Flying via Istanbul: escaping climate measures?

Assessing the impact of EU climate measures on the competitiveness of the EU's aviation industry

September 2023 (**updated briefing**)

Summary

The EU's aviation industry[1] claimed that climate measures in Europe will harm their competitiveness and will result in emissions being exported overseas, a phenomenon referred to as 'carbon leakage'. In this briefing, Transport & Environment (T&E) examines the actual impact of the EU's Fit for 55 (FF55) package on aviation traffic forecast and emissions reduction. It examines industry claims and presents the results of T&E's comprehensive analysis based on the data from the same research institute, SEO Amsterdam Economics (SEO)[2]. The analysis reveals that:

- Risks of carbon leakage are limited to 3% of the total emissions savings brought by FF55 measures by 2035. Instead of reducing emissions by 38.4 Megatonnes of CO_2 ($MtCO_2$), emissions are reduced by 37.2 $MtCO_2$ by 2035, equivalent to the annual emissions of 10 coal-fired power plants.[3]
- Despite the climate measures, there will be 24% more passengers travelling through airports located in the European Economic Area (EEA) in 2035 compared to 2018.
- The growth in traffic at airports located in countries with less stringent climate policies is primarily inherent to the aviation market and is only marginally influenced by the implementation of climate measures in Europe.
- Solutions exist to make climate measures even more effective and reduce this limited carbon leakage. They include reducing the price gap between sustainable aviation fuels (SAF) and fossil kerosene or better regulating access to the European market by non-European airlines through Air Services Agreements (ASA).

Recommendations:

1) Implement measures of the FF55 package and adopt an EU-wide tax on kerosene, as our analysis shows that these measures do not harm aviation industry competitiveness while reducing emissions.
2) Adopt an effective industrial strategy to reduce SAF prices and increase investment certainty.

[1] Adler, M., Boonekamp, T., & Konijn, S. (2022). Aviation Fit for 55 - Ticket prices, demand and carbon leakage. SEO Amsterdam Economics & Royal Netherlands Aerospace Centre.
[2] Text edited Otober 12, 2023.
[3] Calculated using the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator.

3) Restrict access to the EU aviation market from airlines operating from third country hubs that do not introduce equivalent climate measures, through revisions of ASAs.

1. Introduction

Carbon leakage occurs when companies transfer their polluting activities from one region to another to avoid the costs associated with climate measures, resulting in carbon emissions being displaced to areas that are not subject to the same climate regulations. A common illustration is when steel production is relocated to a country not subject to carbon pricing regulations. In the case of air travel, the risk of carbon leakage is limited. The European Commission's own impact assessment[4] states that due "to the nature of aviation (geographical determination of routes), moving the same activity outside Europe has limited possibilities". This is because all airlines are treated equally on routes covered by the Emissions Trading System (ETS), the EU's carbon market, and because changing or diverting routes is often challenging or impossible due to the nature of the traffic. Unlike manufacturing processes, the aviation industry cannot "export" a route from one country to another.

For the purpose of this analysis, we make the hypothesis that one of the reasons that could motivate a passenger to travel to Asia via Istanbul instead of taking a direct flight or a flight transiting through a European hub would be to avoid the increase in ticket prices due to climate measures. This would result in carbon leakage. In the transiting scenario through Istanbul, SAF will be uplifted only for the flight to Istanbul, rather than for the entire journey (direct or transiting through a European hub). This would lead to a reduction in SAF consumption and consequently an increase in CO_2 emissions. In addition, two flights rather than a single direct flight increase emissions due to the additional take-off, and stopovers often add distance leading to additional fuel consumption. While any amount of carbon leakage is undesirable, it only weakens the objective of climate measures when the extent of carbon leakage exceeds the CO_2 savings resulting from this measure. For instance, suppose a tax lowers emissions by 100 $MtCO_2$ but leads to carbon leakage of 20 $MtCO_2$. In that case, the climate is better off by 80 $MtCO_2$ worldwide, making the measure worthwhile. However, if the amount of carbon leakage exceeds 100 $MtCO_2$, the measure's impact is negative overall.

The risk of carbon leakage in the aviation sector has appeared as an issue in recent discussions relating to FF55 policies, parts of which address the aviation sector such as the revision of the carbon market (EU ETS), the promotion of sustainable aviation fuels (ReFuelEU), and a tax on kerosene via the Energy Taxation Directive (ETD). The industry often cites carbon leakage as a concern.[5] Until recently, the use of these arguments has worked politically and the solution was simply to weaken the proposed measures. Indeed, EU climate policy is replete with examples of measures that were weakened following unsubstantial claims of carbon leakage. For instance, industries covered by the EU ETS have received an

[4] European Commission. (2021). *Impact assessment accompanying the proposal for Directive amending Directive 2003/87/EC* (No. SWD(2021) 603 final).
[5] Feedback from: Airlines for Europe A4E. (2021, November 18). *European Commission - Have your say*. Retrieved June 23, 2023.

excessive level of free allowances partly because of carbon leakage concerns.[6] In the aviation sector, airlines received around half of their allowances for free,[7] although the European Commission recognises that free allowances undermine the effectiveness of carbon pricing and remove the incentives for airlines to decarbonise.[8]

It is important to highlight that competition issues opposing European airlines to third-country carriers today are not at all related to the implementation of climate measures in Europe. Competition issues arise for example from giving market access to carriers that are more heavily subsidised, such as gulf carriers (Etihad Airways, Qatar Airways, and Emirates) that set artificially low prices and unfairly compete with European airlines.[9][10] The increase in European airlines' operating costs, which is said to put them in a worse competitive position than these subsidised carriers, originates from a myriad of other factors than climate measures, such as the closure of Russian airspace which resulted in extended flight length and higher fuel costs,[11] the energy crisis which led to a spike in kerosene prices,[12] wage increases and higher maintenance costs.[13] Despite all these additional issues, airlines are still benefiting from increased profits and traffic is continuing to bounce back to pre-pandemic levels.[14]

Finally, when analysing aviation competition, it is essential to note that passengers do not base their travel choices solely on prices. As a result, changes in traffic in the aviation market cannot simply be explained and forecasted based on cost analysis. Several other factors come into play when they decide which airline they will fly with such as convenience[15] (the distance separating their home from the airport), air service quality,[16] perception of airline safety,[17] or airline loyalty.[18]

