premium class tickets alone are very small tax base • Erosion of tax base due to seat class switching and complimentary upgrades	Revenue generation (short term)
Frequent flying levy	• Equitable (income, frequency, trip purpose)	• Complex to implement	Revenue generation (long term)
Air miles levy	• Equitable (income, frequency, trip purpose) • Revenue from international flights	• Complex data collection requirements	Revenue generation (long-term)

Each of these instruments could also be implemented regionally or with a coalition of the willing. **Geographically concentrated coalitions with some large aviation markets could be effective in raising substantial revenue while minimizing emissions leakage.** For instance, a transatlantic coalition formed by North American and European countries could raise half of the total global revenue modeled in this study with a levy applied to all departing flights.

FUTURE RESEARCH

The health and income impacts of a climate levy's distributional effects are worthy of investigation. While lower aviation carbon emissions reduce warming effects uniformly, improvement in airport air quality would benefit the underprivileged communities who live near airports more than others. The effect of an aviation climate levy on tourism-dependent, less developed countries would also be a key consideration in instrument choice and design, and exemptions could be introduced based on a set of standard criteria. It would also be helpful to quantitatively assess the equity implications of using levy revenues for income tax cuts versus green spending, especially considering that some national governments are using general fiscal budgets to provide SAF subsidies.

In terms of real-world policymaking, while this report models different levy instruments separately, it is possible to introduce multiple options at the same time. For example, one instrument could be implemented for reducing aviation emissions, and another could be dedicated to raising funds for climate finance for the Global South. Having domestic levies for aviation decarbonization and international levies for broader climate finance is one option. More policy analysis would be required to understand the implication of having multiple levies in place concurrently, especially if their tax bases overlap. Additionally, as aviation decarbonizes, the tax base for emissions-based levies could change significantly. We plan to conduct a follow-up study focusing on tax base and revenue projection.

Lastly, airlines implement complex pricing strategies to stimulate travel demand and maximize profits. They could distribute more of the increased fuel cost due to a fuel tax or carbon price onto frequent flyers and premium-class passengers who are less price sensitive. Business travel bookings would also be a natural place to place these increased costs. Airline economics research could help inform whether airline behavior would naturally distribute the impacts of a fuel tax or carbon price equitably among air travelers.

REFERENCES

AIR FAIR Act, S.2599, 118th Congress. (2023). https://www.congress.gov/bill/118th-congress/senate-bill/2599/text

Appunn, K., & Wettengel, J. (2024, May 23). Understanding the European Union's Emissions Trading System. *Clean Energy Wire.* https://www.cleanenergywire.org/factsheets/understanding-european-unions-emissions-trading-system#:~:text=As%20part%20of%20this%20reform,albeit%20slower%20than%20initially%20forecast.

Barrington, L., & Goh, B. (2024, February 19). Singapore to impose green fuel levy on flights from 2026. *Reuters*. https://www.reuters.com/sustainability/singapore-green-jet-fuel-levy-travellers-ignites-funding-debate-2024-02-19/

Brons, M., Pels, E., Nijkamp, P., & Rietveld, P. (2002). Price elasticities of demand for passenger air travel: a meta-analysis. *Journal of Air Transport Management*, *8*(3), 165-175. https://doi.org/10.1016/S0969-6997(01)00050-3

California Environmental Protection Agency. (2022). *California climate investments to benefit disadvantaged communities.* https://calepa.ca.gov/envjustice/ghginvest/

Cao, L., Toyohara, A., Li, Y., & Zhou, W. (2024). Willingness to pay for carbon tax in Japan. *Sustainable Production and Consumption, 52*, 427–444. https://doi.org/10.1016/j.spc.2024.11.004

Carbon Tax Center. (n.d.) Canada's federal carbon pricing program, accessed October 10, 2024. https://www.carbontax.org/where-carbon-is-taxed-overview/canada-british-columbia/

Carl, J., & Fedor, D. (2016). Tracking global carbon revenues: A survey of carbon taxes versus cap-and-trade in the real world. *Energy Policy, 96*, 50-77. https://doi.org/10.1016/j.enpol.2016.05.023

