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Polluter pays? A large share of Europe's aviation emissions remain unpriced

But a key opportunity arises in the lead-up to the 2026 EU ETS review

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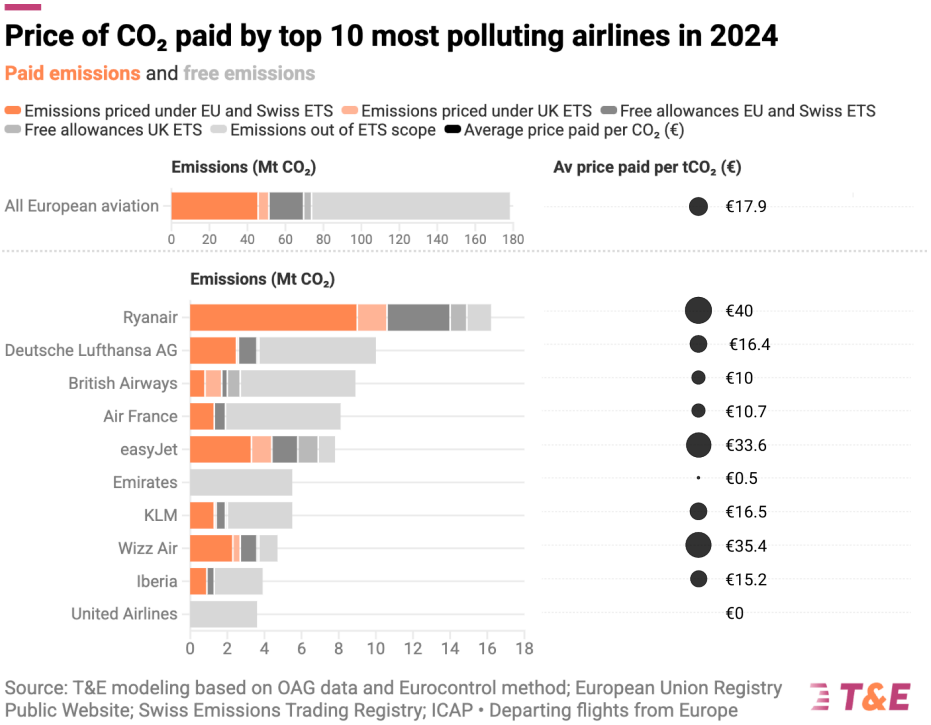
Executive summary

In 2024, **European aviation** traffic and emissions **made a near-complete recovery** to pre-pandemic levels. **Over 8.4 million flights departed** from European airports and **produced 187.6 million tonnes (Mt) of CO_2**— that's an **8% increase in emissions and a 5% rise in flight numbers compared to 2023.** Moreover, intra-European (EEA and UK) flights have even exceeded their 2019 emissions levels, while extra-European flights are swiftly catching up.

Although the EU has made a series of climate commitments and taken regulatory measures, its **existing policies have not done enough to curb the European aviation sector's projected growth**. Without decisive action, aviation could keep consuming as much fossil kerosene in 2049 as it did in 2023, a previous report by T&E shows.

Currently, the EU Emissions Trading System (EU ETS) for aviation only prices emissions from flights between and within the European Economic Area (EEA) and from the EEA to the UK and Switzerland (hereafter referred to as intra-EEA).**The scheduled review of the legislation in 2026 is a chance to address this loophole and expand the scope to all departing flights and therefore apply carbon pricing to a larger portion of European aviation emissions.**

As the EU and UK ETS currently covers just a third of aviation emissions, the related revenues could be more than double if the scheme expanded to all departing flights. **In 2024, airlines paid around €3 billion under the EU/Swiss and UK ETS, yet did not pay €7.5 billion in costs thanks to unpriced extra-European emissions and the remaining free allowances.**



Source: T&E modeling based on OAG data and Eurocontrol method; European Union Registry Public Website; Swiss Emissions Trading Registry; ICAP • Departing flights from Europe

Meanwhile, CORSIA—the international offsetting scheme—offers a far less effective framework. Its carbon prices are significantly lower, it lacks enforcement mechanisms, and it permits emissions growth above a lenient baseline. **As a result, the majority of emissions from extra-European flights remain unpriced,** particularly those operated by non-EU carriers.

As in previous years, Ryanair continued to be the largest emitter among airlines operating flights in Europe, responsible for 16.2 Mt of CO_2 in 2024—an increase of 9% from the year before and 34% above its 2019 level. **Altogether, the ten most polluting airlines emitted 74.2 Mt of CO_2, accounting for 40% of the sector's total emissions.**

Beyond CO_2, aviation's full climate impact includes non-CO_2 effects such as contrails, of which the warming impact is at least equal to that of CO_2. Recognizing this, the EU launched a monitoring system for non-CO_2 effects in 2025, initially covering intra-EEA flights, with expansion to all flights in 2027. **Including emissions from all flights in the monitoring scheme and coming forward with legislation to address non-CO_2 emissions from aviation is essential to align with climate goals and capture the full picture of the sector's environmental impact.**

To meet these challenges, **T&E recommends that the EU and UK extend their ETS to all departing flights by 2027,** ensuring better climate alignment. **Non-CO_2 effects should also be integrated into climate policy,** including monitoring of all flights. In parallel, **the EU should implement a tax on kerosene through the revised Energy Taxation Directive (ETD),** addressing an existing exemption which allows aviation to avoid fuel taxes while contributing disproportionately to emissions. If EU-wide agreement proves elusive, Member States should proceed with bilateral tax agreements for flights departing from their borders.

With the 2026 EU ETS review on the horizon, European policymakers have a critical opportunity to address aviation's rising emissions and secure meaningful progress toward the EU's climate goals.

Introduction

In 2024, **over 8.4 million flights departed** from European airports, **generating 187.6 Mt of CO_2**. This marks a 5% increase in flight numbers and a 8% rise in CO_2 emissions compared to 2023. **The European aviation sector has almost fully bounced back to pre-COVID levels**, reaching 96% of 2019 flight numbers and 98% of emissions of that year. Zooming in on **intra-European flights only** (domestic excluded), **2019 emissions levels have already been surpassed (106% of 2019),** while extra-European flights will reach that level soon (totalling at 91% of 2019 levels in

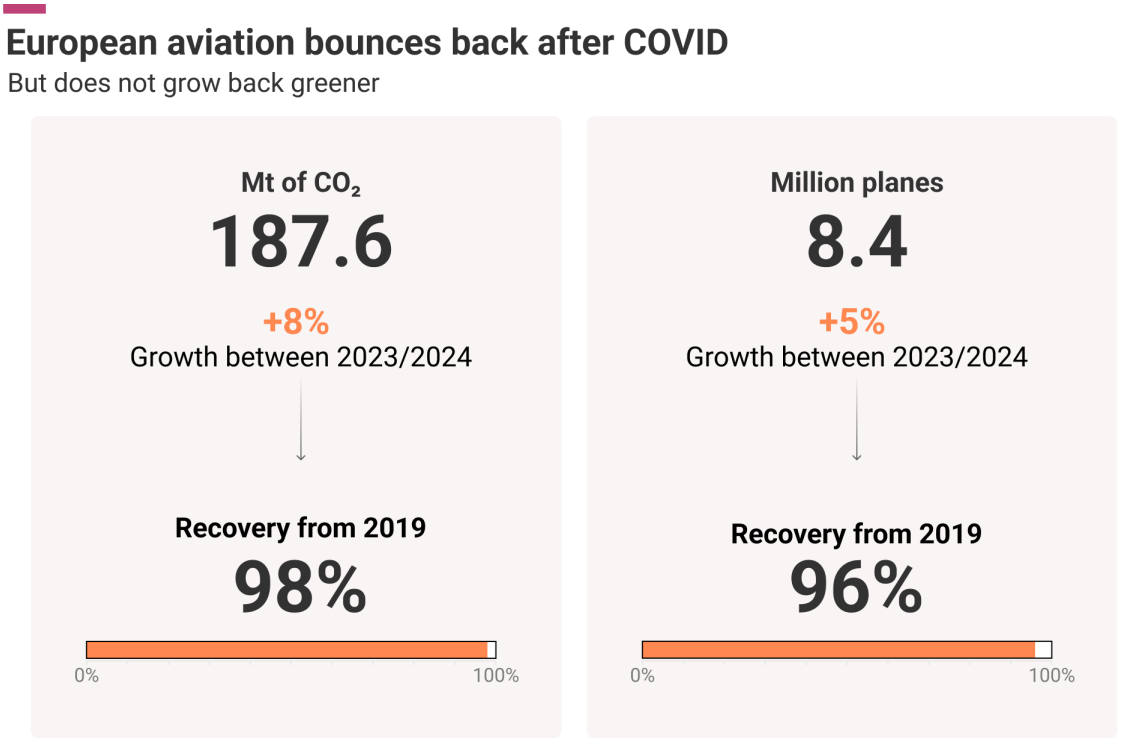
2024). These numbers contradict the pledges made by the aviation sector that they would build back better and greener after COVID.