[6] de Bruyn, S., Schep, E., & Juijn, D. (2021). *Additional profits of sectors and firms from the EU ETS. 2008-2019*. CE Delft.
[7] EU governments voice support for ending airlines' free pollution permits. (2020, March 5). *Transport & Environment*. Retrieved June 23, 2023.
[8] European Commission. (2021). Impact assessment accompanying the proposal for Directive amending Directive 2003/87/EC (No. SWD(2021) 603 final).
[9] Europeans for fair competition. (2015). The effect of unfair gulf competition on European airlines.
[10] O'Connell, J. F. (2011). The rise of the Arabian Gulf carriers: An insight into the business model of Emirates Airline. *Journal of Air Transport Management*, *17*(6), 339–346.
[11] The Canadian Press. (2023, April 23). A year into Russian airspace ban, flight costs and lengths are rising. *Global News*. Retrieved July 23, 2023.
[12] Airlines forecast higher fares after energy price spike. (2022, April 6). Reuters. Accessed 23 July 2023.
[13] Symons, A. (2023, April 26). Are cheap flights a thing of the past? Here's why your summer trip is so expensive. *Euronews*. Retrieved July 23, 2023.
[14] Airline profitability outlook strengthens. (2023, June 5). *IATA*. Retrieved August 5, 2023.
[15] Convenience is top priority for passengers post pandemic. (2023, November 1). Retrieved July 23, 2023
[16] Parrella, B. C., Airport Cooperative Research Program, Transportation Research Board, & National Academies of Sciences, Engineering, and Medicine. (2013). *Understanding airline and passenger choice in multi-airport regions*. Washington, D.C.: Transportation Research Board.
[17] Ringle, C. M., Sarstedt, M., & Zimmermann, L. (2011). Customer Satisfaction with Commercial Airlines: The Role of Perceived Safety and Purpose of Travel. *Journal of Marketing Theory and Practice*, *19*(4), 459–472.
[18] Dolnicar, S., Grabler, K., Grün, B., & Kulnig, A. (2011). Key drivers of airline loyalty. *Tourism Management*, *32*(5), 1020–1026.

2. Analysis of carbon leakage at the European level

In March 2022, SEO and the Royal Netherlands Aerospace Centre (NLR) published an independent assessment of carbon leakage commissioned by Air France-KLM Group, Groupe ADP, Lufthansa Group, and Royal Schiphol Group. The report concluded that the costs associated with FF55 policies make European air travel more expensive and cause carbon leakage due to a shift in demand. The analysed measures include:

- ETS with a 4.2% linear reduction factor and where free allowances are phased out by 2027.
- Kerosene taxation on intra-European flights using the rates proposed by the European Commission, with a rate of 27 cts/litre in 2030 and 38 cts/litre in 2035.
- SAF mandates are the same as in the European Commission's proposal with a blending rate of 2% in 2025, 5% in 2030 and 20% in 2035.

Overall, the climate measures modelled in SEO analysis are more ambitious than the measures currently in place. It includes a kerosene tax on intra-EEA flights which is not currently agreed upon. Compared to the measures which were adopted by the European Parliament and the Council, the ETS and RefuelEU cost assumptions are slightly more conservative. In reality, the ETS will have a slightly higher Linear Reduction Factor (LRF) of 4.3% between 2024 and 2027 and 4.4% from 2028 onwards. Free allowances will be phased out by 2026. RefuelEU's SAF mandates differ slightly, setting a 6% target for 2030 instead of 5%, and maintaining the same target of 20% for 2035.

It is also important to note that the study does not consider the impact of the ongoing war in Ukraine and the closure of Russian airspace. Sheremetyevo International Airport (SVO), which had important carbon leakage potential according to the study, is therefore no longer relevant.

The cost increase leads to demand reduction within the EEA and a shift of demand to competing non-EEA airports. Associated carbon leakage reduces the overall CO_2 emission savings.[19] **However, looking at the results of the study more closely, it is clear that the risk of carbon leakage is largely inflated.**

Findings of 2022 SEO study commissioned by the aviation industry

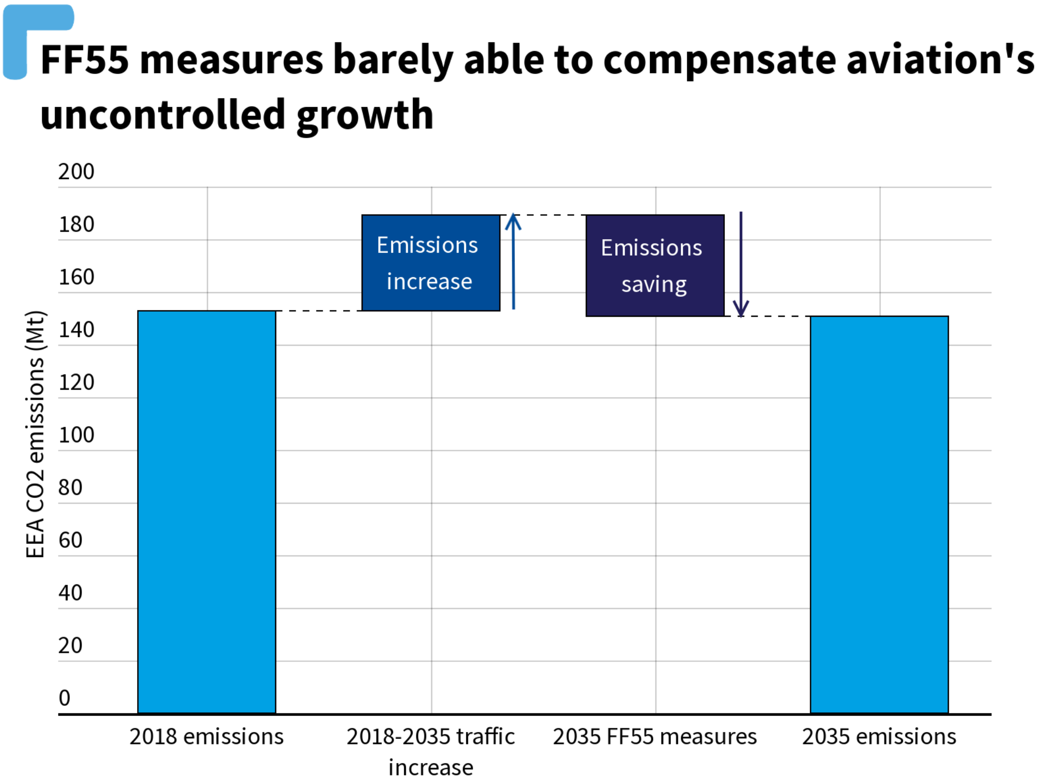
The main findings of the study are the following:

- In 2035, FF55 policy measures are predicted to deliver 38.4 Mt of net CO_2 reduction compared to a business-as-usual scenario. Carbon leakage only causes an increase of 1.2 $MtCO_2$, **this is a very small carbon leakage rate of 3.0%.** Overall, FF55 policy measures would still deliver 37.2 Mt of CO_2 reduction by 2035.
- Implementation of FF55 measures would result in an increase in costs. For return flights of 3,000 km within the EEA, tickets would increase by about €45 per passenger in 2030 and €65 per passenger in 2035. For flights going outside the EEA, costs increase for a return flight of 19,000 km (e.g. Frankfurt-Tokyo) by around €50 per passenger in 2030 and by €105 in 2035. The relatively

[19] Adler, M., Boonekamp, T., & Konijn, S. (2022). Aviation Fit for 55 - Ticket prices, demand and carbon leakage. SEO Amsterdam Economics & Royal Netherlands Aerospace Centre.

minor difference is explained by the scope of some of the regulations imposed by FF55, on flights within the EEA compared to flights departing from the EEA.

- **However, passenger numbers would actually continue to increase with FF55 policies, only by less than under a no-policy change scenario.** With FF55 policies, 903 million passengers would depart from European airports to all destinations by 2035, a 24% increase compared to the 730 million passengers in 2018. Without policies, the increase would be 40% (not considering capacity constraints) by 2035. For travels within the EEA, passenger numbers are predicted to increase from 578 million in 2018 to 682 million in 2035, equating to over 100 million additional passengers in a decade or an 18% increase, even with FF55 policies. The number of passengers on flights between the EEA and the rest of the world is projected to increase from 152 million in 2018 to 221 million in 2035, a 46% increase.
- With FF55, the number of passengers leaving the EEA through EEA hubs would still increase by 33% (or 39 million) by 2035 versus 2018, compared to 42% (or 49 million) under a no-policy scenario. **Traffic through non-EEA hubs is predicted to register strong growth with FF55 (+89% or +30 million) or without it (+85% or +29 million), showing that the shift of passengers from EEA to non-EEA hubs as a result of FF55 measures will be very limited, contrary to industry claims.**
- As a result of FF55 policies, carbon emissions are reduced by 1.6% between 2018 and 2035, from 153 Mt to 151 Mt (Fig. 1). Without FF55 measures, the situation would be much worse, with emissions increasing by 24% to reach 189 MtCO_2 in 2035. This means that any benefits gained from the current FF55 measures will be entirely consumed by the uncontrolled growth of the sector as illustrated in Fig. 1 below.



Source: SEO AMSTERDAM ECONOMICS & ROYAL NETHERLANDS AEROSPACE CENTRE. (2022). AVIATION FIT FOR 55 - TICKET PRICES, DEMAND AND CARBON LEAKAGE.

Figure 1: Effect of Fit for 55 measures and traffic increase on 2035 aviation emissions compared to 2018 levels

3. Analysis of carbon leakage at airport level

In order to deepen the research on carbon leakage, we commissioned SEO to produce an analysis looking specifically at the impact of FF55 on traffic and emissions in major EEA and non-EEA airports. This analysis used the same model and parameters as the one commissioned by the industry.

We selected 20 EEA airports based on their traffic volumes and location in order to represent commercial aviation in all parts of Europe. We also added 10 non-EEA airports with the highest potential to be used as a stop-over on the routes said to be sensitive to carbon leakage. In this briefing, we show the results for six EEA airports, the three biggest hubs (Paris CDG, Frankfurt FRA, and Amsterdam AMS), and two airports located on the outskirts of the EEA, (Madrid MAD and Stockholm ARN) as well as an East-European airport (Warsaw WAW). Airports located closer to the EU borders were identified to be at higher risk of leakage in SEO's study as costs increase with the distance. We also show results for the four non-EEA airports where the biggest leakage potential was identified (Istanbul IST, Dubai DXB, Doha DOH, and Casablanca CMN) as well as London Heathrow LHR. It should be noted that similar to the study commissioned by the industry, this analysis assumes that the ETD does not apply to the UK,[20] while all other measures are in full alignment with the EEA. As a result, the likelihood of LHR becoming a leakage hub is considered to be very limited.

In order to present as representative a picture of EEA hub traffic as possible, we asked SEO to include passenger traffic and emissions from all flights connecting to each hub of interest. The following route types were included in the analysis:

- Intra-EEA flights transiting through the selected airport. Ex: Lisbon - **Amsterdam** - Athens.
- Flights originating from the EEA and transiting through the selected airports with a non-EEA destination. Ex: Lisbon - **Amsterdam -** Dubai.
- Direct flights from the selected airport to an EEA destination. Ex: **Amsterdam** - Athens.
- Direct flights from the selected airport to a non-EEA destination. Ex: **Amsterdam** - Hong-Kong.
- Indirect flights from the selected airport through an unspecified airport with an EEA destination. Ex: Casablanca - **Amsterdam** - Stockholm.
- Indirect traffic from the selected airports through another EEA airport with a non-EEA destination. Ex: **Amsterdam** - Athens - Istanbul.
- Indirect traffic from the selected airport through a non-EEA airport with a non-EEA destination. Ex: **Amsterdam** - Frankfurt - Athens.

The only flights that were not part of SEO's FF55 model were indirect journeys departing from non-EEA countries, connecting in the EEA, and ending in non-EEA countries (Ex: Atlanta - **Amsterdam** - Cape Town). These represent a small share of the traffic of the EEA hubs chosen for the analysis. The analysis of non-EEA hub traffic used the route types, meaning that flights departing from these hubs, connecting in the EEA and arriving in non-EEA countries were excluded (Ex: Istanbul - **Amsterdam** - Casablanca).[21]

Findings of the analysis[22]

Table 1 shows SEO's calculation of total traffic in the six selected EEA airports in 2018 and in 2035. For 2035, we show two scenarios: one without policy change and one with FF55 proposals. We also show in brackets the relative change in traffic in 2035 compared to 2018 traffic levels.

Airport	**Total traffic (passengers)**		
	2018	**2035 - no-policy change**	**2035 - with FF55**
Paris - CDG	67.4M	94M (+39.5%)	84.9M (**+26.0%**)

[20] Despite the Brexit agreement allowing for reciprocity of kerosene taxation (article 8), Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community.
[21] This explains why the non-EEA hub traffic figures we present below are substantially different from reported figures in OAG flight data and statistics.
[22] These tables are based upon NetCost data from SEO Amsterdam Economics that is available upon request.

Frankfurt - FRA	62.3M	87.9M (+40.9%)	77.9M (**+24.9%**)
Amsterdam - AMS	61.7M	86.9M (+40.9%)	77.5M (**+25.7%**)
Madrid - MAD	57.3M	82.7M (+44.5%)	71.6M (**+25.1%**)
Stockholm - ARN	26.8M	40M (+49.0%)	32.8M (**+22.5%**)
Warsaw - WAW	15.7M	22.5M (+43.7%)	19.4M (**+23.5%**)

Table 1: Total and relative change in traffic in 2035 compared to 2018 in selected European airports

Table 1 shows that despite FF55 measures, traffic volumes in major EEA airports increase substantially between 2018 and 2035. **The number of passengers increases by around 25% in all three major hubs (Paris, Amsterdam, and Frankfurt).** Despite the relative increase in ticket prices caused by climate measures, the demand for flying and traffic will continue to grow in the coming years. However with FF55 measures, emissions are expected to reduce, unfortunately not as fast as traffic growth.

Table 1 also shows that airports situated on the periphery of the EEA, which are supposedly more affected than airports centrally located because FF55 costs increase with the flight distance, experience a substantial increase in passengers. For instance, by 2035, Madrid will gain 25% of passengers and Stockholm will gain 22%. The illustration below (Fig. 2) shows the increase in traffic in 2035 for the six selected airports both in absolute and relative terms.

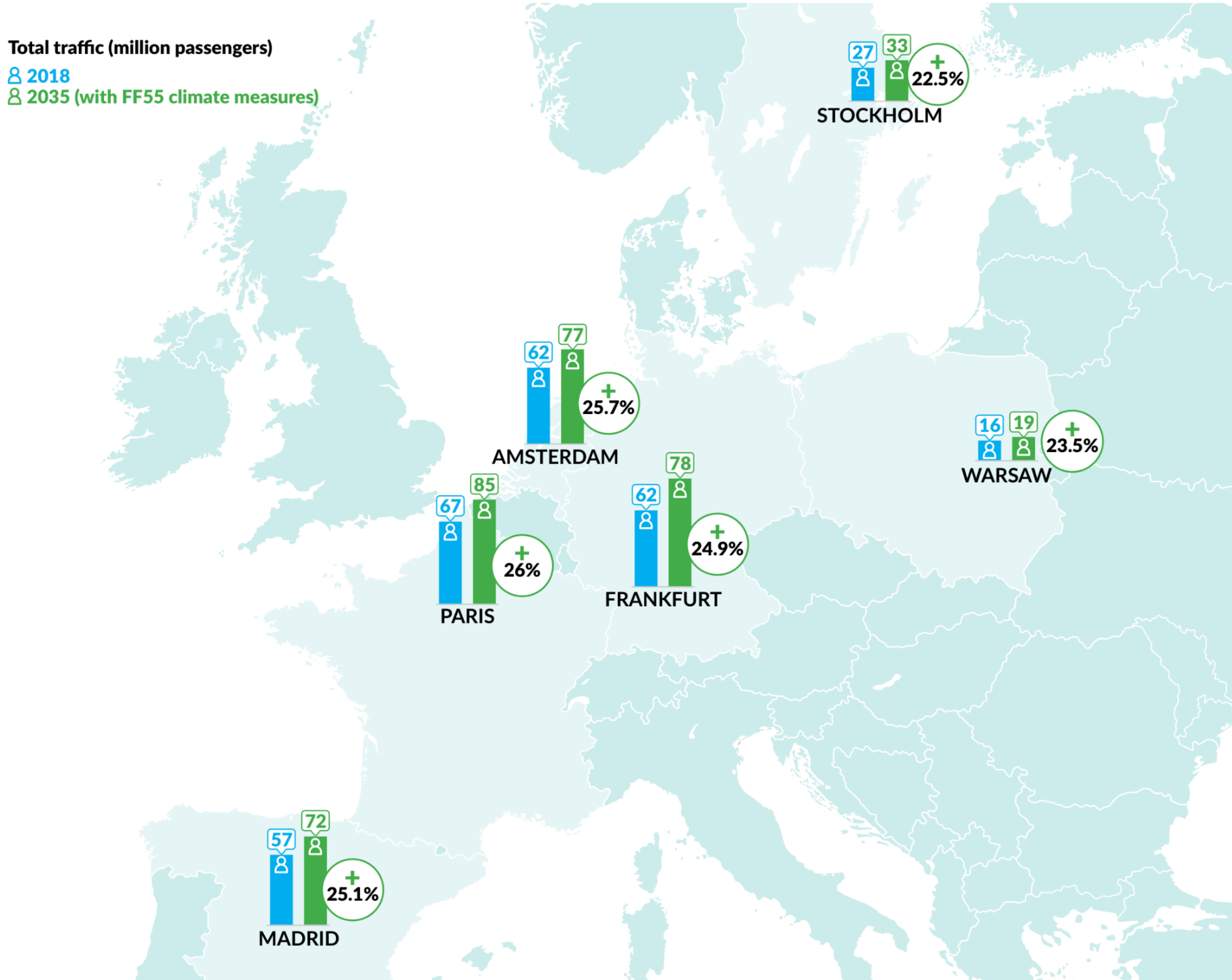


Figure 2: Effect of Fit for 55 measures and traffic increase in 2035 aviation compared to 2018 levels

Table 2 shows SEO's calculation of total traffic in the five selected non-EEA airports in 2018 and in 2035. They were selected because of the carbon leakage potential on these routes. For 2035, we show two scenarios: one without policy change and one with FF55 policies. The no-policy change scenario shows the total number of passengers in 2035 expressed in millions if no climate measures were in place. It also shows in brackets the relative change in traffic in 2035 compared to 2018 if no climate measures were implemented. The right column presents the scenario with FF55 measures. It shows the relative change in traffic in the selected hub as a result of the implementation of FF55 measures in the EEA compared to the no-policy change scenario.

Airport	Total traffic (passengers)		2035 - Additional change in traffic to no-policy change scenario due to FF55
	2018	2035 - no-policy change	
Istanbul - IST	47.3M	81.9M (+73.4%)	**+3.1%**
Dubai - DXB	26.5M	42.5M (+60.8%)	**-1.9%**
Doha - DOH	13M	20.2M (+54.7%)	**<0.1%**
Casablanca - CMN	9.1M	14.1M (+55.0%)	**+1.7%**
London Heathrow - LHR	77.3M	108.3M (+40.0%)	**-8.3%**

Table 2: Change in traffic in non-EEA airports

Table 2 shows that the selected non-EEA hub airports, where no climate policies are in place, experience higher growth rates than EEA airports. Under the no-policy change scenario, by 2035 growth rates range from +40% for London to +73.4% for Istanbul. Under the scenario with climate measures in the EEA, traffic changes but only marginally in most cases. The traffic increase caused by FF55 is minimal in Istanbul (+3.1% compared to baseline 2035 traffic) and Casablanca (+1.6%), and negligible for Doha (<0.1%). Traffic even decreases in Dubai (-1.9%) and London Heathrow (-8.3%). The fact that traffic decreases in these airports is caused by the increase in flight costs on a flight from the EEA to the selected non-EEA hub. The differentiated impact among non-EEA hubs is linked to causes that are inherent to the aviation market (traffic volumes) between the EEA and these hubs, as well as dependent on flight distance. Contrary to carbon leakage claims, **the implementation of FF55 measures does not cause a massive shift of European demand to non-EEA hubs.** Table 2 indicates that most of the traffic growth in non-EEA hubs does not come from a shift in demand from EEA hubs but from growth that would have happened in any case and inherent to the aviation market. It also shows that London Heathrow will not be used as an "avoidance" airport, as traffic volumes do not increase significantly as a consequence of the introduction of the FF55 in the EEA.

Table 3 shows SEO's calculation of the total CO_2 emissions in the selected EEA airports in 2018 and 2035. For 2035, we show 2 scenarios: one with no-policy change showing emissions in 2035 that would occur if no climate measures were in place. The other scenario corresponds to the change in emissions in 2035 with FF55 policies. The emissions are expressed in absolute terms (in $MtCO_2$) and in relative terms (in brackets) compared to 2018 emissions levels. Finally, the right column shows the amount of carbon leakage caused as a result of the climate measures. It refers to the emissions which occur in non-EEA airports as a result of the climate measures and the resulting shift in demand. The amount of leakage is expressed as a share of the emissions savings achieved by FF55 measures. The savings are obtained by calculating the difference in the total CO_2 emissions in 2035 with FF55 measures and the emissions in 2035 with no-policy change. For example, if in a given airport the climate measures have saved 10 $MtCO_2$ but 1 $MtCO_2$ was leaked to another airport, the carbon leakage will be 1%. In addition, the absolute amount of carbon leakage is expressed in brackets in $MtCO_2$.

Airport	CO_2 emissions ($MtCO_2$)			Carbon leakage (as a share of emissions saved by FF55)[23]
	2018	2035 - no-policy change	2035 - with FF55	
Paris - CDG	15.5	21.7 (+40.0%)	17.1 (+9.8%)	**1.7% (0.08 $MtCO_2$)**
Frankfurt - FRA	14.1	19.7(+40.0%)	15.1 (+7.6%)	**1.3% (0.06 $MtCO_2$)**
Amsterdam - AMS	11.3	16.1 (+42.7%)	12.5 (+10.9%)	**1.0% (0.04 $MtCO_2$)**
Madrid - MAD	10.1	14.8 (+47.3%)	11.4 (+13.4%)	**1.3% (0.04 $MtCO_2$)**
Stockholm - ARN	2.9	4.0 (+40.5%)	3.2 (+10.2%)	**2.8% (0.02 $MtCO_2$)**
Warsaw - WAW	1.9	2.7 (+41.2%)	2.0 (+6.1%)	**2.2% (0.01 $MtCO_2$)**

Table 3: Change in emissions and related carbon leakage in EEA airports

Table 3 shows that without climate measures, the emissions in the selected airports would continue to grow exponentially by 2035. The emissions increase ranges from 40% in Paris to a staggering 47.3% in Madrid, compared to the emissions levels in 2018. Table 3 also shows that the implementation of FF55 measures in 2035 mitigates part of the emissions growth compared to the no-policy change scenario. However, these emission savings barely compensate for the growth of emissions caused by the growth of traffic. Despite FF55 measures emissions increase in all selected airports in 2035 compared to 2018 levels, ranging from +6.1% (or 2.0 $MtCO_2$) in Warsaw to +13.4% (or 11.4 $MtCO_2$) in Madrid. It is worth highlighting that the analysis reveals a limited amount of carbon leakage in all selected airports, ranging from 1.0% (or 0.04 $MtCO_2$) to 2.8% (0.02 $MtCO_2$) of the total emissions savings achieved compared to the no-policy change scenario.

To provide a visual representation of the emissions with and without FF55 measures, as well as the associated carbon leakage, the map below (Fig. 3) depicts the following: the **red chart** represents the emissions that would have occurred in 2035 in a no-policy change scenario, the **blue chart** represents the total emissions generated with the climate measures in place, to which the amount of carbon leakage is added and represented **in orange**.

This analysis clearly shows that contrary to some of Europe's leading airline claims, the growth in traffic taking place in extra-EU airports is not mainly caused by FF55 policies but by the traffic increase that would occur regardless. Unfortunately, the analysis also shows that more ambition is needed on top of

[23] This is the ratio between the carbon leakage as explained in section 1 and the CO_2 savings expected from FF55 measures.

FF55 to bring aviation emissions down in line with the EU's climate objective, but it is also clear that without FF55 policy measures the growth in emissions would be left completely unaddressed.

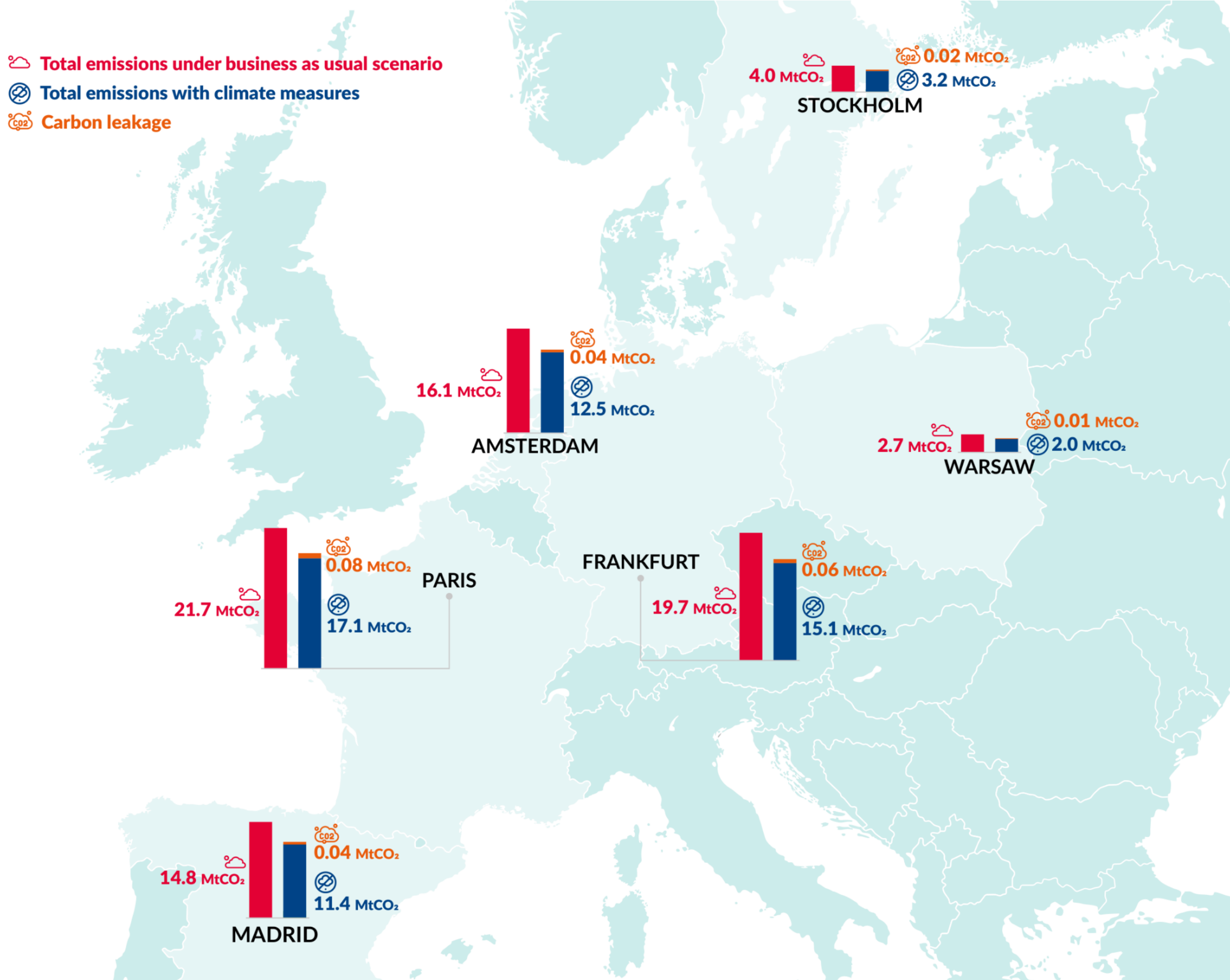


Figure 3: Effect of Fit for 55 measures, CO_2 emission and carbon leakage in 2035

Despite carbon leakage being minimal as previous results have shown, measures to mitigate this shift would increase the overall effectiveness of the climate measures. They would allow upward revisions in ambition and show internationally that climate measures can be introduced while safeguarding European competitiveness.

4. How to address potential carbon leakage

Rather than using the existence of any degree of carbon leakage as justification to weaken climate measures, regulators should instead explore policies that can help minimise the level of carbon leakage without reducing the ambition of their climate measures.

4.1 Bring down SAF costs

The level of carbon leakage can be relative to the cost of the measure. In theory, the more expensive the measure, the more airlines will transfer the cost onto the price of a ticket and the more passengers will seek to avoid routes where they apply. The use of SAFs is seen as the most important cost of FF55 on the most sensitive routes to carbon leakage - direct flights to Asia.[24] If a measure mandates the use of a certain mitigation technology which is still more expensive than the legacy technology (fossil jet fuel), the higher the potential carbon leakage risk. However, the costs of mitigation technologies such as batteries, and renewables have often been overestimated and mandating the use of these technologies through regulations (CO_2 standards for cars and renewable energy targets) has enabled these to come to market and gradually decrease costs. The same can happen for SAFs, especially as ReFuelEU creates a guaranteed market for this technology through its mandated uptake. However, for the cost reduction potential to be unlocked, two conditions need to be met:

1) **A coherent regulatory environment under ReFuelEU:** one of the reasons for the failure to bring about the uptake of SAFs is uncertainty over the sustainability of different feedstocks, particularly crop and waste oil-based feedstocks. ReFuelEU's task is to mandate genuinely sustainable SAFs for aviation, targeting the use of sustainable biofuels. While food crops and palm oil by-products (PFADs) are excluded, other problematic feedstocks like animal fats and used cooking oil remain eligible, posing sustainability and scalability challenges. A notable aspect of RefuelEU is its emphasis on synthetic fuels, specifically e-kerosene, as the key SAF that can be sustainably scaled up to meet aviation fuel demands. Negotiators have reached an agreement to implement a synthetic fuel mandate, with percentages of 1.2% between 2030 and 2031, and 2% between 2032 and 2035.[25]

2) **Industrial support:** scaling up e-kerosene production requires scaling up renewable hydrogen production, which is used as a feedstock. This involves building industrial capacity and attracting a mix of public and private investments to support the production of renewable hydrogen. Public investment should be targeted at projects which reduce cost and are funded within the sector. Auctioning or competitive bidding scheme, a funding mechanism where money is awarded to producers who can produce green hydrogen or e-fuel at the lowest cost, can be the right instrument to achieve this. Through the scheme, producers receive public support to cover operational costs between a pre-agreed fixed price (the strike price) and the market price (the reference price) which can be either the price of renewable hydrogen or the carbon price. Such auctioning schemes can take several forms:
    - Through a **Contract for Difference** (CfD), whereby a public entity pays the price difference between the auction winning price (the strike price) and the renewable hydrogen market price (the reference price). CfDs have been used successfully in the UK to bring about cost reductions in offshore wind. The European Commission is implementing such a competitive bidding scheme for the production of renewable hydrogen through the Innovation Fund using fixed premiums and has announced a first auction with a budget of €800 million at the end of 2023.[26]

[24] Adler, M., Boonekamp, T., & Konijn, S. (2022). *Aviation Fit for 55 - Ticket prices, demand and carbon leakage.* SEO Amsterdam Economics & Royal Netherlands Aerospace Centre.
[25] Council of the European Union. (2023). *Regulation on ensuring a level playing field for sustainable air transport - Analysis of the final compromise text with a view to agreement.*
[26] European Commission. (2023). *Communication: A green deal industrial plan for the net-zero age*.

- Via a **Carbon Contract for Difference** (CCfD), whereby the public entity guarantees the difference between the strike price and the yearly average price of the EU ETS.
- Or with a **fixed premium**, providing the producer with a fixed amount per produced unit.

INFO BOX: The cost of a 2% e-kerosene mandate

We analysed the impact on ticket prices of the REFuelEU 2% e-kerosene mandate in 2032. Based on the Impact Assessment from the European Commission,[27] the price of e-kerosene will be about €3/kg by then, while the price of fossil jet fuel will be €1/kg. The fuel consumption of aircraft will be about 24 kg per passenger per 1000 flight kilometres. This means that on a 2000 km flight (Paris - Helsinki), one passenger will consume 48 kg of fuel, costing €48 if only kerosene is used. If 2% of those 48 kg is e-kerosene and costs €2/kg more, this results in an additional cost per passenger of €1.92 for a 2000 km flight.

It is also important to highlight that the costs of e-kerosene production will substantially decrease in the coming years. McKinsey's 2020 Clean Skies for Tomorrow report identifies PtL fuels as the SAF with the biggest cost reduction potential. PtL production pathways are capital intensive, but these costs are expected to decrease as electrolysers become cheaper. Production cost will also decrease with scale-effect mainly driven by the global shift to renewable energy production such as renewable electricity and hydrogen. This shows that while PtL is currently the most expensive SAF (between $1500-5500/t), prices are expected to decrease significantly and could reach €1000-1500/t by 2050, as referenced in Fig. 4 below.

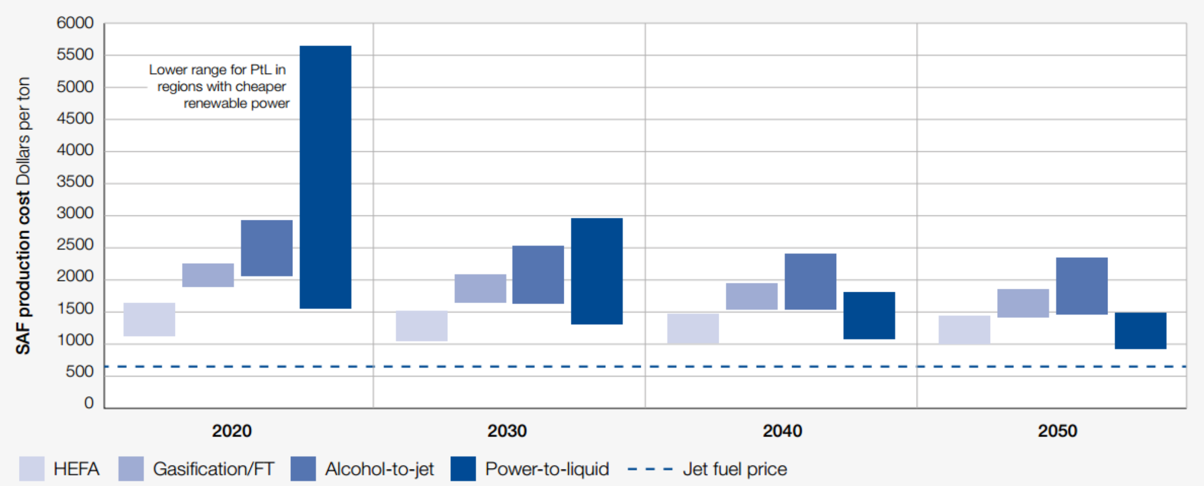


Figure 4: Global SAF production cost for selected feedstocks[28]

[27] European Commission. (2021). *Impact assessment accompanying the proposal for a Regulation on ensuring a level playing field for sustainable air transport* (No. SWD(2021) 633 final).
[28] Wolff, C., & Riefer, D. (2020). *Clean Skies for Tomorrow Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation*. World Economic Forum; McKinsey & Company.

3) **Demand side**: on the demand side, the reformed ETS[29] puts in place a subsidy scheme using the revenues of the carbon market to support the purchase of SAFs by airlines. It consists of a financial instrument of €2bn from 2024 to 2030, which will cover the price gap between the eligible SAF and fossil kerosene. Different price coverage rates are set for the different types of eligible SAFs:
   - 70% of the price differential for renewable hydrogen and advanced biofuels
   - 95% of the price differential for synthetic kerosene
   - 100% of the price differential for any SAF in airports situated on islands smaller than 10,000 km_2, smaller airports and at airports located in outermost regions.
   - 50% of the price differential for other eligible biofuels

The coverage of the price differential for synthetic kerosene and hydrogen is an encouraging sign and provides an additional incentive for rolling out an e-kerosene and hydrogen industrial value chain for aviation. Inversely, the financial support of biofuels is unwelcome because it provides a subsidy to SAFs with limited growth potential given limited feedstock availability which can have a harmful environmental impact.

4.2 Regulate access to the European market

A potential cause of carbon leakage could be linked to competitive distortions caused by allowing airlines based outside Europe to compete with airlines based in Europe. For example, airlines based in Turkey or the UAE could offer cheaper flights to growing markets in Asia through their hub airports to channel more traffic towards their airports. Instead of flying direct from Europe, European customers would first fly to these hub airports and then onwards, benefiting from cheaper fares but also avoiding climate measures at these hubs. Although SEO's assessment referenced above highlights that there is only a minimal risk of carbon leakage, this risk might increase from 2035 as EU climate measures tighten (i.e. SAF mandates are increased).

For this shift to happen, non-European airlines need access to the European market to bring customers to their hub, which raises the question as to how this access is granted, whether that access can be easily expanded and whether limits can be placed on such an expansion. Put simply: non-European carriers need access to the EU's market, and this provides the EU leverage to demand that similar climate measures are put in place in those jurisdictions to avoid carbon leakage concerns.

Unlike the trade of goods, which is governed by the WTO, aviation access is granted by governments through agreements negotiated either bilaterally between States or at EU level with third countries. These are known as Air Service Agreements. As soon as an EU-wide Air Service Agreement is negotiated and agreed upon, it replaces national bilateral agreements concluded by member states directly with third countries. These agreements can differ in nature. T&E has commissioned legal research on two particular types, which are relevant to this paper.

[29] Directive (EU) 2023/958 amending Directive 2003/87/EC as regards aviation's contribution to the Union's economy-wide emission reduction target and the appropriate implementation of a global market-based measure (Text with EEA relevance) (2023).

Can Moscow and Istanbul compete with German airlines?

Lufthansa has recently claimed that Europe's FF55 measures might cause passengers to shift from German hub airports to hub airports in Turkey and Russia.[30] For this to be a risk, Turkish and Russian airlines need access to the German market, access which was negotiated bilaterally between Germany and these two countries (there is no EU-level market access ASA between the bloc and these countries). The analysis (which is available on our website) examines these ASAs to determine the feasibility of increased access to the German market.

1) **Russian ASA:** The Germany-Russia ASA, which dates from 1993, is rather limited in its level of market access. It contains what is known as a "predetermination mechanism", where pre-approval is needed before carriers can increase their access to the counterparty's market. Russian airlines therefore cannot increase access to the German market in order to expand hub activities without the approval of the German government.

2) **Turkey ASA:** The Germany-Turkey ASA is a more liberal agreement, dating from 1962. Operators are not bound by strictly determined capacity rules, and must only notify the contracting parties of intended operations one month in advance. Turkish Airlines therefore can increase its market access to Germany in order to expand its hub activities. However, this agreement does contain renegotiation and termination provisions, which if used judiciously can be used to limit carbon leakage and market distortion. Through this strategy, Germany would inform Turkey that it has to introduce equivalent measures at its hub by a certain period (i.e. 10 years) or the agreement will be terminated.

The information in the above box demonstrates that a much closer examination of ASAs is required to determine the leakage and competitiveness effects of these measures. For too long, ASA negotiation has focused on increased market access with little consideration for environmental and social effects. ASAs are negotiated behind closed doors but with preferential access for industry representatives. Negotiating mandates often remain under wraps.

The above proposal to terminate ASAs, even with a substantial notification period, may strike some as an extreme response: it goes against decades of further liberalisation in the sector. However, it is a perfectly reasonable response to a potential situation where European airports are increasingly required to blend SAFs, while competitor airports operate on 100% fossil fuel and international arenas such as ICAO fail to provide credible decarbonisation pathways. In the 2030s, while the world should be on a path to decarbonisation, such a scenario is totally unacceptable.

The impact of this strategy can be mitigated: the EU can give financial support to help these countries develop their SAF industry. The requirement to adopt equivalent measures could be liberally interpreted

[30] Lufthansa Group. (September/October 2021). *Fit for 55 Nachbesserungen erforderlich, um Carbon-Leakage zu verhindern und fairen Wettbewerb im Luftverkehr zu sichern.*

to allow somewhat lower levels of SAF, temporarily. However, it is certainly a strategy which should be pursued.

5. Conclusions and recommendations

The above shows that there is very little risk of carbon leakage from the EEA aviation market until at least 2035 and ample measures are available to mitigate the potential and limited risk of carbon leakage. Instead of weakening the EU's FF55 package measures, which some have suggested, it is imperative to focus on pursuing and strengthening these measures. As the current package falls short of meeting the emission reduction required by the Paris Agreement, the EU should finalise the adoption of the Fit for 55 measures and introduce a tax on kerosene at least on intra-EEA flights through the revision of the Energy Taxation Directive.

By implementing additional measures, the EU can further enhance the carbon-saving effect of the FF55 package and effectively reduce the limited risk of carbon leakage. These include:

- Adopting an effective industrial strategy to drive down prices of synthetic kerosene and bridge the gap with fossil kerosene. This includes effective implementation of the ReFuelEU mandates and an increase in SAF use above the mandate where possible.
- Using existing legal mechanisms to restrict access to the European aviation market from airlines operating from non-EU hubs which do not introduce equivalent climate measures.

Further information

Roman Mauroschat Aviation Policy Officer Transport & Environment roman.mauroschat@transportenvironment.org Mobile: +32(0)4 88 24 89 01	**Matteo Mirolo** Aviation Policy Manager Transport & Environment matteo.mirolo@transportenvironment.org Mobile: +32(0)4 84 32 00 45	**Valentin Simon** Senior Data Analyst Transport & Environment valentin.simon@transportenvironment.org