Carmichael, R. (2019). *Behaviour change, public engagement and net zero*. UK Committee on Climate Change. https://www.theccc.org.uk/publication/behaviour-change-public-engagement-and-net-zero-imperial-college-london/ https://www.theccc.org.uk/publication/behaviour-change-public-engagement-and-net-zero-imperial-college-london/

CE Delft. (2019). *Taxes in the field of aviation and their impact: Final report.* Publications Office of the European Union. https://data.europa.eu/doi/10.2832/913591

Chirac Foundation. (2013, September 27). *The Fondation Chirac applauds the increase in the solidarity contribution on airline tickets* [Press release]. https://web.archive.org/web/20150924014311/http:/www.fondationchirac.eu/en/2013/09/the-fondation-chirac-applauds-the-increase-in-the-solidarity-contribution-on-airline-tickets/

Dama A-A., Dequiedt V., de Ubeda A-A., & Rota-Graziosi G. (2023). *Taxation of civil aviation fuels as a source of financing for vulnerable countries*. Foundation for Studies and Research on International Development. https://ferdi.fr/en/publications/taxation-of-civil-aviation-fuels-as-a-source-of-financing-for-vulnerable-countries

European Commission. (n.d.-a) *Excise taxes*, accessed December 17, 2024. https://taxation-customs.ec.europa.eu/taxation/excise-duties_en

European Commission. (n.d.-b) *Allocation to the aviation sector*, accessed December 17, 2024. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/allocation-aviation-sector_en

European Commission. (2023). *ETS allowances for SAF.* https://climate.ec.europa.eu/document/download/9a82627a-8a5c-4419-93de-e5ed2d6248eb_en?filename=policy_ets_allowances_for_saf_en.pdf&prefLang=hu

European Environment Agency. (2023, December 19). *Use of auctioning revenues generated under the EU Emissions Trading System*. https://www.eea.europa.eu/en/analysis/indicators/use-of-auctioning-revenues-generated

FCC Aviation. (n.d.). *Portugal carbon tax.* https://www.fccaviation.com/regulation/portugal/carbon-tax

Fremstad, A., & Paul, M. (2019). The impact of a carbon tax on inequality. *Ecological Economics, 163*, 88-97. https://doi.org/10.1016/j.ecolecon.2019.04.016

Gallet, C. A., & Doucouliagos, H. (2014). The income elasticity of air travel: A meta-analysis. *Annals of Tourism Research, 49,* 141-155. https://doi.org/10.1016/j.annals.2014.09.006

Graver, B., Rutherford, D., & Zheng, S. (2020) *CO_2 emissions from commercial aviation, 2013, 2018, and 2019*. International Council on Clean Transportation. https://theicct.org/publication/co2-emissions-from-commercial-aviation-2013-2018-and-2019/

Graver, B., Zheng, X. S., Rutherford, D., Mukhopadhaya, J., & Pronk, E. (2022). *Vision 2050: Aligning aviation with the Paris Agreement.* International Council on Clean Transportation. https://theicct.org/publication/global-aviation-vision-2050-align-aviation-paris-jun22/

Gokhale, H. (2021). Japan's carbon tax policy: Limitations and policy suggestions. *Current Research in Environmental Sustainability, 3,* 100082. https://doi.org/10.1016/j.crsust.2021.100082

HM Revenue & Customs. (2024). *Rates for air passenger duty*. https://www.gov.uk/guidance/rates-and-allowances-for-air-passenger-duty

Internal Revenue Service. (n.d.) *Excise tax.* https://www.irs.gov/businesses/small-businesses-self-employed/excise-tax

International Air Transportation Association. (2019). *Fuel: fact sheet.* https://www.iata.org/ contentassets/25e5377cf53c4e48bbaa49d252f3ab03/fact-sheet-fuel.pdf

International Air Transport Association. (2023a). *Taxes and environmental transition.* https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet--taxes-environment/

International Air Transport Association. (2023b). *Air passenger market analysis December 2023.* https://www.iata.org/en/iata-repository/publications/economic-reports/air-passenger-market-analysis-december-2023/

International Air Transport Association. (2024). *Net zero 2050: Sustainable aviation fuels: Fact sheet.* https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet-sustainable-aviation-fuels/

International Air Transport Association. (n.d.). *Global Passenger Survey (GPS)* [Dataset]. https://www.iata.org/en/publications/manuals/global-passenger-survey/