These numbers paint a bleak picture: not only is the sector flying and polluting as much as in pre-COVID times, but continued growth in air traffic is on the cards. This risks locking Europe into sky-high emissions from aviation, as the right regulatory measures are not currently in place to keep the sector in check.

As captured in T&E's *Down to Earth* report, passenger traffic at European airports could more than double by 2050. While fleet modernisation and sustainable aviation fuels (SAFs) have a role to play, compliance with the EU's mandate on these will not be enough to address the unsustainable growth of Europe's aviation sector. Indeed, if Europe continues down this path, aviation could be burning as much fossil kerosene in 2049 as it did in 2023 – that's even while complying with the EU's SAF mandate.

Robust and effective climate policies are crucial to keep aviation on the right flightpath. This makes the upcoming 2026 review of the EU's carbon market (EU ETS) for aviation particularly significant.

Since 2012, the EU ETS is limited to intra-EEA flights. A big topic on the table for this revision is whether it should be extended to cover all flights departing the EEA. Part of this review is the assessment of the effectiveness and ambition of ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The EU has committed to evaluating whether CORSIA delivers emissions reductions in line with the EU's climate goals and the Paris Agreement by 1 July 2026. If CORSIA is deemed insufficiently robust - meaning ICAO has not strengthened CORSIA in line with achieving the aforementioned climate goals or less than 70 %



Source: Eurocontrol

of international aviation emissions are covered - the European Commission should propose to apply the EU ETS to emissions from all departing flights from 2027 onwards.

T&E calculations outlined in this report point to only one conclusion: the urgent need to extend the scope of EU ETS for aviation to all departing flights.

This report covers the following analyses and includes policy recommendations:

2. Analysis

2.1. Airlines: ranking of top 10 most polluting airlines in Europe

The graph below presents the top 10 most polluting airlines departing from Europe in 2024, along with their evolution compared to 2023 levels.

Most polluting airlines in 2024

Ranking	Airline	CO_2 emissions 2024 ($MtCO_2$)	CO_2 emissions growth 2023 - 2024 (%)
1	Ryanair	16.2	↑ 9%
2	Deutsche Lufthansa AG	10	↑ 6%
3	British Airways	8.9	↑ 3%
4	Air France	8.2	↓ -1%
5	easyJet	7.7	↑ 6%
6	Emirates	5.5	↑ 5%
7	KLM	5.5	↑ 3%
8	Wizz Air	4.6	↑ 1%
9	Iberia	4	↑ 10%
10	United Airlines	3.6	↑ 2%

Source: T&E modeling based on OAG data and Eurocontrol method • Departing flights from Europe

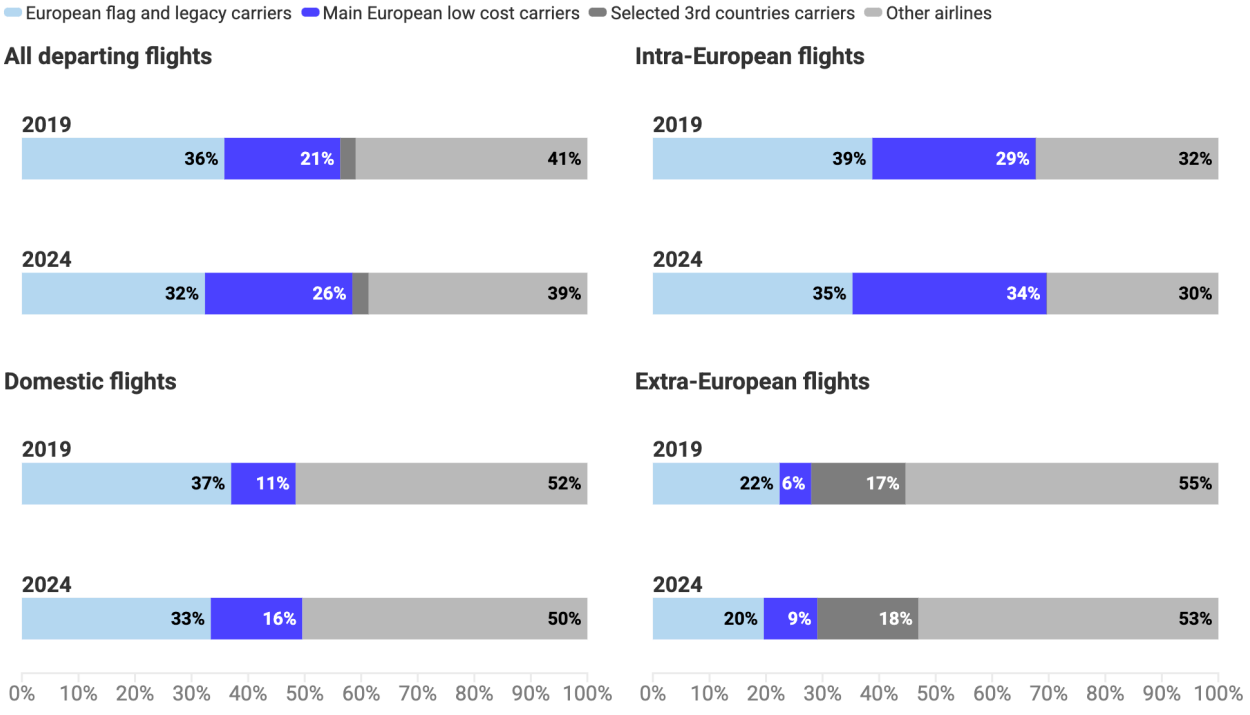
Consistent with previous years, **Ryanair remains Europe's top polluting airline**, with 16.2 Mt of CO_2 emitted from its departing flights—**9% higher than last year and 1.3 times the 2019 figure**. Emissions of other carriers in the top 10 also kept growing at varying rates, between 2% (United Airlines) and 10% (Iberia). However, looking at their post-COVID recovery, low-cost carriers significantly outperformed their legacy peers. Ryanair and Wizz Air have not only recovered but realized a significant increase at 134 and 144% respectively compared to their 2019 levels, whereas legacy airlines are still somewhat below their pre-pandemic emission levels (Lufthansa 77%, KLM 84%, Air France 85%).

The **airlines in the top 10 emitted a total of 74.3 Mt of CO_2** last year, that equals to **40% of the emissions from all flights departing Europe**. Ryanair's emissions alone make up 9% of those.

Rise of low-cost carriers across flight segments

The figure below shows how the market (measured by the share of departing flights operated by airlines) has evolved since 2019 among low-cost carriers, legacy airlines, and third-country carriers. It covers four categories: 1) all flights departing from European airports, 2) intra-European flights (excluding domestic), 3) domestic flights, and 4) extra-European flights. Across all categories, our analysis shows a steady increase in market share for low-cost carriers within the European aviation sector.