International Civil Aviation Organization. (2023). *ICAO Conference delivers strong global framework to implement a clean energy transition for international aviation* [Press release]. https://www.icao.int/Newsroom/Pages/ICAO-Conference-delivers-strong-global-framework-to-implement-a-clean-energy-transition-for-international-aviation.aspx

International Civil Aviation Organization. (n.d.). *Convention on International Civil Aviation - Doc 7300*. https://www.icao.int/publications/pages/doc7300.aspx

InterVISTAS. (2007). *Estimating air travel demand elasticities.* International Air Transport Association. https://www.iata.org/en/iata-repository/publications/economic-reports/estimating-air-travel-demand-elasticities---by-intervistas/

Kellogg, E., & Zheng, S. (2024, February 8). Taxing aviation for loss and damage caused by climate change. *International Council on Clean Transportation Staff Blog.* https://theicct.org/taxing-aviation-for-loss-and-damage-caused-by-climate-change-feb24/

Koopmans, C., & Lieshout, R. (2016). Airline cost changes: To what extent are they passed through to the passenger? *Journal of Air Transport Management, 53,* 1-11. https://doi.org/10.1016/j.jairtraman.2015.12.013

Legislative Analyst's Office. (2023). *California's Cap-and-Trade Program: Frequently asked questions.* https://lao.ca.gov/Publications/Report/4811#:~:text=CARB%20hosts%20four%20auctions%20of,investors%20at%20a%20future%20date

Nakano, K., & Yamagishi, K. (2021). Impact of Carbon Tax Increase on Product Prices in Japan. *Energies, 14*(7), Article 7. https://doi.org/10.3390/en14071986

O'Malley, J., & Pavlenko, N. (2022). *Leveraging EU policies and climate ambition to close the cost gap between conventional and sustainable aviation fuels.* International Council on Clean Transportation. https://theicct.org/publication/eu-fuels-aviation-cost-gap-safs-apr22/

Opportunity Green. (2024). *Clearing the air on how we tax aviation fuels*. https://www.opportunitygreen.org/publication-clearing-the-air-on-how-we-tax-aviation-fuels

Organisation for Economic Co-operation and Development. (2021). Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading. https://www.oecd.org/en/publications/effective-carbon-rates-2021_0e8e24f5-en.html

RDC Aviation Ltd. (n.d.). *Air fares* [Dataset]. https://rdcaviation.com/data/air-fare/

Regional Greenhouse Gas Initiative. (n.d.) *Elements of RGGI,* accessed October 10, 2024. https://www.rggi.org/program-overview-and-design/elements

Rutherford, D. (2023, June 23). Fair fares for the climate. *International Council on Clean Transportation Staff Blog.* https://theicct.org/aviation-fair-fares-for-the-climate-jun23/

Shang, B. (2023). The Poverty and distributional impacts of carbon pricing: Channels and policy implications. *Review of Environmental Economics and Policy, 17*(1), 64-85. https://doi.org/10.1086/723899

Transport & Environment. (2019). *Why ICAO and Corsia cannot deliver on climate.* https://www.transportenvironment.org/articles/why-icao-and-corsia-cannot-deliver-climate

Transport & Environment. (2023). *Aviation tax gap: How much revenues are governments losing out on due to poor aviation taxation?* https://te-cdn.ams3.cdn.digitaloceanspaces.com/files/tax_gap_report_July_2023.pdf

United Nations. (2023). Global Issues: Population. Retrieved from https://www.un.org/en/global-issues/population

U.S. Department of Transportation. (2023). Airline Origin and Destination Survey. https://www.transtats.bts.gov/DatabaseInfo.asp?QO_VQ=EFI&Yv0x=D

World Bank. (2017). *State and trends of carbon pricing, 2017.* https://documents1.worldbank.org/curated/pt/468881509601753549/pdf/State-and-trends-of-carbon-pricing-2017.pdf

World Bank. (n.d.). *World Bank country and lending groups.* https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

World Inequality Database. (n.d.). *Pre-tax national income share by income bracket* [Dataset]. https://wid.world/data

Wozny, F., Grimme, W., Maertens, S., & Scheelhaase, J. (2022). CORSIA—A feasible second best solution? *Applied Sciences, 12*(14), 7054. https://www.mdpi.com/2076-3417/12/14/7054

Wozny, F. (2024). *Tax incidence in heterogeneous markets: The pass-through of air passenger taxes on airfares*. IZE Institute of Labor Economics. https://docs.iza.org/dp16783.pdf

WWF. (2021). *Fit for 2030: Making EU ETS revenues work for people and climate.* https://wwfeu.awsassets.panda.org/downloads/making_eu_ets_revenues_work_for_people_and_climate_summary_report_june_2021__2_.pdf

Zheng, X.S., & Rutherford, D. (2022). *Aviation climate finance using a global frequent flying levy.* International Council on Clean Transportation. https://theicct.org/publication/global-aviation-frequent-flying-levy-sep22/

Zheng, X.S. (2023). *Priorities for government spending on net-zero aviation.* International Council on Clean Transportation. https://theicct.org/publication/priorities-for-government-spending-on-net-zero-aviation-nov23/

Zheng, X.S. (2024). *Demand response to potential aviation carbon pricing in Canada.* International Council on Clean Transportation. https://theicct.org/publication/demand-response-to-aviation-carbon-pricing-in-canada-apr24/

APPENDIX A. SURVEY DATA AND MODEL VALIDATION

Traveler behavior data for 2019 was purchased from the IATA Global Passenger Survey (n.d.) to help validate the flying frequency modeling and to illuminate the distribution of trip purpose, seating class, and average distance flown for each income-flying frequency category. Analysis of the survey data showed clearly that wealthy, frequent flyers are a large portion of the respondents.

The modeled flying frequency was validated against the survey data by comparing low-income households' share of frequent flyer tickets for the 30 largest aviation markets with sample sizes greater than 100 in the survey data. This is because the statistical modeling using a linear relationship between income and flying activity does not capture the edge cases of low-income, frequent flyers very well. We implemented low-income frequent flyer correction factors by increasing the probability of flying 6-9 times a year by 0.0004 for country-income groups with estimated average annual frequency between 0.4 and 2; the number of flights attributed to a country-income group was held constant by lowering the number of flights categorized as infrequent flyers accordingly.

The implied distance flown was calculated using an average dollar per km rate of $0.05 for leisure trips, based on fare data purchased from RDC Aviation Ltd. (n.d.) and our GACA-based inventory data, and $0.07 for business trips, which accounts for last-minute or less cost-conscious purchasing behaviors. A 3x dollar-per-km multiplier was applied to premium class tickets, based on Airline Origin and Destination Survey data (U.S. Department of Transportation, 2023).