Share of departing flights per type



Source: T&E modeling based on OAG data and Eurocontrol method. Departing flights from Europe • Main European low cost: easyJet, Ryanair and Wizz Air. Flag/legacy carriers: Aer Lingus, Air France, Alitalia, Austrian Airlines, British Airways, Brussels Airlines, Finnair, Iberia Airlines, KLM, LOT - Polish Airlines, Lufthansa, Scandinavian Airlines and TAP Portugal. Selected third country carriers: Delta Airlines, Emirates Airlines, Etihad Airways, Ethiopian Airlines, Qatar Airways,Turkish Airlines and United Airlines

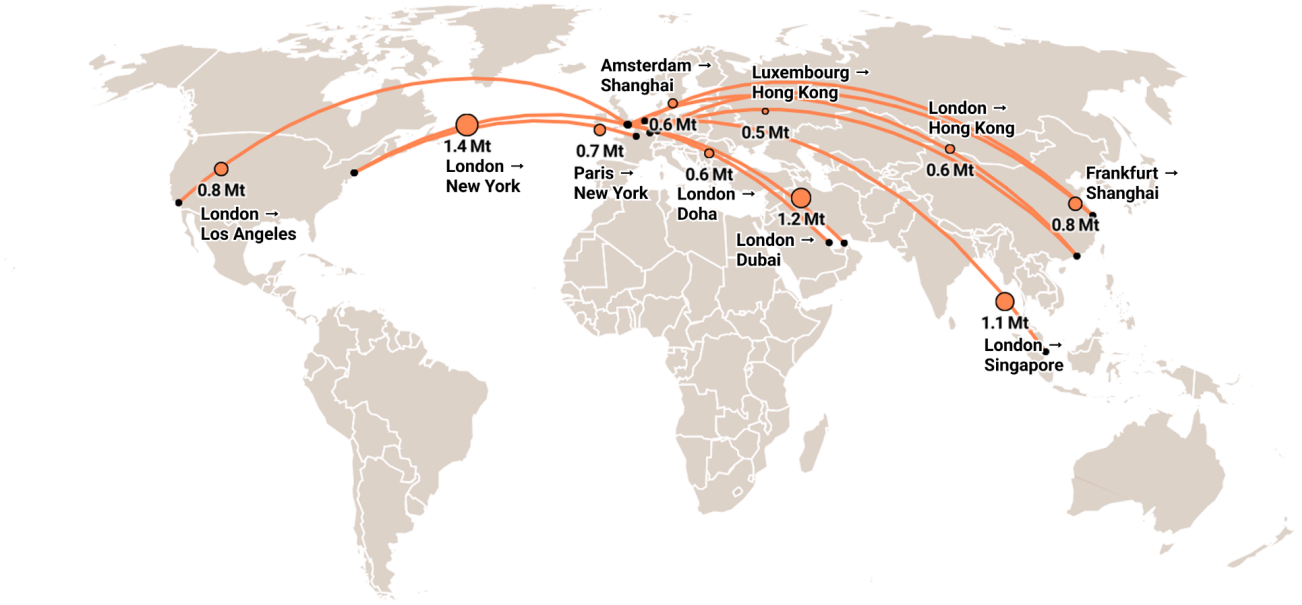
While, overall, legacy airlines remain the market leader in all four categories (operating approximately a third of departing flights for intra-European and domestic routes), low-cost carriers are catching up – they even managed to grow their market share in the extra-European market.

2.2. Most polluting long-haul routes departing from Europe still avoid taxation

The chart below shows the most polluting flights by city pairs with their emissions in 2024.

Most polluting routes in 2024

CO_2 emissions per city pairs (only departing flights)



Source: T&E modeling based on OAG data and Eurocontrol method • Departing flights from Europe

Unsurprisingly, the most polluting flights departing from Europe in 2024 were all long-haul, with the London-New York flight topping the list and releasing over 1.4Mt of CO_2 for departing flights. The first EU-originating flight to reach the ranking was the Frankfurt-Shanghai route, in 5th place, emitting 0.8Mt of CO_2 for departing flights. Most other top-polluting flights depart from London.

The first route that is included in the current scope of the EU ETS, Barcelona-London, would land as the 135th on the ranking, with 0.15Mt of CO_2 for departing flights.

This analysis perfectly illustrates the existing loophole in the European carbon markets: **the most polluting routes in 2024 were all intercontinental and were therefore not covered by the**

EU, Swiss, or UK carbon markets. Indeed, T&E calculations suggest that as much as 70% of CO_2 emissions from aviation remained unpriced in 2024, as detailed in the next section.

2.3. Shortcomings of the current ETS scope: 70% of CO_2 emissions remained unpriced

Aviation was integrated in the EU's carbon market– the EU Emissions Trading System (EU ETS)– in 2012. UK to EU routes joined the UK ETS when it was established in 2021, after Brexit. Every year, polluters must surrender permits equal to their CO_2 emissions from the previous year, which they acquire through an annual allocation process. If polluters don't have enough allowances to cover these emissions, they can purchase additional permits at auction or from other companies with a surplus. Both the EU and the UK impose a cap on CO_2 emissions by limiting the number of permits available in the market. As the cap is progressively reduced and permits become scarcer, the expectation is that the price of permits rises, creating an incentive for emitters to cut emissions when it's more cost-effective than buying permits.

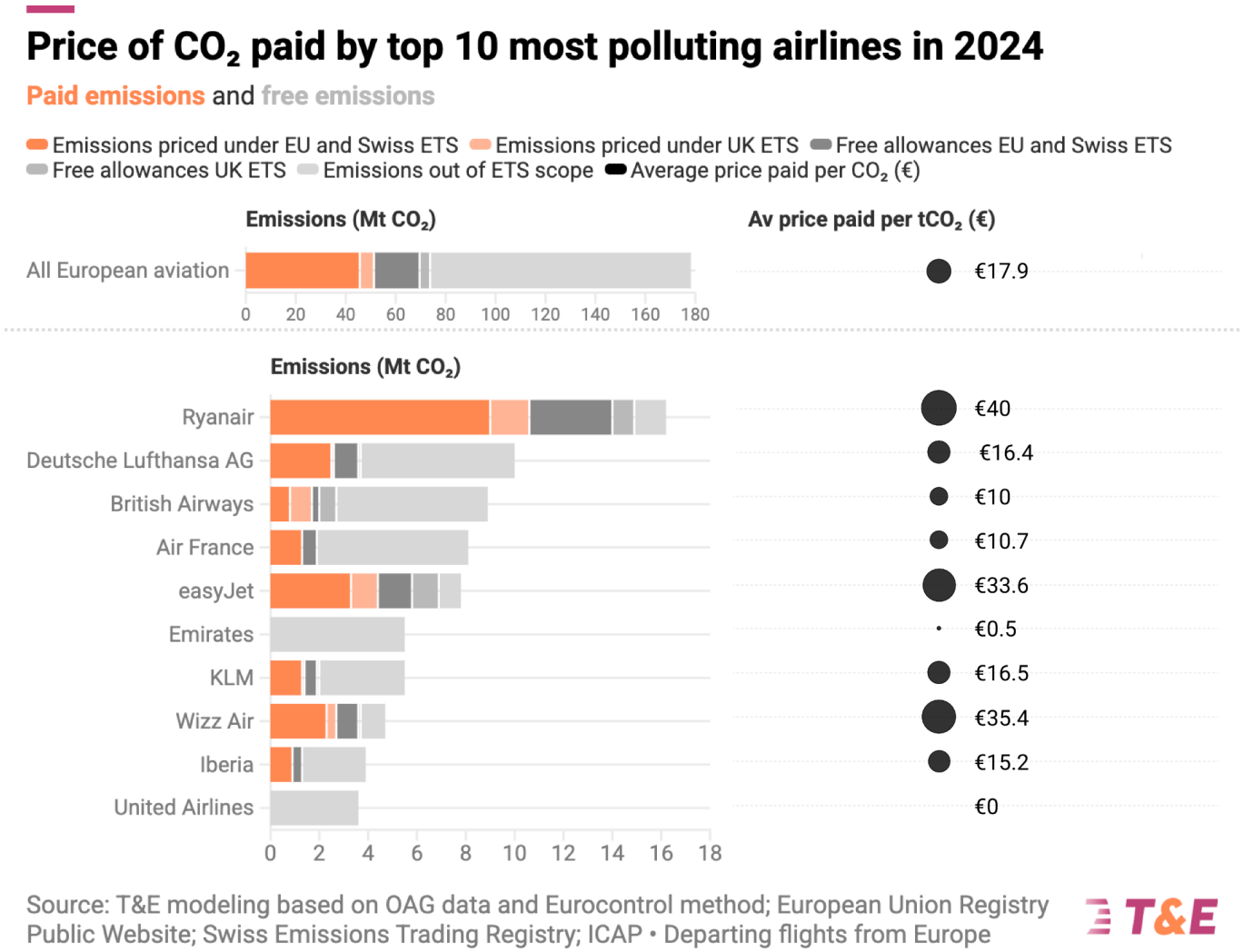
2024 marked the **beginning of the gradual phase-out of the free allocation provided to aircraft operators in the EU**. In 2024, free allocation decreased by 25%. In 2025 it will be reduced to 50%, and completely phased-out by 2026. This is a highly welcomed and long-awaited measure. In the UK, free allowances will be phased out by 2026.