Table A1
Summary of interpreted IATA Global Passenger Survey data

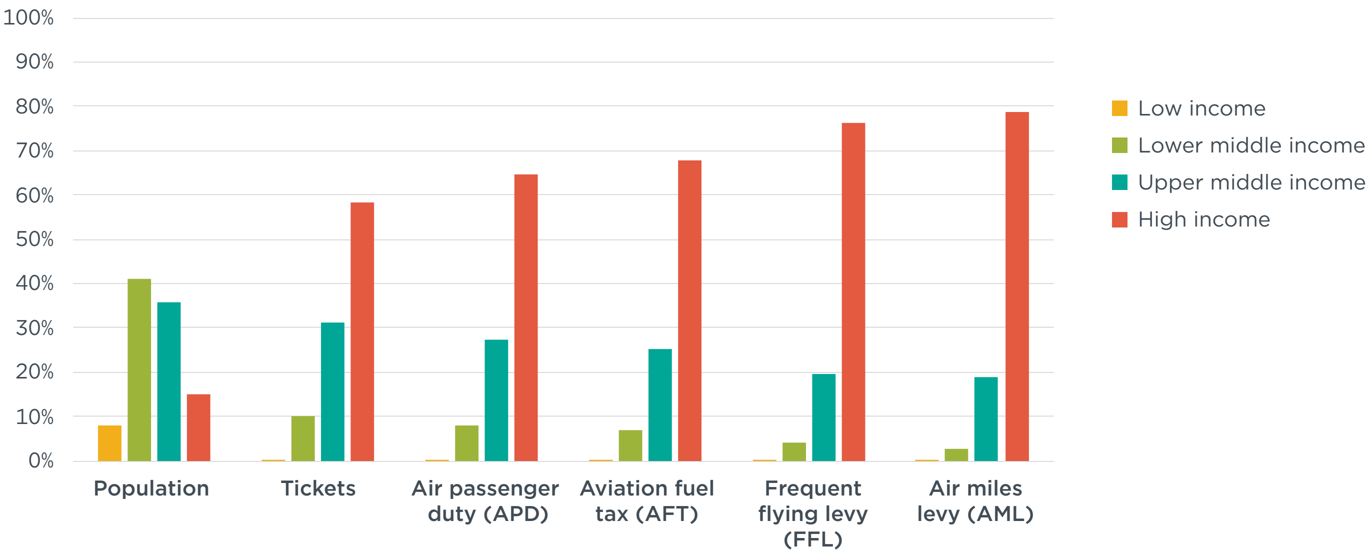
Frequency category	Seat class	Estimated number of trips		Median of estimated total expense	Implied annual distance flown per traveler (km)		
		Leisure	Business		Low	Mid	High
Infrequent (≤ 6)	Economy	6,441	249	750	6,000	15,000	90,000
	Premium	183	12	2,500	2,000	16,667	100,000
	Mixed	468	33	2,500	7,500	25,000	150,000
Frequent (7–20)	Economy	11,649	8,369	2,750	13,143	43,571	167,143
	Premium	610	450	4,800	11,524	31,429	139,048
	Mixed	1,551	1,007	4,500	18,571	45,000	168,000
Super (> 20)	Economy	28,894	27,123	5,000	37,143	97,143	557,143
	Premium	4,229	3,816	17,000	21,524	96,190	385,714
	Mixed	10,308	10,571	17,000	39,119	144,286	434,721
Total		**64,333**	**51,630**				

APPENDIX B. DISTRIBUTION BY COUNTRY INCOME GROUP

High income countries, as defined by the World Bank, constitute about 15% of the world's population and took almost 60% of the flights in 2019. These countries could be responsible for raising up to 79% of the global revenue under an air miles levy. The other country groups do not have nearly as many frequent flyers and only need to shoulder a small subset (from 21% under an air miles levy to 35% under an air passenger duty).

Figure B1

Share of global total population, tickets, and levy amount by country income groups under the World Bank definition



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

Most first-time flyers in the next couple of decades are likely to reside in lower-income countries; they have not contributed to any of the historical aviation emissions and policymakers may want to consider if they should be subject to the decarbonization costs that are embedded in the ticket price. Many small-island development states are also highly dependent on tourism. A lower levy on flights departing from these countries, especially for households that only travel once or twice a year for vacation, could reduce the levy's impact on their tourism industry.

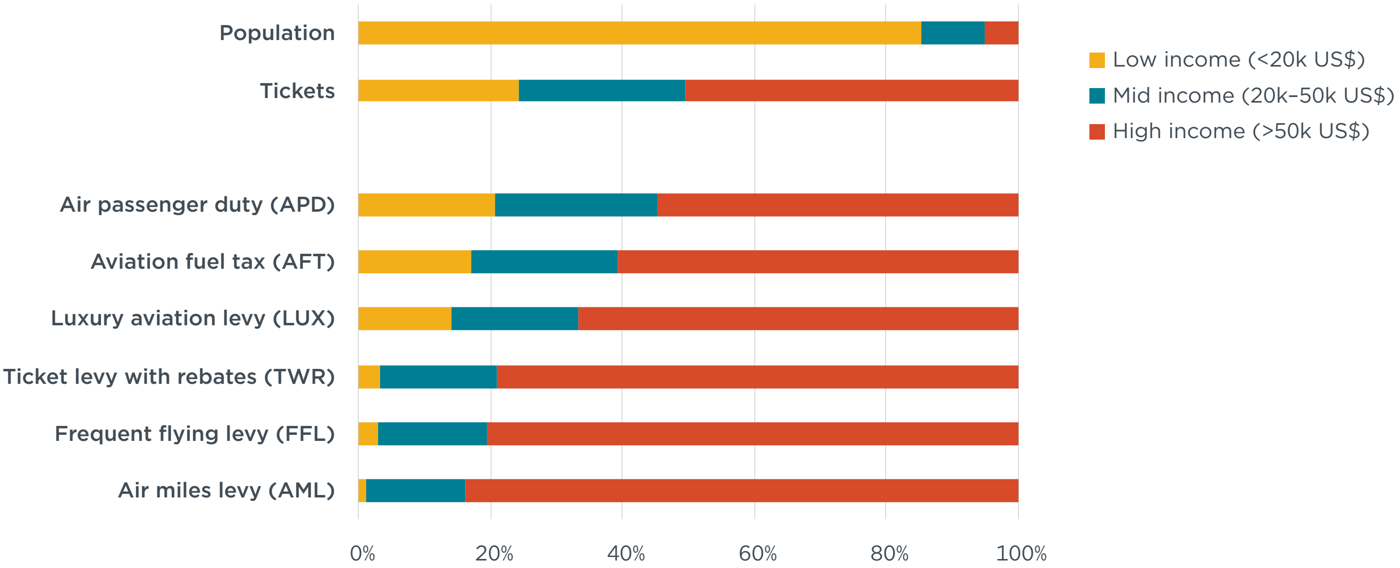
APPENDIX C. COMPARISON OF THE DISTRIBUTIONAL EFFECTS OF THE SIX INSTRUMENTS

Figures C1–C3 are supplements to Figures 2–4 in the main text, recreated with a luxury aviation tax and ticket levy with rebates included. Observe that the luxury aviation tax and the ticket levy with rebates consistently fall in between the more efficient instruments (the air passenger duty and the aviation fuel tax) and the more equitable instruments (the frequent flying levy and the air miles levy), and the luxury aviation tax shows distributional effects that are more similar to the air passenger duty and the aviation fuel tax than to the ticket levy with rebates.

In Figure C3, the ticket levy with rebates contrasts with the luxury aviation tax in its ability to protect low-income travelers from being affected and delivers similar demand response distribution as the frequent flying levy. The demand response to the luxury aviation tax still skews toward lower-income travelers, like the aviation fuel tax and the air passenger duty.