As previously mentioned, a major shortcoming of the European carbon markets for aviation is that they do not include long-haul flights in the pricing scheme. As a result of these highly polluting routes evading the scheme, **only a third of emissions were priced** under the European carbon markets in 2024.

The **EU ETS system** alone covered nearly 64 Mt of CO_2 emissions last year (this covers emissions from EU and Swiss administered airlines). If the EU and UK ETS were applied to all departing flights, more than 100 Mt of supplementary CO_2 emissions would have been covered. Taking this and free allowances into account, **70% of CO_2 emissions were not covered by European carbon markets** .

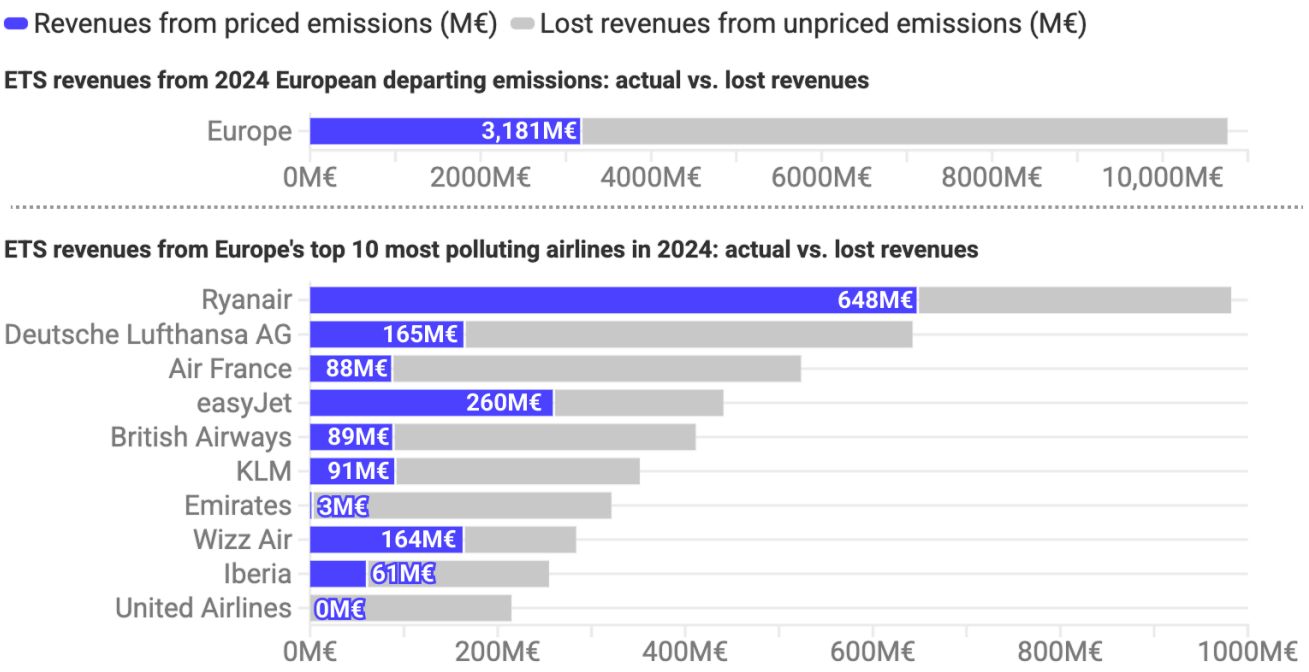
Moreover, despite the start of the free allowance phase-out in 2024, the estimated effective **price for a tonne of CO_2** (*i.e.* the price of a tonne of CO_2 by accounting for free allowances and unpriced emissions) **remained the same as in 2023 – €17.9 per ton.** This is because the price of ETS credits on the primary market decreased by 23 and 29% on average in 2024 in comparison with 2023 for both EU and UK ETS, respectively. As such, the European Commission's review of the Market Stability Reserve (MSR) next year will be important, as it could lead to changes that would adjust the supply of allowances to avoid price crashes or oversupply.

Based on an average carbon price of the EU ETS and the UK ETS (€64.4 and €43.7, based on ICAP data), T&E calculated the average price paid per tonne of carbon by the 10 highest-emitting airlines in 2024 as seen in the chart below.



In 2024, airlines operating in Europe paid more than €3 billion for EU and UK ETS allowances. However, they did not pay an estimated €7.5 billion for their emissions due to free allowances and emissions not covered by the carbon market. The breakdown by airline shows how little some carriers contributed to their emissions costs last year.

How much airlines paid (or not) for their emissions in 2024



Source: T&E modeling based on OAG data and Eurocontrol method; European Union Registry Public Website; Swiss Emissions Trading Registry; ICAP • Departing flights from Europe. Lost revenues were calculated without taking into account the effect of pricing on passenger demand

Legacy carriers like Lufthansa, Air France and British Airways did not fully pay for their emissions: 74%, 83%, and 81% of their emissions, respectively, remained unpriced in 2024. This is mostly due to the fact that the majority of their flights are to destinations outside of Europe - and therefore not covered by any carbon market - but also because they still received free allowances. Meanwhile, third-country airlines such as Emirates and United Airlines, which produce emissions similar to European carriers, paid even less. Despite having similar levels of emissions, these non-European airlines are benefiting from lower costs, given that they operate extra-European flights. This highlights the need for the EU and the UK to ensure that emissions from third-country airlines are included in the EU and UK ETS to ensure fair competition between European and non-European carriers and be aligned with the polluter pays principle.

Due to their Europe-focused geographical market, low-cost carriers paid for a higher share of their emissions, but still a lot remained unaccounted for. For instance, Ryanair did not pay for 35% of its emissions, easyJet for 43%, and Wizz Air for 42%.

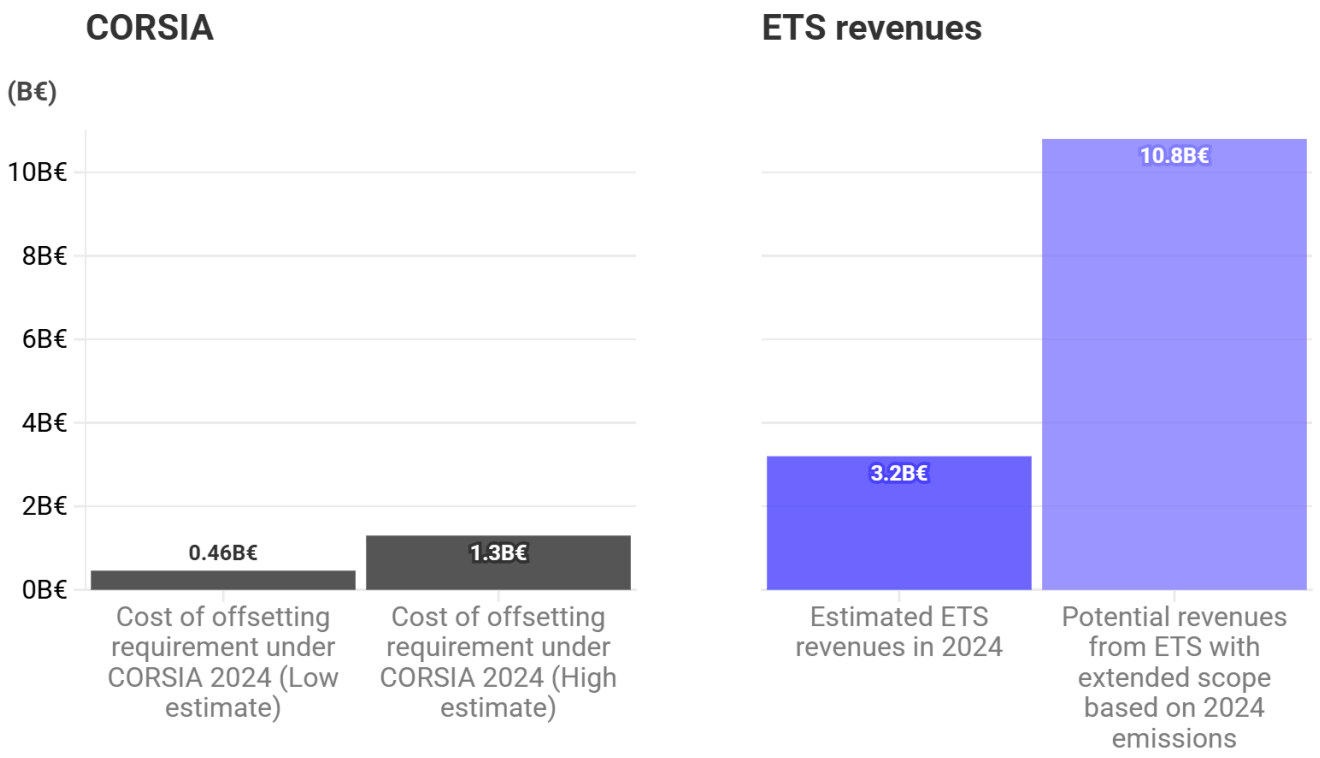
2.4. Expanding European carbon markets could unlock up to €7.5 billion in extra revenue

Besides being in line with the polluter pays principle and via the linear reduction factor encouraging gradual emissions reduction in the sector, the **European carbon markets generate revenues for the green transition.**

Last year the revenues generated under the EU and UK ETS schemes for aviation totalled more than €3 billion, as only 29% of emissions were priced. That is only a third of the €10.8 billion that could have been generated - ceteris paribus-, had the schemes been applied to all departing flights. As such, extending the scope of the European carbon markets could **unlock a further €7.5 billion that could fuel the green transition of Europe's aviation industry.**

CORSIA is the current alternative used for 'pricing' of flights outside the EEA. Its offsets are much cheaper than ETS credits, and their price is highly variable. In a recent report, RICARDO estimates carbon offset prices to range between €3 to €5 per tonne between 2022 and 2027, while MSCI forecasts that prices may range between €16.6 to €47 per tonne during the first phase of CORSIA. Using the lowest and highest CORSIA offset price estimate from MSCI, the total bill of EU aviation would range from €0.5 billion to €1.3 billion. This is between 8 to 23 times less compared to an EU ETS scope extended for all departing flights from Europe. Moreover, CORSIA revenues would not stay in Europe, but land in the pockets of global offset providers. The projects funded through the offsets tend to be unclear in their scope, lack proper oversight and verification, or would have happened regardless of the scheme .

CORSIA vs extended ETS: Relying on CORSIA for international flights would cost Europe billions in lost revenue



Source: T&E modeling based on OAG data and Eurocontrol method; ICAP; MSCI carbon markets • Departing flights from Europe. Potential revenues from ETS scope extension were calculated without taking into account the effect of pricing on passenger demand

2.5. CORSIA: A flawed solution to pricing international aviation emissions

A key argument to maintaining the EU ETS in its current, limited scope has been the development and launch of ICAO's global offsetting scheme CORSIA. Through the adoption of three time-bound derogations to the EU ETS scope, the so-called stop-the-clock decisions (first in 2012, and the latest one is in place until 2027) the EU exempted all flights to and from the EEA from paying for their pollution under the EU ETS.

But is CORSIA a real and efficient alternative for the European carbon pricing scheme for extra-European flights? The following section covers different aspects of the system, focusing on coverage (both geographical and emissions covered), emissions reduction incentivization, and revenues, and finds that the **UK and EU carbon markets are much stronger alternatives to price departing flights.**

Firstly, the ICAO CORSIA scheme only applies to international flights operated by airlines from countries that participate in the program - on a **voluntary** basis until 2027. Domestic flights, representing 40% of total global aviation emissions, are not covered.

126 countries are currently applying CORSIA voluntarily according to ICAO figures. The participation is more nuanced if we take into account two things: out of the 126 volunteer states, 54 states are classified as Small Island Developing States (SIDS), least developed countries (LDCs), or landlocked developing countries (LLDCs), that are exempt from the CORSIA offsetting requirements unless they voluntarily participate in the scheme. From an EU ETS perspective, the European Commission's list contains 93 states that are considered applying CORSIA regarding 2024 emissions. More intriguingly, despite it being meant to be a global scheme, **participation remains limited** as key aviation markets are missing either by not joining (e.g. China, Russia) or by not implementing CORSIA to the national laws (e.g. USA). Bearing this in mind, based on emissions reported for 2022, the 126 Member States that committed to participating in CORSIA from 2024 account for 66% of global aviation emissions.

Furthermore, carriers **must only offset emissions above a 2019-2020 baseline** on eligible routes**.** Previous T&E analysis has shown that, with this 85% baseline, a mere 22% of total international aviation emissions would be covered by the scheme and therefore offset. Unlike the European ETS systems, there is no emissions reduction incorporated in the system, and carriers can continue to grow as long as they purchase offsets for the emissions above the baseline. This leads to the next issue with the scheme. **CORSIA offsets lack credibility** due to the low-quality and inconsistent offset standards, which also makes double counting possible with the country's NDCs.

Another difference between the European carbon pricing schemes and CORSIA is that unlike the EU, the ICAO has no enforcement power in case of non-compliance.

Last but not least, **revenues from the European carbon pricing schemes remain in Europe - and in the case of the EU with Member States.** They are to be spent on green transition, whereas in the case of CORSIA, airlines purchase carbon credits from global offset providers or schemes.

Earlier on in the report, we compared revenues raised by the EU/Swiss and UK ETS with those of CORSIA: under CORSIA, revenues generated will be 8 to 23 times smaller than those collected under an EU/Swiss and UK ETS scope extended for all departing flights from Europe.

3. The importance of non-CO_2 emissions and the need to address aviation's full climate impact

Beyond its limited geographical scope, another shortcoming of the EU emission trading scheme is that it only considers CO_2 emissions. This is despite the fact that there is scientific consensus and EU legislation which confirms that the climate impacts of aviation's non-CO_2 emissions is at least as important as that of its CO_2 emissions.

An important step in the right direction in the EU was the launch of the Monitoring, Reporting and Verification (MRV) scheme of aviation's non-CO_2 emissions in January 2025. The system allows non-CO_2-related data to be gathered. For the first two years it applies to intra-EEA flights only and then will be automatically extended to all flights arriving to or departing from the EEA. This will allow European lawmakers to propose an inclusion of aviation's non-CO_2 emissions in the 2026 EU ETS review.

The non-CO_2 emissions reported by airlines for the year 2025 will only be available in 2026. Therefore, we give an estimate of the routes causing the most contrail warming, the biggest quantified contributor to aviation's non-CO_2 warming. Our estimate is based on simulations for the year 2019.

European routes with the highest contrail climate impact

Ranking	Airport 1	Airport 2	Included in reduced MRV scope?	Contrail climate impact in Mt CO_2eq (GWP20)
1	Amsterdam Airport Schiphol	Shanghai Pudong International Airport	No	3.80
2	Luxembourg-Findel International Airport	Hong Kong International Airport	No	2.90
4	Frankfurt am Main Airport	Incheon International Airport	No	2.60
5	Charles de Gaulle International Airport	Shanghai Pudong International Airport	No	2.20
7	Frankfurt am Main Airport	Shanghai Pudong International Airport	No	2.03
8	Charles de Gaulle International Airport	John F Kennedy International Airport	No	1.87
9	Malpensa International Airport	John F Kennedy International Airport	No	1.50
10	Charles de Gaulle International Airport	Tokyo Haneda International Airport	No	1.49
11	Charles de Gaulle International Airport	Incheon International Airport	No	1.42
12	Charles de Gaulle International Airport	Beijing Capital International Airport	No	1.37
13	Luxembourg-Findel International Airport	Zhengzhou Xinzheng International Airport	No	1.28
14	Amsterdam Airport Schiphol	John F Kennedy International Airport	No	1.23
15	Amsterdam Airport Schiphol	Hong Kong International Airport	No	1.21
16	Adolfo Suárez Madrid–Barajas Airport	John F Kennedy International Airport	No	1.20
17	Charles de Gaulle International Airport	Sheremetyevo International Airport	No	1.20
18	Adolfo Suárez Madrid–Barajas Airport	Miami International Airport	No	1.20
19	Leonardo da Vinci International Airport	John F Kennedy International Airport	No	1.14
20	Adolfo Suárez Madrid–Barajas Airport	El Dorado International Airport	No	1.09
21	Charles de Gaulle International Airport	Hartsfield Jackson Atlanta International Airport	No	1.06
22	Charles de Gaulle International Airport	Hong Kong International Airport	No	1.05
23	Malpensa International Airport	Incheon International Airport	No	1.02
24	Paris-Orly Airport	Pointe-à-Pitre – Le Raizet	Yes	1.01
25	Frankfurt am Main Airport	Beijing Capital International Airport	No	1.00

Source: Transport & Environment, based on data by Teoh et al. (2024) and OAG (2024) for the year 2019 • Routes (cargo+passenger) include return flights, except for flights between the EEA and the UK and Switzerland where outbound and inbound flights are listed separately.

4. Policy recommendations

The analysis in this report shows that European aviation emissions have bounced back to pre-COVID levels, with intra-EU flights even surpassing pre-pandemic figures. While emissions from most other sectors are declining, transport— and in particular aviation—continues to be a major and growing source of pollution. In light of the upcoming review of the EU ETS for aviation, there is a window of opportunity to include the missing two third of emissions in the scheme and unlock an increased revenue stream to support green transition of the sector.

To address this and other matters raised in this report, T&E calls for the following:

Expand the Emissions Trading Schemes (EU and UK ETS) in 2027, instead of relying on CORSIA to cover all extra-European flights departing from European airports, addressing the current gap that leaves most aviation emissions outside an effective carbon pricing system. The EU has a crucial opportunity to implement this expansion in 2026 during the ETS revision and should act swiftly to seize it. The UK should also consider expanding the ETS to departing flights to align with the EU.

Address aviation's full climate impact by integrating non-CO_2 emissions into the EU and UK's climate objectives and existing policies, creating a comprehensive regulatory framework to drive innovation, improve public health, and enhance sustainability in aviation. Part of it is **the inclusion of those emissions in the EU ETS** and ensuring their monitoring automatically expands to all departing and arriving flights from and to Europe in 2027. The UK should align its legislation with the EU and start monitoring non-CO_2 emissions of aviation and come forward with legislation to address these effects.

Implement taxes on kerosene by implementing a revision of the Energy Taxation Directive (ETD) as proposed by the European Commission in 2021. In the UK, this means applying a fuel duty on all departing flights where air service agreements allow. It is essential to address the climate and social inequities that allow kerosene to remain one of the few untaxed fuel products in Europe. Should the introduction of an EU-wide kerosene tax be significantly delayed, Member States should implement taxes at national level through bilateral agreements to compensate.

5. Methodological note

5.1. Forenote

Every April, the European Commission releases compiled EU and Swiss emissions trading system (ETS) emissions data. T&E analyses this data to understand the trends of the aviation sector. Since 2023, we have extended the scope of the analysis to cover the emissions from all flights departing from EU27, Norway, Iceland, Switzerland and the UK - hereon referred to as EU31-, to get a more complete picture of the ETS pricing mechanisms. This was done by calculating the aircraft fuel consumption of scheduled flights data, from OAG, using Eurocontrol's fuel consumption methodology. Our analysis focuses on 2024 and 2023 emissions, as well as 2019 emissions, as the historical peak year of European aviation emissions, prior to the COVID crisis.

This methodological note details how the emissions from the different scopes were estimated in order to build the top polluting airline ranking, the market share changes between low-cost and legacy carriers, the most polluting routes, how we estimated the effective average carbon pricing paid per airline, and how the CORSIA offset requirements were estimated.

5.2. Geographical scopes and corresponding emission sources

Our analysis covers emissions from flights departing from EU31 countries. Depending on the destination, emissions from those flights are covered by one of three Emission Trading Systems in Europe - the EU ETS, the Swiss ETS, and the UK ETS - or not covered by any of them.

Since the agreement between Switzerland and the EU on linking their ETSs in 2020, airlines report emissions and allocations from flights within Switzerland, and departing from Switzerland to the EEA (i.e. EU member states, Norway and Iceland) in a separate section in the ETS log (called "CH emissions" and "CH allocations"). Additionally, airlines administered by Switzerland (e.g. SWISS International Air Lines and easyJet Switzerland) publish their verified emissions on the Swiss ETS portal.

In 2021 the scope of the EU ETS was reduced. Aircraft operators now report emissions from UK domestic flights and flights from the UK to the EEA under the UK ETS. Since UK ETS verified emissions were not made available at the time of publication, we estimated them from OAG data.

It is important to mention that, since January 2024, flights between EU member states and European outermost regions have been included in the ETS scope. Similarly, flights departing from Switzerland to the EU's outermost regions are also now covered by the Swiss ETS. Domestic flights between a Member State and its own outermost regions are still exempted from the ETS until 2030.

The table below gives an overview of the ETS coverage of emissions depending on the countries of departure and arrival of a flight, as well as the source used in our analysis to estimate the corresponding emissions for airlines, both in 2024 and 2019.

Geographical scope of emissions	ETS coverage in 2019	ETS coverage in 2024	Source for 2019 emissions	Source for 2024 emissions
Emissions from flights within the EEA	EU ETS	EU ETS	EU transaction log	EU transaction log
Emissions from flights from the EEA to the UK	EU ETS	EU ETS	EU transaction log	EU transaction log
Emissions from flights from the UK to the EEA and Switzerland	EU ETS	UK ETS**	EU transaction log	OAG, Eurocontrol*
Emissions from Switzerland to the EEA and UK	Not covered	Swiss ETS	OAG, Eurocontrol*	EU transaction log
Emissions from the EEA to Switzerland	Not covered	EU ETS	OAG, Eurocontrol*	EU transaction log
Other emissions, from flights departing from EU31 that are not included in the above categories	Not covered	Not covered	OAG, Eurocontrol*	OAG, Eurocontrol*

Geographical scopes, ETS coverage and emission sources.
* Estimated emissions. **Official UK ETS emissions are to be released later this year.

5.3. EU transaction log

5.3.1 Emissions filling

We fill emissions if an ETS account has not yet reported their emissions (i.e., they have -1 reported), is listed as an open account and is not excluded from reporting. Typically, a certain number of accounts do not report their emissions on time. For the aviation sector, as of April 14th, 26 operators had not yet reported their 2024 emissions. For these operators we multiplied their 2023 verified emissions by the average growth in aviation verified emissions between 2023 and 2024 (13% for EU verified emissions and 2% for Swiss verified emissions).

It is worth mentioning that the scope of this year's analysis is slightly different from last year's as we corrected a minor oversight from previous editions of our publication. This year, our analysis includes ETS verified emissions data from airlines administered by Switzerland. This data is available on the Swiss ETS registry. Previously, we used only data from the EU ETS registry, which did not encompass data from Swiss administered airlines.

5.3.2 Airline Grouping

Some airlines have different accounts in different member states of the EU. For all intents and purposes, these different accounts are attributable to an airline based on whether or not a passenger believes they are flying with a certain company or not. easyJet, for example, has four accounts, however they do not have four separate airlines, or websites to book those flights, or are operated by different entities. This differs from subsidiaries, for example Lufthansa owns Brussels Airlines, but Brussels Airlines is a different brand than its parent company. The airlines that we grouped together are shown in the table below, under an airline alias that is the commonly used name.

Airline ALIAS	Identifier in ETS log	Note
TUI	30011.TUI AIRLINES BELGIUM	
	Handelskonto TUIfly GmbH	
	TUI Airlines Nederland BV	
	TUIfly Nordic AB	
	Thomson Airways Limited	
Ryanair	Ryanair Sun S.A.	
	Ryanair UK Limited	
	Ryanair DAC	
ASL	27011.ASL Airlines Belgium	
	ASL AIRLINES FRANCE SA	
	Farnair Switzerland	Account closed
	ASL Airlines (Hungary) Kft.	Account closed
	ASL Airlines (Ireland) Limited	
FedEx	11102.FedEx Express Corporate Aviation	
	FEDERAL EXPRESS CORPORATION	
EasyJet	easyJet Switzerland SA	Account closed in the EU ETS log. Verified emissions from easyJet Switzerland are displayed in the Swiss ETS portal
	EACL ETS Account	
	EASYJET UK LIMITED	
	easyJet Europe Airline GMBH	
Norwegian	Norwegian Air Shuttle AOC	
	Norwegian Air Sweden AOC AB	

	Norwegian Air International Limited AOHA	Excluded
	Norwegian Air UK	
DHL	European Air Transport Leipzig GmbH	
	DHL Air Limited	
Iberia	IBERIA LAE SA OPERADORA SU	
	Iberia Express, S.A.	
Eurowings	Handelskonto der Germanwings GmbH	
	Eurowings GmbH	
Transavia	TRANSAVIA FRANCE	
	Transavia Airlines	
Wizz air	WIZZ AIR UK LIMITED	
	WIZZ AIR HUNGARY LTD	
British Airways	British Airways PLC	
	BA CITYFLYER LIMITED	
Deutsche Lufthansa AG	Deutsche Lufthansa AG	
	Lufthansa Cargo AG	
Qatar Airways	Qatar Airways	
	QATAR EXECUTIVE	
SunExpress	SunExpress ETS holding account	
	ETS Konto SunExpress Deutschland	Account closed
Air China	Air China Cargo Co., Ltd	
	Air China Limited	
Singapore Airlines	27975.SINGAPORE AIRLINES CARGO PTE LTD	Account closed
	Singapore Airlines Limited	

Accounts combined in the ETS

5.4. Estimates of emissions from the remaining geographical scopes

The emissions not covered by the EU and Swiss ETS are estimated by calculating the aircraft fuel consumption of scheduled flights data from OAG, to which we apply the

emission factor of kerosene. Fuel consumption from aircraft is calculated following Eurocontrol's fuel consumption methodology.

5.4.1 OAG flight coverage

Whereas cargo integrators (e.g. DHL) report their emissions in the ETS log, they are excluded from OAG coverage due to the economic sensitivity of the data. As a consequence, although ETS emissions from cargo integrators are included in the analysis, emissions from cargo integrators outside the ETS scope are excluded. This inconsistency is deemed minimal since emissions from full cargo operators were only 5% of all emissions in 2018.

Other types of flights such as chartered flights, flights from military aviation or governmental and humanitarian flights, for instance, are not covered by OAG. This results in a lower number of flights when compared with other data sources, such as Eurocontrol. However, the impact on emissions is estimated to be minimal, as detailed in section 5.4.2. In the introduction section of this report, we used Eurocontrol figures instead of OAG data, to display a more comprehensive overview of the aviation sector in terms of total European flights, emissions and recovery from pre-COVID levels. In last year's report, we used verified emissions and estimates based on OAG data to calculate those figures.

As the number of flights is not reported in the ETS log, all data on flights and market share are derived from OAG, and therefore only include scheduled passenger flights (including flights with belly cargo).

5.4.2 Comparison of OAG estimates with other data sources

We calculate that the emissions from flights departing from EU27 using OAG data are 4.6% below the emissions from UNFCCC in 2019 and that emissions from the 2019 ETS scope are 1.3% below the verified emissions from the EU transaction log. The same comparison for 2024 shows that OAG emissions are 4.5% higher than ETS emissions calculated from the EU and CH ETS portals (see the table below). We further compared emissions calculated using OAG for 2019 and 2024 to emissions published by Eurocontrol for these two years. We calculated that our data are respectively 2% and 3.5% below Eurocontrol emissions. The table below shows, by airline, the comparison between the emissions calculated from OAG, and the emissions reported under the EU and Swiss ETS for the years 2019 and 2024. Although the OAG estimates of ETS emissions are not used in our analysis (we use OAG estimates only for the emissions not covered by the EU and Swiss ETS) this comparison aims to verify the accuracy of the estimates from OAG at the airline level. We contacted all airlines from the top 10 ahead of publication to provide them their emissions under EU/CH ETS scope and outside of ETS scope, and giving them the opportunity to correct this data in case of any discrepancies.

Scope of emissions	2019 EU ETS scope (incl. flights to and from the UK)			2024 EU ETS scope (incl. flights from and to Switzerland, but excl. flights from the UK)		
Airline / scope	OAG estimated emissions 2019 (Mt)	Reported ETS emissions in 2019* (Mt)	Difference OAG - ETS (Mt)	OAG estimated emissions 2024 (Mt)	Reported ETS emissions in 2024* (Mt)	Difference OAG - ETS (Mt)
Overall EU/CH verified emissions	67.5	68.5	-0.9	66.8	63.9	3.0
Ryanair	11.1	10.5	0.59	14.1	12.4	1.8
Deutsche Lufthansa AG	4.6	4.4	0.21	3.8	3.5	0.3
British Airways	2.9	2.9	-0.03	1.3	1.1	0.2
Air France	2.6	2.5	0.06	2.2	1.9	0.3
easyJet**	6.5	6.6	-0.03	4.8	4.7	0.1
Emirates	0.1	0.0	0.01	0.1	0.1	0.0
KLM	2.1	1.9	0.18	2.1	1.8	0.3
Wizz Air	2.9	2.6	0.24	3.6	3.1	0.5
Iberia	1.7	1.3	0.43	1.8	1.3	0.5
United Airlines	0.0	0.0	0.0	0.0	0.0	0.0

Comparison of OAG data with ETS data from the EU transaction for the top 10 airlines. Note that the scope of the ETS in 2024 is different from the one in 2019, and that emissions are not directly comparable from one year to the other.* Verified emissions from EU and Swiss ETS registries as of April 14th. ** easyJet Switzerland emissions are available on the Swiss ETS

5.4.3 Top 10 polluting airlines

Airlines are ranked by their total emissions from flights departing from EU31. It should be noted that our emission estimates for the 11th airline of the EU31 top emitters, Qatar Airways (3.57 Mt), were close to the emissions estimates of the last airline from the top 10: United Airlines (3.65 Mt).

5.5. Market share change between 2019 and 2024

In this analysis, we define the market share as the share of flights departing from an EU31 airport operated by a certain airline. The number of flights operated by an airline is directly derived from OAG data. For this analysis, we distinguished between specific categories of airlines, as displayed in the table below. The same analysis was performed for flights departing from France, from Germany, and from the United Kingdom.

Category	Airline
European flag and legacy carriers	Finnair
	Scandinavian Airlines
	TAP Portugal
	Alitalia
	LOT - Polish Airlines
	Iberia Airlines
	Austrian Airlines
	Brussels Airlines
	Aer Lingus
	Air France
	KLM
	Lufthansa
	British Airways
Main European Low Cost Carriers	EasyJet
	Ryanair
	Wizz Air
Selected 3rd Countries Carriers	Turkish Airlines
	Qatar Airways
	Emirates Airlines
	Etihad Airways
	United Airlines
	Delta Air Lines
	Ethiopian Airlines

Airline categories

5.6. Effective price of carbon emissions

For each airline, we calculate the effective prices of a tonne of CO_2 emitted. To do so, we divide the amount of money they pay for their emissions priced under the ETSs by their total emissions from flights departing from EU31. Under the EU ETS scheme, around 500 aircraft operators are allocated free allowances. 2024 saw the initial phase-out of free allowances, with 25% fewer free allowances distributed to airlines. In 2025, this will be reduced to 50%, and the phase-out completed by 2026. Free allowances data is available on EU, Swiss and UK ETS data portals. Emissions priced under an ETS are emissions covered by this ETS, minus the number of free allowances. Using ICAP data, we used an average carbon price of €64.4 per tonne of CO_2 for the EU and the Swiss ETS (which are linked) and €43.7 per tonne of CO_2 for the UK ETS price. It is worth mentioning that these prices are

significantly lower than in 2023 (€85.3/tonne of CO_2 for the EU and the Swiss ETS, and €62.24/tonne of CO_2 for the UK price).

5.7. CORSIA

5.7.1 Offsetting requirement estimation

The first phase of the CORSIA offsetting scheme began in January 2024, and will run until 2026. Participation is voluntary – in 2024, 126 states participated in CORSIA. The scheme covers only international flights between voluntary states. Within participating states, not all airlines fall under offsetting requirements. As stated in the CORSIA handbook from January 2024, '*new entrants are exempt from offsetting requirements for three years from the year their total annual emissions within CORSIA's scope exceed 10 000 tonnes*'. However, if at any time during this three year period, the airline emissions exceed 0.1% of the total CO_2 emissions from 2019 international flights, it will be subjected to offsetting requirements from the following year.

To determine which airlines active in Europe in 2024 were subjected to CORSIA offsetting requirements, we applied the above criteria on their worldwide emissions under the CORSIA scope.

During this first phase, CORSIA offset requirements are calculated as follow:

$$CO2\ offset\ requirements\ =\ Operator's\ annual\ emissions\ under\ CORSIA\ scope\ \times\ Sectoral\ Growth$$

The sectoral growth factor of 2024 (SGF_{2024}) can be calculated based on aviation worldwide emissions using the following formula:

$$SGF_{2024}\ =\ \frac{(Total\ emissions\ under\ CORSIA\ scope\ in\ 2024\ -\ 85\%\ of\ Total\ emissions\ from\ the\ current\ CORSIA\ scope\ in\ 2019)}{Total\ emissions\ under\ CORSIA\ scope\ in\ 2024}$$

Using world global coverage OAG data, we estimated that total emissions under CORSIA scope in 2024 amount to 353 million tonnes of CO_2 and that total emissions from the current CORSIA scope in 2019 amounted to 358 million tonnes of CO_2. Using these estimates, we calculated a SGF_{2024} of 0.14.
We then applied this factor to European emissions from carriers we categorized as being subject to carbon offsetting requirements. As CORSIA covers whole routes, we used departing and arriving emissions.

Cross checking of CORSIA offsetting requirement estimates

In its 2023 publication of CORSIA annual sector's growth factor, ICAO indicated that the total CO_2 emissions in 2019 for the 2023 CORSIA scope was of 351 Mt of CO_2, and that total 2023 CO_2 emissions of all state pairs under CORSIA scope was of 330 Mt of CO_2.

Our own estimates are aligned with these numbers:

- We estimated that the total CO_2 emissions in 2019 for the 2024 CORSIA scope was 358 Mt of CO_2, which sounds plausible as the State participant list was updated in 2024.
- We calculated that the total emissions under CORSIA scope in 2024 amount to 353 million tonnes of CO_2. In comparison with ICAO's 2023 figure (330 Mt), this represents a growth of 7% in emissions under CORSIA scope.

5.7.2 CORSIA carbon credit prices

In a recent report, RICARDO estimates carbon offset prices to range between €3 to €5 per tonne between 2022 and 2027, while MSCI forecasts that prices may range between €16.6 to €47 per tonne during the first phase of CORSIA. Recent auctions saw prices of CORSIA-eligible carbon credits sold at around $21.7 per tonne. As CORSIA credit price predictions seem highly variable, and considering these recent auction prices, we chose to use the lowest and highest CORSIA offset price estimate from MSCI to estimate a range of offsetting requirement costs for European aviation emissions.

5.8. Most frequented and most polluting routes in Europe

Using frequencies of flights departing from EU31 from OAG, we estimated the most polluting routes in 2024. We used the City data field from OAG to regroup airports belonging to the same hub. The regrouping of airports per European city used in our analysis is presented in the table below. We ranked routes based on one-way emissions.

City	Airport	IATA Code
Brussels	Brussels Airport	BRU
	Brussels South Charleroi Airport	CRL
Hamburg	Hamburg Airport	HAM
	Hamburg Finkenwerder Airport	XFW
	Lübeck Airport	LBC
Berlin	Berlin Tegel International Airport	TXL
	Berlin Schönefeld International Airport	SXF
	Berlin Brandenburg Airport	BER
Belfast	Belfast International Airport	BFS

	George Best Belfast	BHD
London	London Gatwick Airport	LGW
	London Heathrow Airport	LHR
	London City Airport	LCY
	London Stansted Airport	STN
	Southend Airport	SEN
	London Luton Airport	LTN
Glasgow	Glasgow International Airport	GLA
	Glasgow Prestwick Airport	PIK
Stockholm	Stockholm Västerås Airport	VST
	Stockholm Arlanda Airport	ARN
	Stockholm Bromma Airport	BMA
	Stockholm Skavsta Airport	NYO
Tenerife	Tenerife South Airport	TFS
	Tenerife Norte Airport	TFN
Paris	Charles de Gaulle International Airport	CDG
	Paris Orly Airport	ORY
	Paris Beauvais Tillé Airport	BVA
	Paris-Vatry Airport	XCR
Milan	Milano Linate Airport	LIN
	Malpensa International Airport	MXP
	Il Caravaggio International Airport	BGY
Rome	Leonardo da Vinci Fiumicino Airport	FCO
	Ciampino G.B. Pastine International Airport	CIA
Frankfurt	Frankfurt am Main Airport	FRA
	Frankfurt Hahn Airport	HHN
New York	John F Kennedy International Airport	JFK
	Newark Liberty International Airport	EWR
	New York Stewart International Airport	SWF

Main cities and their respective airports