Figure C1

Share of population and levy burden by household income levels

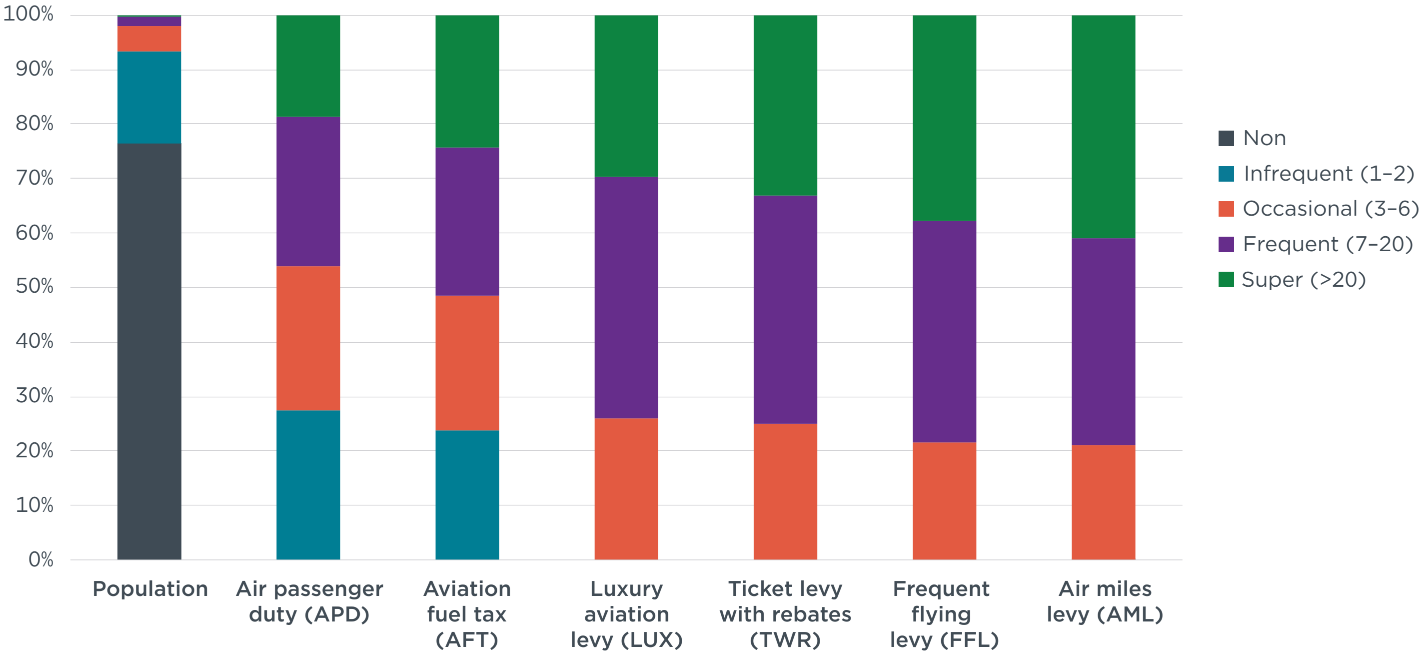


Note: The distribution of emissions by income level is the same as that of the aviation fuel tax.

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

Figure C2

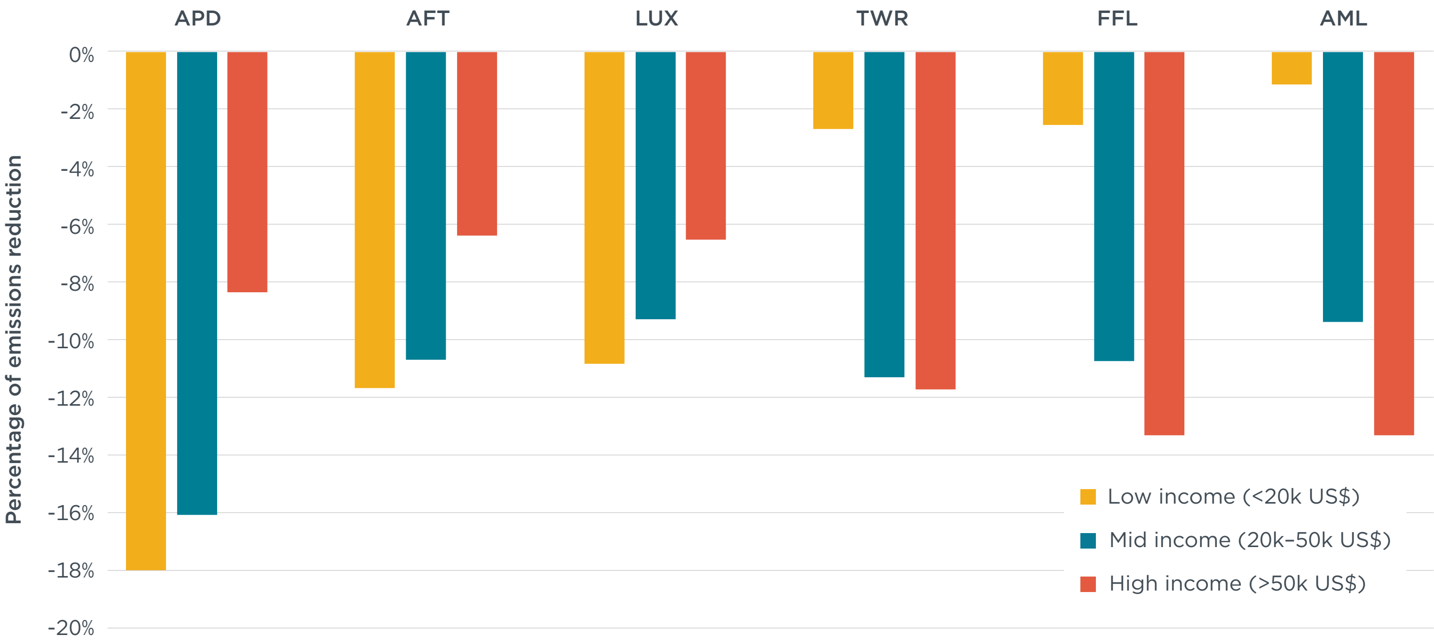
Share of population and levy burden by flying frequency categories



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

Figure C3

CO_2 emissions change by instrument and household income category



THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION **THEICCT.ORG**

www.theicct.org

communications@theicct.org

@theicct.org

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION