Schwingeler Consulting

Evaluation of the **impact of** Europe's initiative **"Fit for 55"** **on air traffic**

- update May 2024 -

Content

Executive Summary

Objective and Methodology: The European Union's "Fit for 55" legislation is designed to reduce greenhouse gas emissions by 55 % by 2030, with significant implications for the aviation industry. This analysis evaluates the impact on European aviation, specifically in terms of carbon leakage and competitiveness. The study is designed to provide answers to the questions of how the costs related to the "Fit for 55" measures develop over the years and whether this creates conditions that lead to carbon leakage and distort competition.

The Analysis utilizes a combination of real production data, industry forecasts, and regulatory impact simulations across various typical airline routes. The study does not attempt to forecast expected developments, but rather illustrates scenarios that were created with the support of experts. Costs were determined on the basis of current and future market prices and extrapolated into the long-term projection. Due to the long-term outlook up to 2050 and the related challenges of estimating price trends, two scenarios were used in the study. An upper and lower boundary of market price development is assumed, in which future prices are very likely to remain. This range was only defined for Sustainable Aviation Fuels (biogenic SAF and PtL), as an excessive number of variables would lead to inconsistent results in the study. Moreover, the influence of Sustainable Aviation Fuels on cost development is the most significant. Technological developments and fleet replacements were considered as annual increase of efficiency and thus a reduced fuel consumption.

Key Regulations Analyzed:

1. **ReFuelEU Aviation:** Mandates an increasing share of Sustainable Aviation Fuels (SAF) in aviation fuel.
2. **EU Emissions Trading System (EU-ETS):** Requires airlines to purchase emission certificates, with an increasing share being auctioned.
3. **Energy Taxation:** Proposes including aviation in the EU energy tax directive, imposing a tax on kerosene starting in 2028. Temporarily on hold.
4. **CORSIA:** Focuses on offsetting CO2 emissions from international flights but does not apply to flights within Europe.

Regulatory Impact on Selected Routes: The report details the financial impact of these regulations on several representative routes, emphasizing cost developments due to the SAF blending mandate and emission trading costs:

- **Intra-European Routes:** Significant cost increases are projected, such as on the Hamburg-Munich and Dusseldorf-Palma routes, with SAF blending mandate being a major cost driver.
- **Long-Haul Routes:** Routes like Stockholm-Bangkok and Paris-Hong Kong with a transfer at a European hub show severe competitive disadvantages compared to transfers via non-EU hubs due to higher regulatory costs.

Competition and Carbon Leakage: Unilaterally increased costs for European airlines would most likely lead to carbon leakage, a shift of market shares to non-EU carriers that do not face the same regulatory costs, potentially leading to an overall increase in global emissions rather than a decrease. This is particularly noted on long-haul routes where European airlines could lose a substantial market share to competitors with hubs in Turkey, Dubai, or other regions outside the stringent EU regulatory environment. As the cost increases caused by the "Fit for 55" measures for airlines using European hubs are driven primarily by the high prices for SAF and the blending mandate starting as early as 2025, the significant disadvantages for these carriers will be visible in the near future. The increase in the blending mandate in the following years will increase the negative effects accordingly.

Economic Impact: European airlines are projected to face significant revenue losses as the regulatory costs render them less competitive. Long-haul passenger and cargo services are particularly affected, with potential shifts in demand to non-EU carriers ranging between 5-25 % by 2050. This shift represents a substantial financial risk for European aviation stakeholders.

Conclusions: The "Fit for 55" measures, while aligned with environmental goals, pose serious economic threats to the competitiveness of European airlines. Adjustments to the regulatory approach may be needed to balance environmental objectives with economic realities.

Final Thoughts: The analysis underscores the need for a careful review of the "Fit for 55" policies, illustrating that without adjustments, the European aviation sector could face severe competitive disadvantages, leading to economic challenges and even unintended environmental consequences.

1 Methodology

The European Union has developed the "Fit for 55" initiative to achieve climate neutrality by defining and scheduling appropriate measures. It consists of a set of inter-connected proposals to implement the ambitious new 2030 climate target to reduce emissions by 55%. Three files thereof address CO_2 reduction in aviation (RefuelEU Aviation, EU Emissions Trading Scheme for Aviation, Energy Tax). EU-ETS Aviation and ReFuelEU Aviation have been adopted in 2023 and will be in force year to date. The proposal on Energy Taxation is highly controversial and still in the legislative process.

With our analysis, we evaluate the impact of the "Fit for 55" legislation on Carbon Leakage and the competitiveness of European aviation. We describe the effects using data and examples for Germany. However, the effects are chosen in such a way that they can be transferred equally to other participating countries in Europe.

To evaluate the effects, we use a model which is based on actual production for the past and a production forecast in line with the "Climate Path Study" of the German industry association BDI[1] as described in the according document of BDI. The production is translated into the factors determining the "Fit for 55" measures. We use the resulting factors for a calculation of effects that illustrates the regulation impact per passenger on selected routes, where such routes cover a scope of various typical route and demand patterns. Finally, we evaluate and illustrate the impact of regulative measures on competition and point out arising Carbon Leakage.

We use publicly available sources where available, which are listed and linked to in chapter 8. In the absence of such sources, we use assumptions and estimates, which are described and justified in chapter 2. Any input information is listed in chapter 2. Where we have to use assumptions, we explain how the respective parameters are determined.

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[1] see: "Climate Paths 2.0 – A Program for Climate and Germany's Future Development", October 21, 2021 (https://english.bdi.eu/publication/news/climate-paths-2-0-a-program-for-climate-and-germanys-future-development/)

The assumptions for SAF prices are expressed as scenarios for highest and lowest expected values.

The SAF blending mandate raises several questions. Available quantities and prices today are just as uncertain as demand. Therefore, we base this update on two scenarios in which we describe a minimum and a maximum price scenario for the SAF blending mandate related costs.

2 Description of the underlying evaluation model

The evaluation is based on a model that combines a broad scope of input data and allows to calculate different scenarios.

2.1 Basic factors related to production

2.1.1 Production

The production of air traffic is expressed in available seat kilometres (ASK) resp. available ton kilometres (ATK). For 2019-2023, the values used in our model are based on actual figures for Germany related air transportation as published by CIRIUM / SRS Analyser.

The future years' production is based on the Climate Path Study developed by BCG and Bundesverband der Deutschen Industrie e. V. (BDI).

This path is distributed to the traffic areas

- Germany domestic
- Intra EU
- European Economic Area (Switzerland, Norway, Iceland, Liechtenstein)
- UK
- Non-EU

based on the structure of the actual values 2023 and the input of BDL to the Climate Path Study of BDI.

2.1.2 Distribution of production and fuel consumption / emissions to passenger and cargo services

As the planned regulation differentiates between passenger and other air services, we have to breakdown fuel consumption to passenger carriage and cargo/mail/others.
The total fuel consumption is based on actual figures for Germany as published publication by the German government ("Amtliche Mineralöldaten für die Bundesrepublik Deutschland" by "Bundesamt für Wirtschaft und Ausfuhrkontrolle", value for heavy air turbine fuel) for the full year of 2019. The total consumption is derived from the production figures and split up between passenger services and cargo/mail/others in a ratio of 75% passengers: 25% based on the above described considerations.
In this evaluation, the total fuel consumption of air traffic is assumed to grow relative to the production. As we assume an increase of efficiency, the specific consumption is reduced by 1.5% annually starting in the year 2020.
For the calculation of emission tons, we apply a factor of 3.15 on the fuel consumption.

The applied prices for fossil fuel have been agreed between experts from BDL member airlines (BDL = Bundesverband der Deutschen Luftverkehrswirtschaft / German Aviation Association; further information see chapter 6 "Glossary and list of abbreviations").

2.2 Underlying factors for evaluating costs of measures

2.2.1 ReFuelEU-Aviation (blending fossil fuel with SAF)

Adding SAF to aviation fuel is part of the requirements that intend to reduce the aviation industries' CO_2 emissions.

Based on the current state of discussion we assume for our evaluation the following SAF blend minima:

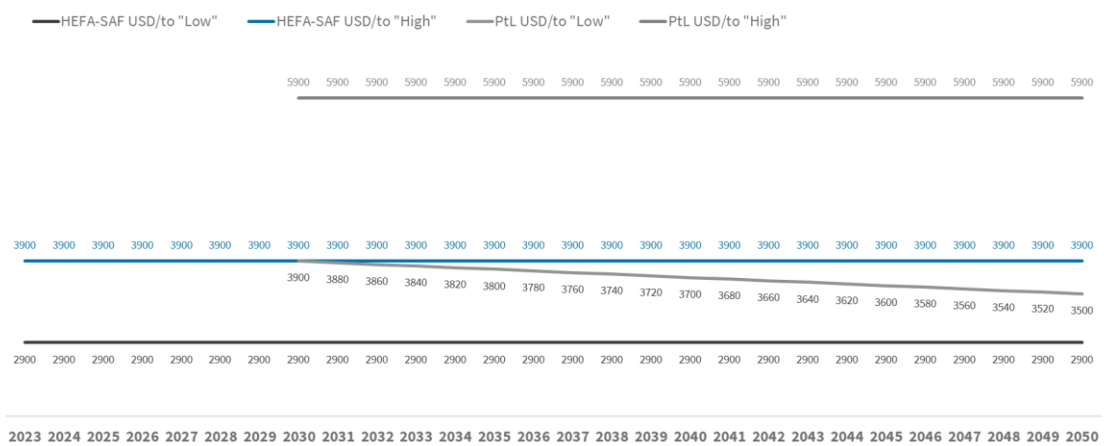
	2025	2030	2035	2040	2045	2050
All SAF vs. total fuel supply	2%	6%	20%	34%	42%	70%

Table 1: mandatory share of SAF blending in kerosene

The ReFuelEU regulation contains minimum refuelling quantities: aircraft operators shall refuel at least 90% of the annual fuel required on their flights departing at a given EU airport at that airport. It covers all flights departing at EU airports with more than one million traffic units per year (equivalent to one million passengers or 100,000 tons of air cargo).

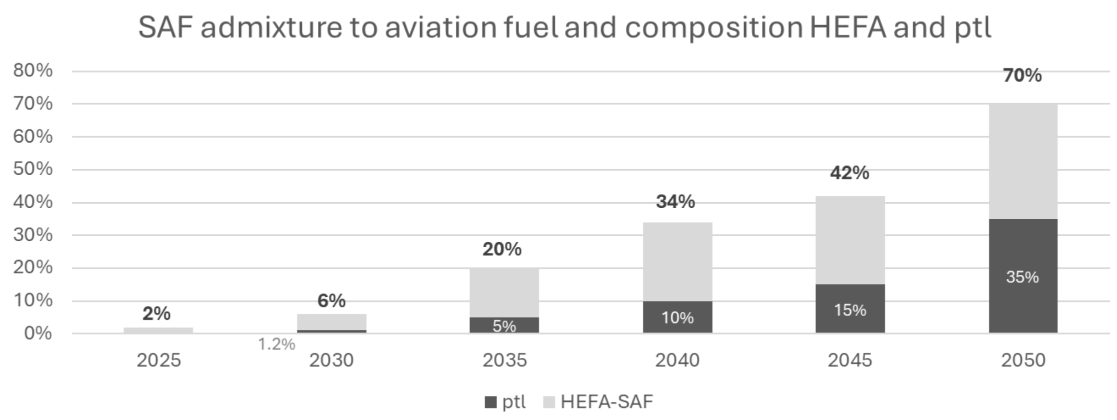
The price for SAF in this model corresponds to a mixture of biological and synthetic fuels. The range of SAF prices paid today provides an initial indication of future SAF prices. Due to the currently scarce and barely increasing supply of SAF in general and PtL in particular, it cannot be assumed that prices will fall significantly in the medium term. In scientific attempts to estimate (future) SAF prices, it should be noted that production costs are often assumed. A relatively small margin is applied to these, and a price is formed from this. From today's perspective, however, these prices from the academic literature are not comparable with those of the market. This is because pricing on the market is not cost-based, but primarily takes into account other factors such as competition (foreseeably low), the shortage of SAF (continuously high), the ReFuelEU quota obligation and also the price of fossil kerosene or the difference to this.

The assumptions for fuel groups have therefore been agreed between experts from BDL member airlines. The following graph shows the price scenarios for HEFA-SAF (Hydrotreated Esters and Fatty Acids) and Power-to-Liquid (PtL) fuels:



Graph 1: SAF prices in USD per ton until 2050 (for the following calculations translated into EUR using an exchange rate of 1.10 USD => 1.00 EUR and a price for fossil kerosene of 900 USD/to)

For the composition of SAF prices we use the following distribution between HEFA-SAF and PtL:



Graph 2: predicted composition of SAF

The composition of SAF is based on the results of a panel of experts from BDL member airlines.

2.2.2 European Emission Trading System (EU-ETS)

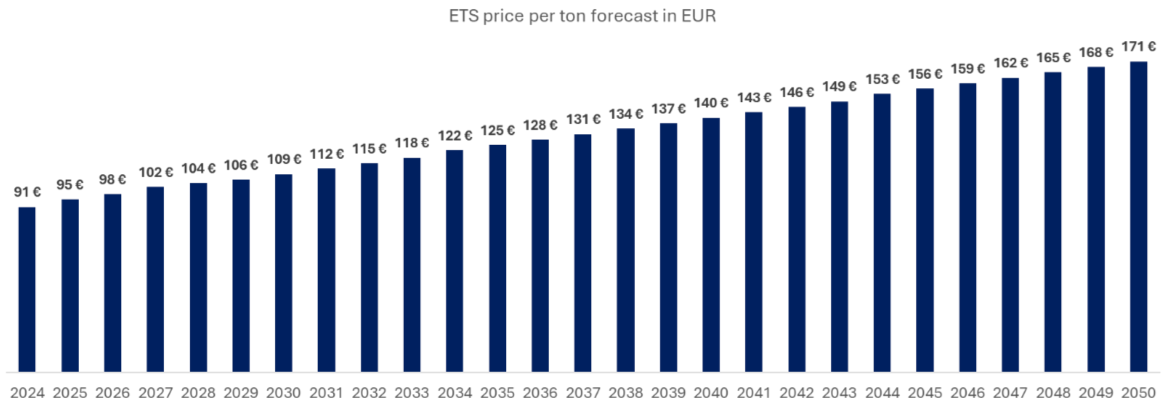
For each ton of CO_2 emission on routes within Europe, airlines require related certificates. Actually, a share of such certificates is distributed free of charge, but an increasing portion is payable.

Against the background of its target of 100% payable certificates until 2026 distributed to airlines to be auctioned, we set a value of 76% for 2024 (today) and 85% for 2025.

In the context of weakening economy, the price of certificates has fallen significantly during the recent months. The expectations of market participants indicate that a substantial price increase is not likely in the near future. Based on this, price assumptions from various studies that still assume higher prices of certificates will have to be revised accordingly.

In this impact assessment, we continue to assume constantly increasing prices, but from a lower base and with a smaller gradient. This is also in line with the market's price expectations. In addition, the peak prices of more than € 100 per ton in 2023 were also the result of speculation and did not reflect the actual demand. In the long term, the price performance will be driven primarily by the political parameters and the potential of technological innovation. The estimation of certificate numbers and prices have been evaluated as follows:
The relevant fuel quantities and emissions correspond to traffic in the EU27+EFTA/UK traffic segment. Here, too, both directions are to be used. To define emissions, fuel consumption is related to production. For the purpose of mapping the reverse direction, international departing traffic will be doubled.

The applied price forecast for ETS certificates is shown in the following figure:



Graph 3: expected price development

2.2.3 Energy Taxation

Our model factors reflect the current proposal on the inclusion of air traffic in the taxation of energy, the so called "Kerosene Tax". The EU directive intends to include air traffic into the energy tax ruling as off 2028. Our model applies energy tax of € 0.21 per litre as of 2028 and € 0.42 per litre as of 2033 for fossil fuels used on intra-European flights. The assumptions on the development of Energy Taxation Directive pricing are based on the compromise proposal of the Swedish EU Council Presidency in 2023.

2.2.4 CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation)

In 2016, the International Civil Aviation Organization (ICAO) adopted a global market-based mechanism (CORSIA) to address CO_2 emissions arising from international aviation.

CORSIA focusses on a CO_2-neutral growth of international aviation from 2020 onwards by compensation of additional emissions through project credits (offsets) and emission allowances from emissions trading systems. The corresponding set of rules and standards were decided in 2018 and came into effect on January 1, 2019, starting with a reporting of emissions by the providers of air traffic, followed by a voluntary participation 2021-2026 and mandatory application as of 2027. Until September 2021, 107 countries have volunteered which cover about 77% of all international aviation activities, while the mandatory application starting in 2027 involve more than 90%.

CORSIA applies to all ICAO member states whose aircraft operators have exceeded 0.5% of global air traffic in 2018 on international flights with aircraft with a maximum take-off weight of more than 5.7 tons. There are exceptions for countries from the groups of Least Developed Countries and small island developing countries. CORSIA is not applicable on flights within Europe.

Different from the initial approach and as a consequence of the pandemic situation, ICAO decided in July 2020 to use the year 2019 as baseline instead of average annual values of 2019 and 2020 to measure the growth to be compensated by CORSIA certificates.

In view of the given set of rules, we expect the following impact of CORSIA:

- Along with its mandatory introduction, the effects of CORSIA will affect all major aviation states. It thus remains neutral in terms of competition between European and Non-European providers, CORSIA will not create or increase Carbon Leakage.
- CORSIA is applicable on growth of emissions versus 2019 only. Considering the significant impact of the pandemic situation on air traffic demand and the blending of SAF according to the ReFuelEU regulation in Europe, our evaluation sees no increase of emissions versus this baseline.
- Even if CORSIA would mean burdens for European airlines, we currently see no reliable estimation of the related certificate prices.

We refrain from a description of any effects related to CORSIA as:

- We do not see any growth of emissions versus the baseline 2019 that would require the acquisition of CORSIA certificates.
- Even if CORSIA would have impacts on airlines' costs, they would not create or increase Carbon Leakage.
- There are no reliable estimations of prices of CORSIA certificates.

The analysis clearly demonstrates that by far the largest share of the regulatory costs caused by the "Fit for 55" measures as of 2025 are based on the ReFuelEU quotas. For intercontinental flights without transfer in the EU, the blending quota of sustainable fuels is the only cost driver attributable to "Fit for 55" measures. For other flights, the share on long-haul routes is up to 95 percent, while ReFuelEU also accounts for up to 73 percent of regulatory "Fit for 55" costs on short and medium-haul routes within Europe. The costs for ETS and ETD represent a smaller fraction compared to the blending of Sustainable Aviation Fuels.

3 Route scenarios

The initial model is designed to calculate overall figures and factors for each year between 2019 and 2050. In this document, we show the according results for today (2024) and the years 2025, 2030, 2035 and 2050.

For selected routes from European airports, we illustrate the impact of the application of the planned measures of the "Fit for 55" initiative. In order to reflect the broad scope of possible impacts, we have selected routes which represent the most relevant route types:

- Intra-European short and medium-haul flights
  - Business traveller demand driven intra-European route: Hamburg–Munich
  - Intra-European medium-haul leisure route: Dusseldorf–Palma de Mallorca
  - Intra-European leisure demand driven long route: Hamburg–Las Palmas/Gran Canaria
- Long-haul flights
  - Southeast Asian long-haul route Stockholm–Bangkok v.v. with high leisure demand: comparison of transfer in Munich versus transfer in Istanbul
  - Southeast Asian long-haul route Amsterdam–Singapore v.v. with high business demand: comparison of transfer in Munich versus transfer in Dubai
  - East Asian long-haul route Paris–Hongkong v.v. with high business demand: comparison of transfer in Frankfurt versus transfer in Istanbul
  - East Asian long-haul route Barcelona–Tokyo v.v.: comparison of transfer in Munich versus transfer in Istanbul
  - African long-haul route Hamburg–Johannesburg v.v.: comparison of transfer in Paris versus transfer in Istanbul
  - North American long-haul route Frankfurt–Seattle: comparison of Nonstop flight versus transfer in London
- Cargo flight
  - Freighter services Frankfurt–Shanghai: nonstop service versus reloading in Istanbul

The calculations reflect return flights. The incremental costs are listed in the description of each scenario. The underlying specific fuel consumption of the operating aircraft type per route is taken from an estimation provided by German airlines, the CO_2 emissions are calculated based on the fuel consumption.

For each route we show scenarios for the mentioned years and compare them to today's status. The following elements are considered as drivers of cost increase:

- Costs for blending mandate for SAF (ReFuelEU regulation)
- Directive on the European Emission Trading Scheme for Aviation (EU-ETS)
- Regulation on Energy Taxation

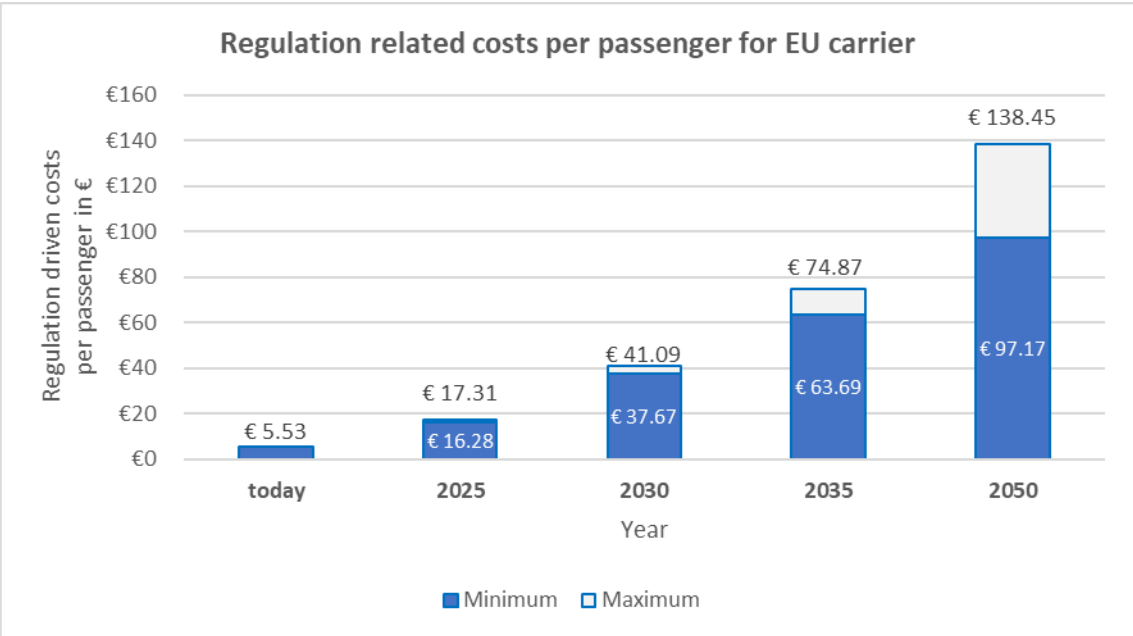
3.1 Example for business traveller demand driven intra-European route: Hamburg-Munich

With a great circle distance of 600 km, this route is a typical short haul business traffic affected flight. It is also relevant as feeder/de-feeder service for the hub in Munich. We calculated the operation, using the average of the respective Lufthansa subfleet.

EU regulation apply in both directions. That contains SAF blending mandate, EU-ETS regulation and Fuel Tax Regulation.

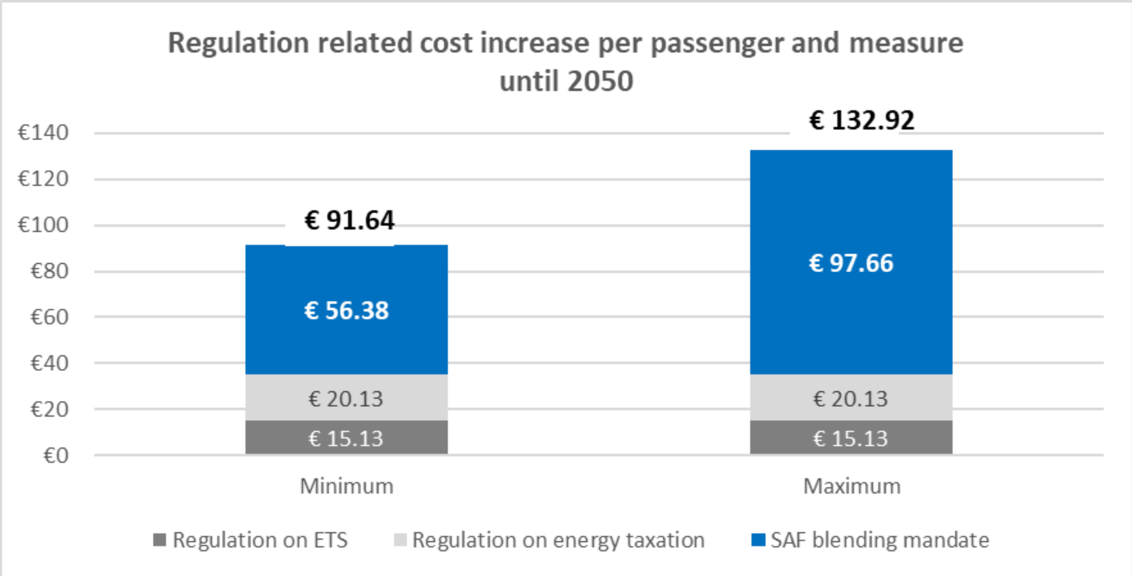
3.1.1 Cost development

Today, the regulation related costs per passenger and round trip sum up to € 5.53 for ETS costs distributed to a single passenger. The gradual inclusion of "Fit for 55" measures (SAF blending mandate, EU-ETS, energy taxation) grow the costs in a minimum scenario to € 97.17 in 2050, in the maximum scenario even to € 138.45.



Graph 4: Hamburg–Munich regulation related costs per passenger by scenario year

On the route between Hamburg and Munich, the “Fit for 55“ regulations increase the costs per passenger by € 91.64 in a minimum and up to € 132.92 for the maximum scenario.



Graph 5: Hamburg–Munich: cost increase until 2050 by measure

On this route, the major cost increase arises from the SAF blending mandate. They stand for 61.5% of the total cost increase in a minimum and 73,5% in a maximum scenario. SAF related costs grow by € 56.38 contributing to a total increase of € 91.64 in the minimum scenario, while the maximum scenario sees a plus of € 97.66 for SAF related costs and total incremental burdens of € 132.92.

3.1.2 Impact on competition

Both route ends are located in Germany. Accordingly, the *complete* regulation in Germany and the European Union applies, regardless of the operating airline. All airlines operating the route bear identical burdens, the regulation remains neutral to competition. Even flights to/from neighbour airports such as Salzburg and Lubeck would completely be subject to EU rules.

A competitive impact arises for demand using the route as feeder service *via* Munich as hub compared to feeder services into hubs outside of the EU27+EFTA. The related effects for transfer demand are illustrated in some of the following chapters.

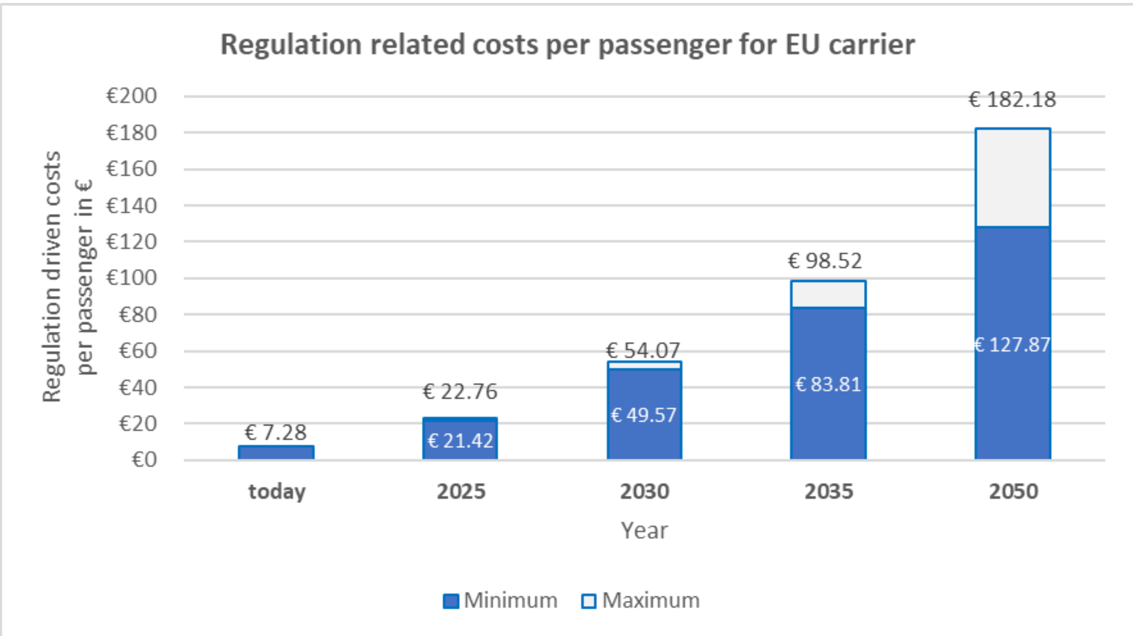
3.2 Example for an intra-European medium stage leisure route: Dusseldorf–Palma de Mallorca

With a great circle distance of 1,342 km, this route is a typical intra-European leisure flight. We calculated the operation, using the average of the respective subfleet of BDL member airlines.

The EU regulations apply in both directions. That contains the blending mandate for SAF, EU-ETS and Fuel Taxation.

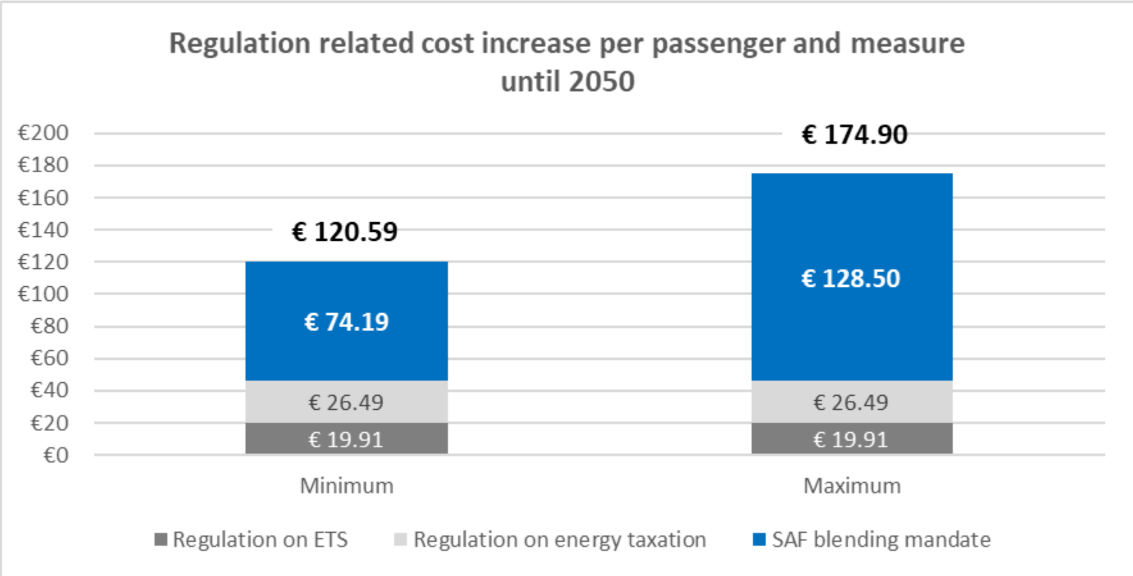
3.2.1 Cost development

The regulation related costs per passenger and round trip today sum up to € 7.28 (ETS). The gradual inclusion of "Fit for 55" measures (SAF blending mandate, EU-ETS, energy taxation) increase the costs per passenger until 2050 – depending on the scenario – to between € 127.87 (minimum) and € 182.18 (maximum).



Graph 6: Dusseldorf–Palma de Mallorca regulation related costs per passenger by scenario year

The "Fit for 55" regulations would increase todays' costs per passenger by another € 120.59 (minimum scenario) up to € 174.90 (maximum scenario). Considering the high price sensitivity of leisure passengers, the resulting increase of ticket prices will go along with a significant decrease of demand on this as well as on comparable routes.



Graph 7: Dusseldorf–Palma de Mallorca: cost increase until 2050 by measure

The most significant impact arises from the SAF blending mandate. Even in a minimum scenario, this measure increases the costs by € 74.19 and in a maximum scenario even up to € 128.50. Translated into percentages, the SAF stands for 61.5% (minimum) to 73.5% (maximum) of the total increase.

3.2.2 Impact on competition

Both route ends are located in the European Union. Accordingly, the complete regulation in the European Union applies, regardless of the operating airline. All airlines operating the route have to bear identical burdens, to that degree the regulation remains neutral to competition.

With EU regulation applying for any operator on this route, there is no impact of "Fit for 55" regulations on competition on this route.

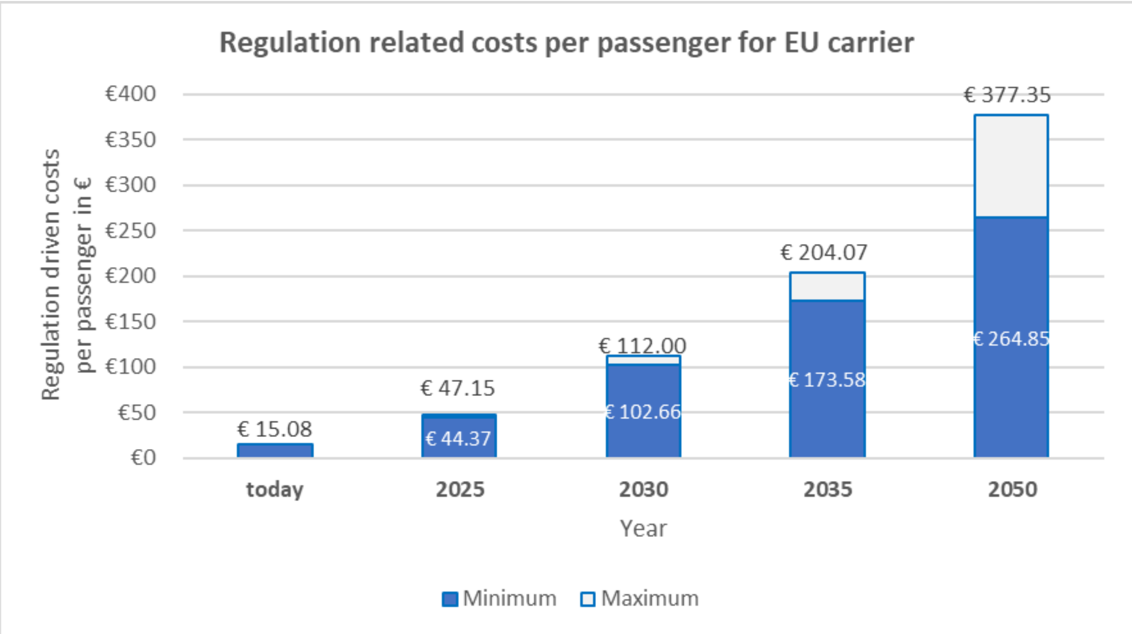
3.3 Example for an intra-European leisure demand driven long route: Hamburg–Las Palmas/Gran Canaria

With a great circle distance of 3,528 km, this route an example for long, intra-European leisure flights. We calculated the operation using the average for the respective subfleet of BDL member airlines.

The EU regulations apply in both directions. That contains the blending mandate for SAF, EU-ETS and Fuel Taxation.

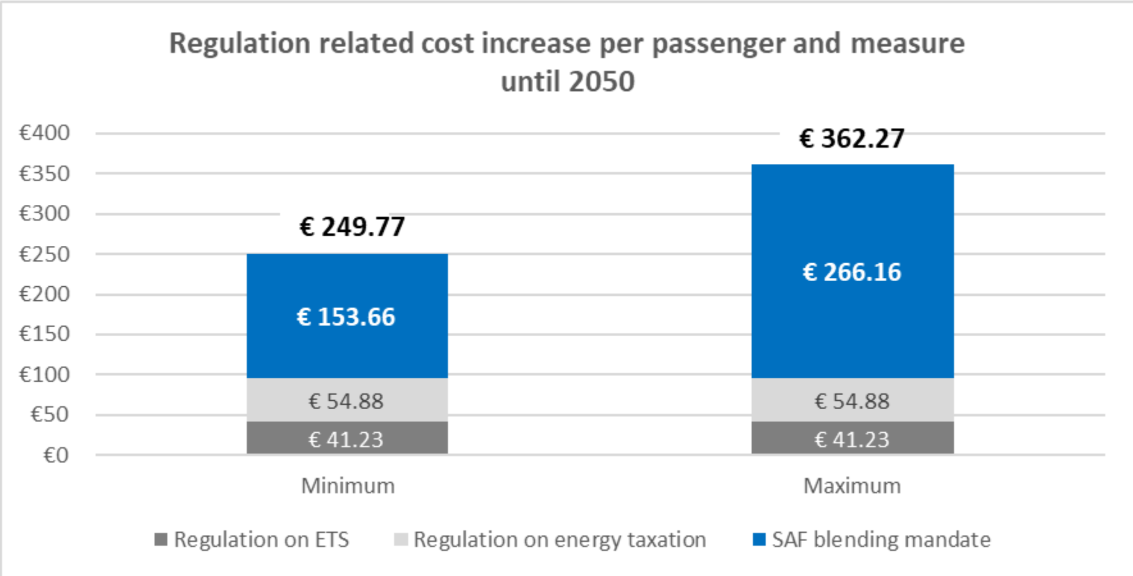
3.3.1 Cost development

The regulation related costs per passenger and round trip today sum up to € 15.08 EU-ETS distributed to a single customer. The gradual inclusion of "Fit for 55" measures (SAF blending mandate, EU-ETS, energy taxation) would grow the costs per passenger until 2050 as minimum by € 264.85, in a maximum scenario even up to € 377.35.



Graph 8: Hamburg–Las Palmas: regulation related costs per passenger by scenario year

With a cost increase of € 249.77 until 2050, the route from Hamburg to Las Palmas would see already in the minimum scenario a significant plus. The maximum evaluation even results in additional costs of € 362.27. Considering the high price sensitivity of leisure passengers, the resulting increase of ticket prices will go along with a significant decrease of travellers on this as well as on comparably affected routes.



Graph 9: Hamburg–Las Palmas: cost increase until 2050 by measure

3.3.2 Impact on competition

Both route ends are located in the European Union. Accordingly, the complete regulation in the European Union applies, regardless of the operating airline. All airlines operating the route must bear identical burdens, to that degree the regulation remains neutral to competition.

Accordingly, the “Fit for 55” measures are here fully competitive neutral.

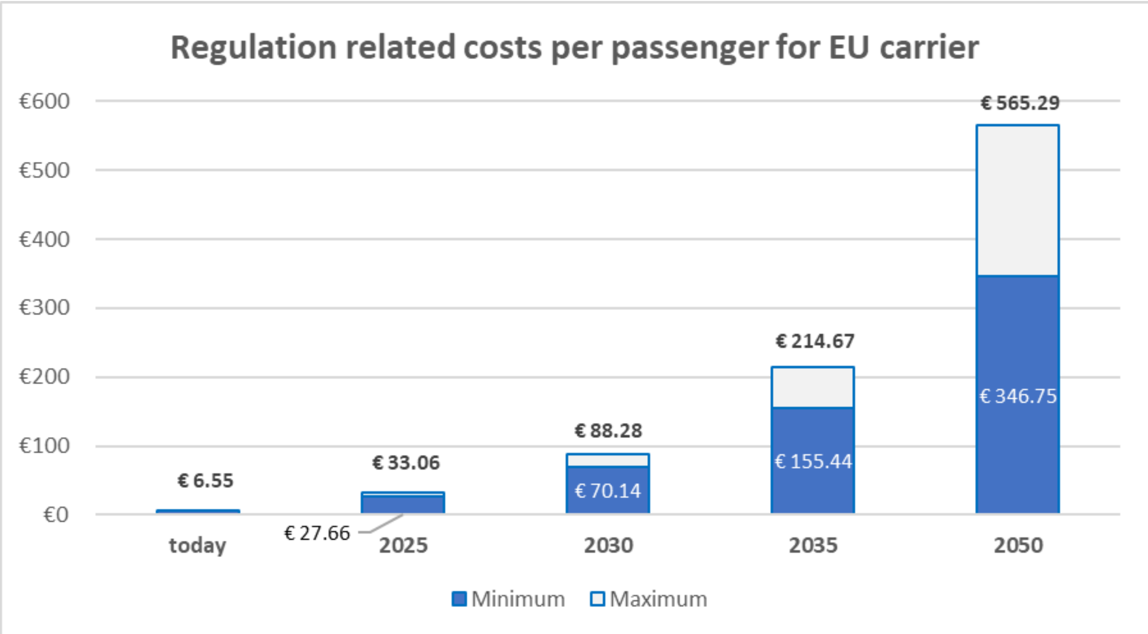
3.4 Example for a Southeast Asian long-haul route: Stockholm–Bangkok v.v. with high leisure demand, comparison of transfer in Munich versus transfer in Istanbul

With a great circle distance of 8,294 km, this route represents typical connections between Europe and Southeast-Asia. We calculated the following operation, using average data of the respective subfleet of BDL member airlines.

The EU regulation applies for the routing via Munich on all segments, while for the transfer in Istanbul just the feeder flights from/to Stockholm are contained.

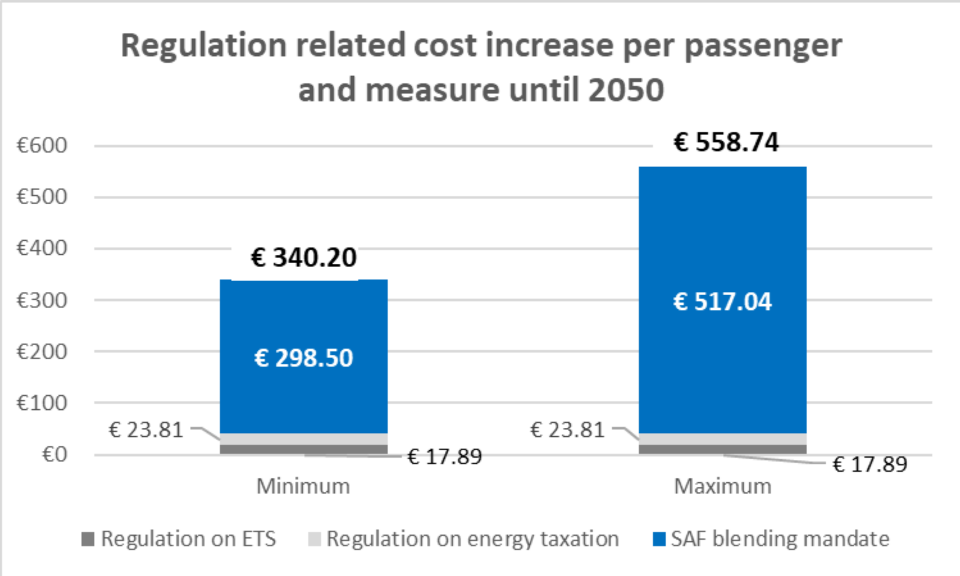
3.4.1 Cost development

For an airline operating a hub in Europe (here: Munich), the regulation related costs per passenger and round trip would be increased by the „Fit for 55“ regulations (SAF blending mandate, EU-ETS, energy taxation) by at least € 346.75 per passenger. The maximum scenario would even lead to regulation related additional costs of € 565.29.



Graph 10: Stockholm-Munich–Bangkok regulation related costs per passenger by scenario year

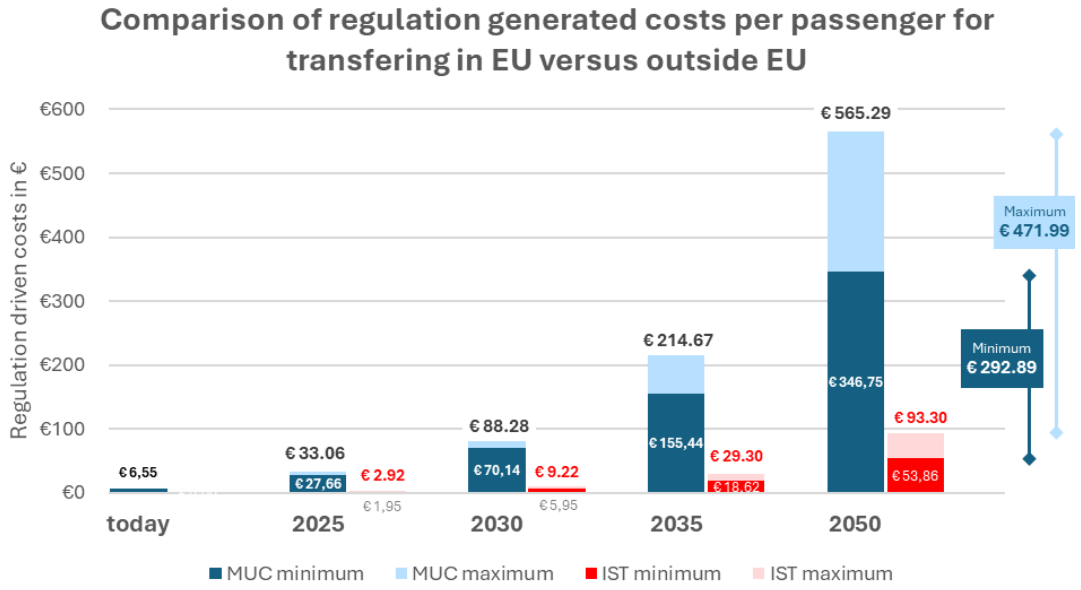
For the routing Stockholm to Bangkok via Munich, „Fit for 55“ regulations would lead to additional costs versus today of between € 340.20 and up to € 558.74. The major impact would arise from the SAF blending mandate, which stands for € 298.50 (87.7%) up to € 517.04 (92.5%).



Graph 11: Stockholm-Munich–Bangkok cost increase until 2050 by measure

3.4.2 Impact on competition

As the following graph illustrates, a transfer via airports outside of EU27+EFTA sees significantly lower burdens than transferring within EU27+EFTA:



Graph 12: Stockholm–Munich–Bangkok cost comparison for transferring in Munich (MUC) versus Istanbul (IST)

The strong cost increase for a European airline to € 346.75 as a minimum and a maximum of € 565.29 per passenger would have a significant impact on competition versus carriers outside of the European Union, as a transfer in Istanbul would remain significantly below (€ 53.86 up to € 93.30).

„Fit for 55“ would establish a competitive advantage for transportation via IST between € 292.89 (= € 346.75 - € 53.86) and € 471.99 (= € 565.29 - € 93.30) per passenger for airlines operating hubs outside of the EU27+EFTA such as Istanbul. Translating the gap into accordingly lower pricing and considering the existing price levels[2], such massive advantage will lead to a substantial shift of demand in favour of hubs outside of the EU/EEA such as Istanbul (or comparable airports like DOH, DXB, AUH, eventually DMM).

[2] A spot check with various flight search engines for April 2024 (queried on March 26, 2024) indicate available return flight prices between 527€ and 862€

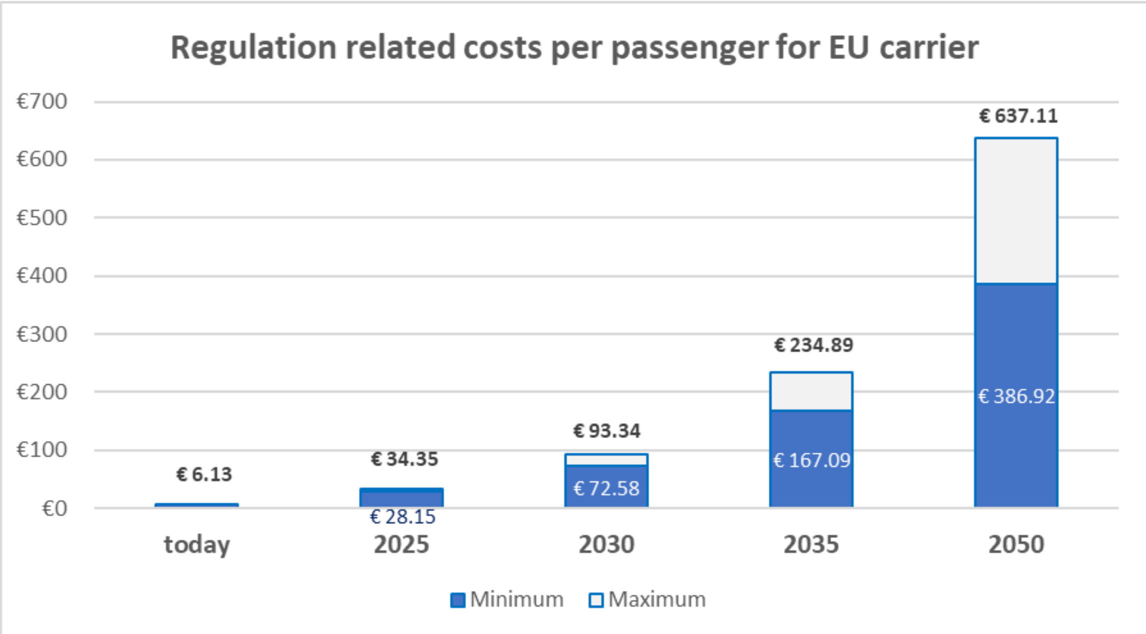
3.5 Example for a Southeast Asian long-haul route: Amsterdam–Singapore v.v. with high business demand, comparison of transfer in Munich versus transfer in Dubai

With a great circle distance of 10,517 km, this route represents a business demand driven connection between Europe and Southeastern Asia. We calculated the following operations, using average data of the respective subfleet of BDL member airlines.

The EU regulation applies for the routing via Munich on all segments, while for the transfer in Dubai just the feeder flights from/to Amsterdam are contained.

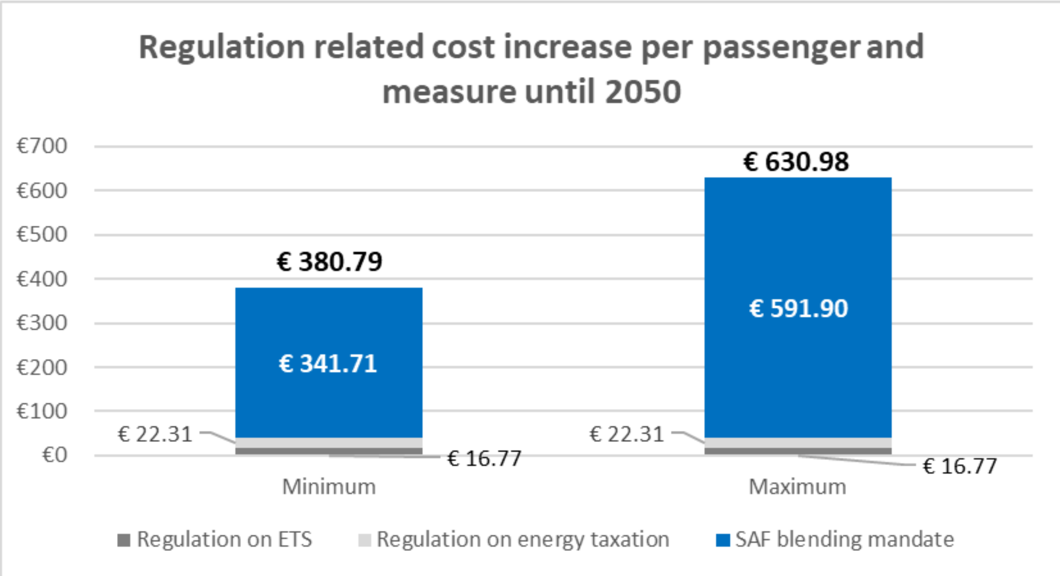
3.5.1 Cost development

For an airline operating a hub in Europe (here: Munich), the regulation related costs per passenger for a round trip will be increased by the „"Fit for 55" regulations (SAF blending mandate, EU-ETS, energy taxation) to € 386.92 per passenger at least, the maximum scenario even sees a plus of € 637.11.



Graph 13: Amsterdam–Munich–Singapore: regulation related costs per passenger by scenario and year

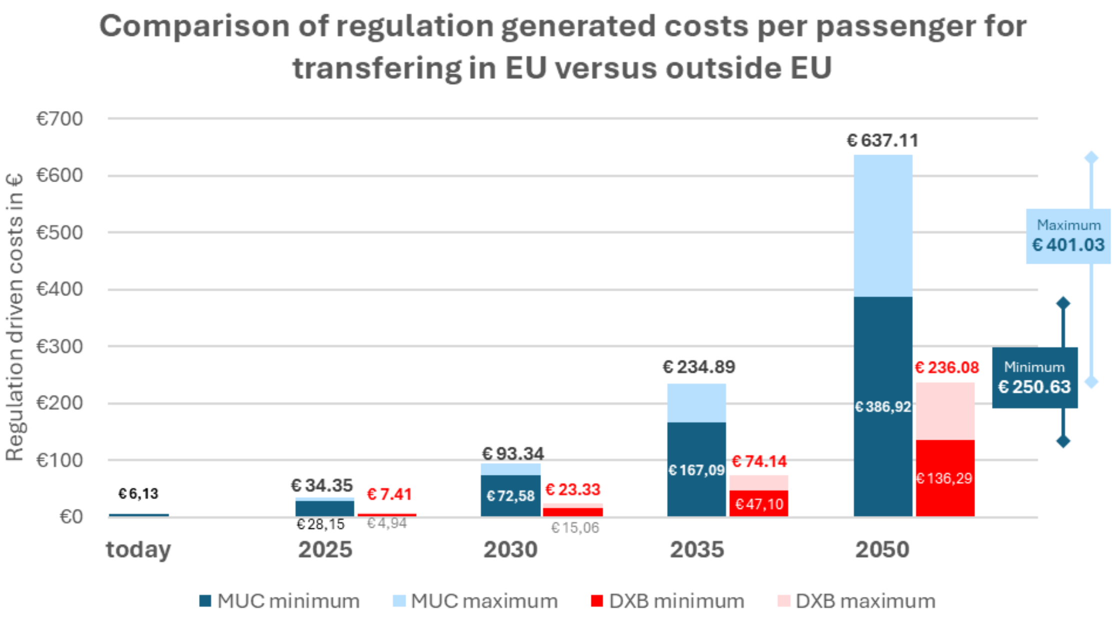
In a minimum scenario for the routing Amsterdam to Singapore via Munich, € 341.71 (89.7%) of the total increase of € 380.79 would result from the SAF blending mandate. The maximum scenario sees a significantly higher value arising from the SAF blending mandate, € 591.90 translating into 93.8% of the total increase of € 630.98.



Graph 14: Amsterdam–Munich–Singapore cost increase until 2050 by measure

3.5.2 Impact on competition

The strong cost increase for EU carriers of between € 380.79 (minimum scenario) and € 630.98 (maximum scenario) establishes a substantial disadvantage for the transfer within Europe (example Munich) versus a competing hub outside of the European Union like Dubai, which faces significantly lower burdens between only € 136.29 and € 236.08, as the following graph illustrates:



Graph 15: Amsterdam–Singapore cost comparison for transferring in Munich (MUC) versus Dubai (DXB)

The „Fit for 55" regulations in their current form would establish a competitive advantage for transferring in Dubai of € 250.63 (minimum) up to € 401.03 (maximum) per passenger. Translating the gap into accordingly lower pricing and considering the existing price levels[3], such advantage will lead to a remarkable shift of demand in favour of hubs outside of the EU27+EFTA.

[3] A spot check with various flight search engines for April 2024 (queried on March 26, 2024) indicate available return flight prices between 672€ and 1,031€

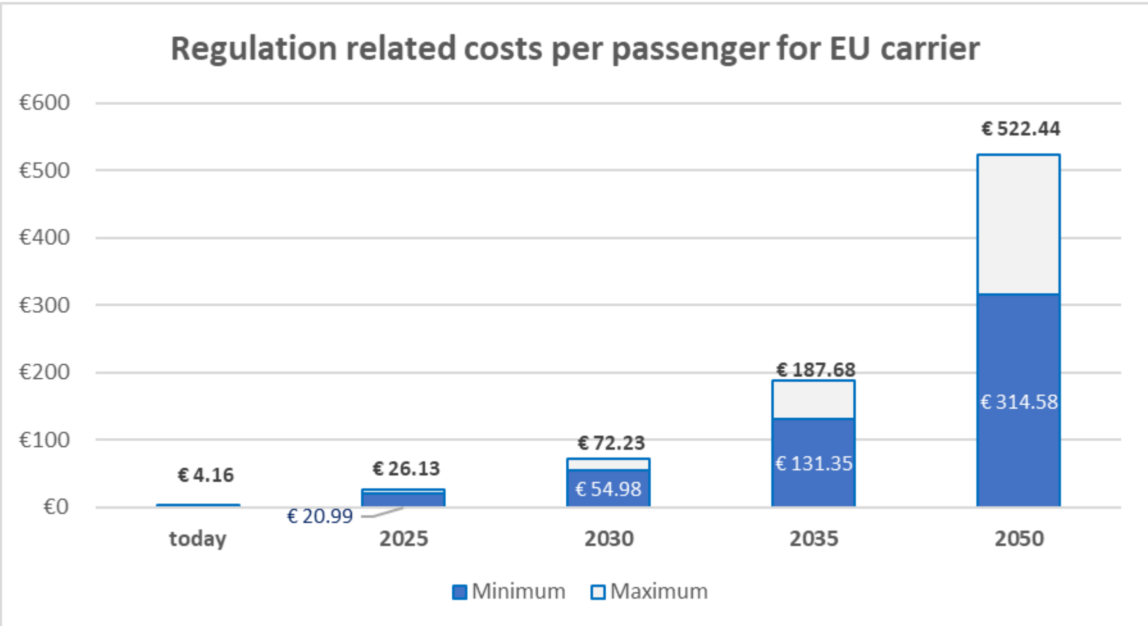
3.6 Example for an East Asian long-haul route: Paris–Hongkong v.v. with high business demand, comparison of transfer in Frankfurt versus transfer in Istanbul

With a great circle distance of 9,607 km, this route represents a rather business demand driven connection between Europe and East Asia. We calculated the following operation, using average data of the respective subfleet of BDL member airlines.

The EU regulation applies for the routing via Frankfurt on all segments, while for the transfer in Istanbul just the feeder flights from/to Paris are contained.

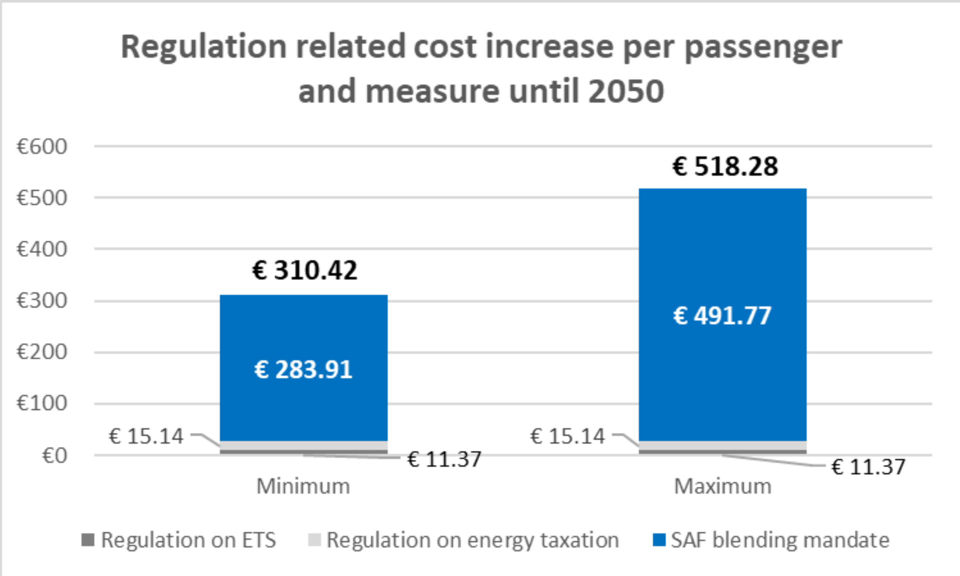
3.6.1 Cost development

For an airline operating a hub in Europe (here: Frankfurt), the regulation related costs per passenger and round trip will be increased by the „Fit for 55“ regulations (SAF blending mandate, EU-ETS, energy taxation) to between € 314.58 and € 522.44 per passenger.



Graph 16: Paris–Frankfurt–Hongkong: regulation related costs per passenger by scenario year

For the routing Paris–Hongkong via Frankfurt, the major cost increase arises from the SAF blending mandate. In the minimum scenario, 91.5% (€ 283.91 versus € 310.42) arises from this measure, this value could grow up to 94.9% (€ 491.77 versus € 518.28) in the maximum scenario.

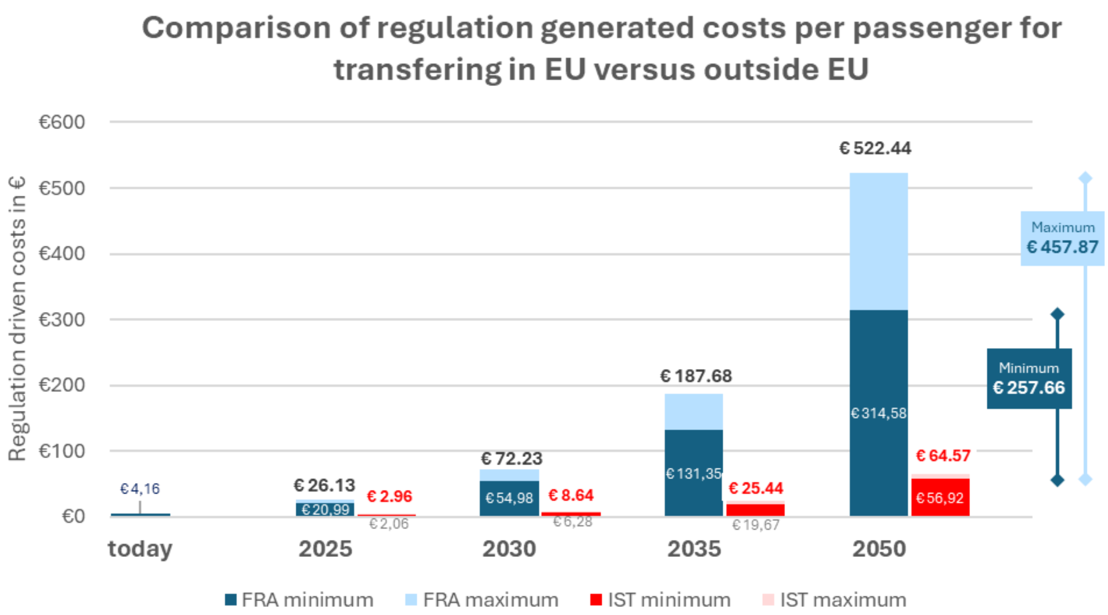


Graph 17: Paris–Frankfurt–Hongkong cost increase until 2050 by measure

3.6.2 Impact on competition

Today, the routing via Frankfurt translates into regulation related costs of 4.61€ (EU-ETS), while the routing via Istanbul which does not apply to EU-ETS.

The strong cost increase for European carriers of between € 314.58 and € 522.44 applies for the routing via Frankfurt, while for the routing via Istanbul the growth is only between 56.92 € and 64.57 €. The following graph illustrates the significant difference:



Graph 18: Paris–Hongkong cost comparison for transferring in Frankfurt versus Istanbul

The „Fit for 55“ regulations in their current form would establish a competitive advantage for transferring in Istanbul of € 257.66 up to € 457.87 per passenger. Translating the gap into accordingly lower pricing and considering the existing price levels[4], such advantage will lead to a remarkable shift of demand in favour of hubs outside of the EU27+EFTA.

[4] A spot check with various flight search engines for April 2024 (queried on March 26, 2024) indicate available return flight prices between 744€ and 1,286€

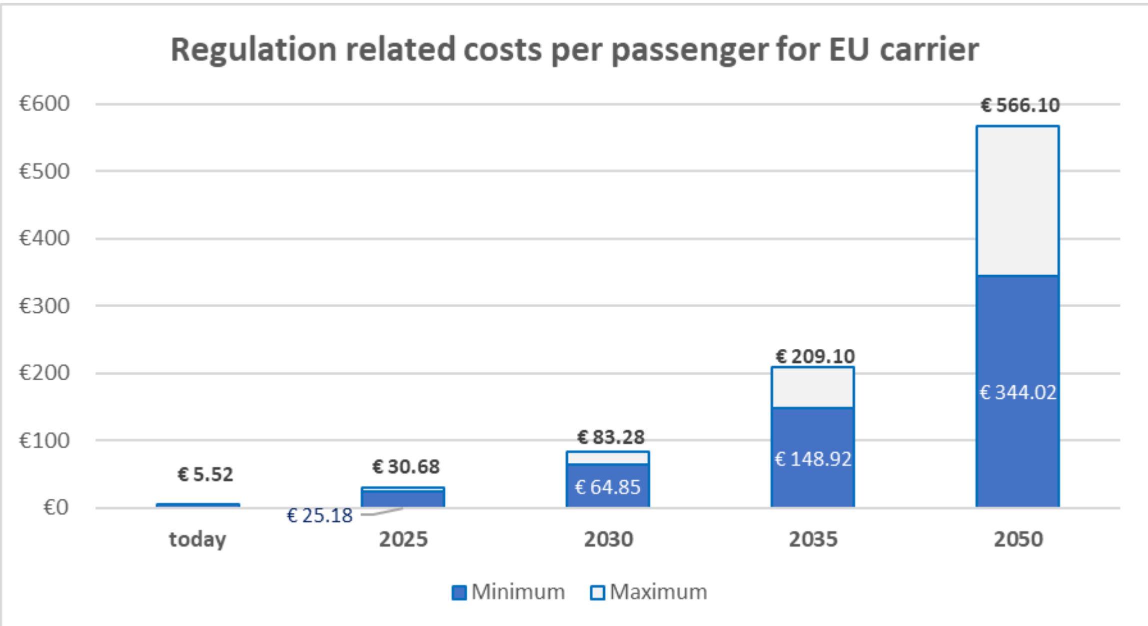
3.7 Example for an East Asian long-haul route: Barcelona-Tokyo v.v. with high business demand, comparison of transfer in Munich versus transfer in Istanbul

With a great circle distance of 10,467 km, this route represents a rather business demand driven connection between Europe and East Asia. We calculated the following operation, using average data of the respective subfleet of BDL member airlines.

The EU regulations apply for the routing via Munich on all segments, while for the transfer in Istanbul just the feeder flights from / to Barcelona are contained.

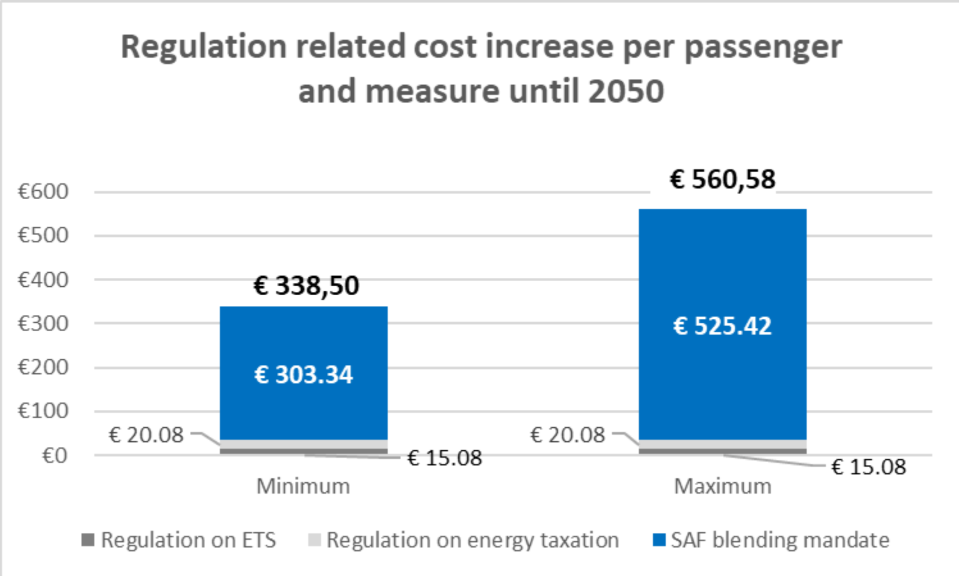
3.7.1 Cost development

For an airline operating a hub in Europe (here: Munich), the regulation related costs per passenger and round trip will be increased by the „Fit for 55“ regulations (SAF blending mandate, EU-ETS, energy taxation) to between € 344.02 and € 566.10 per passenger.



Graph 19: Barcelona–Munich–Tokyo: regulation related costs per passenger by scenario year

For the routing Barcelona-Tokyo Haneda via Munich, the major cost increase arises from the SAF blending mandate. In the minimum scenario, 89.6% (€ 303.34 versus € 338.50) arises from this measure, this value could grow up to 93.7% (€ 525.42 versus € 560.58) in the maximum scenario.

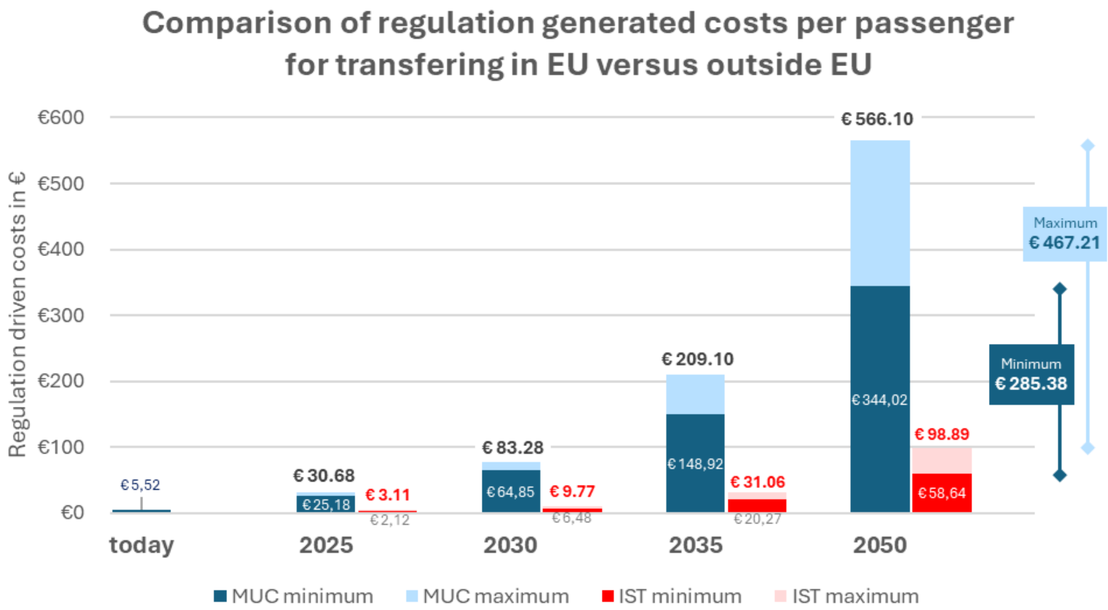


Graph 20: Barcelona–Munich–Tokyo cost increase until 2050 by measure

3.7.2 Impact on competition

Today, the routing via Munich translates into regulation related costs of € 5.52 (EU-ETS), while the routing via Istanbul which does not apply to EU-ETS.

The strong cost increase for European carriers of between € 344,02 and € 566.10 applies for the routing via Munich, while for the routing via Istanbul the growth is only between € 58,64 and € 98,89. The following graph illustrates the significant difference:



Graph 21: Barcelona–Munich–Tokyo cost comparison for transferring in Munich versus Istanbul

The „Fit for 55" regulations in their current form would establish a competitive advantage for transferring in Istanbul of € 285.38 up to € 467.21 per passenger. Translating the gap into accordingly lower pricing and considering the existing price levels[5], such advantage will lead to a remarkable shift of demand in favour of hubs outside of the EU27+EFTA.

[5] A spot check with various flight search engines for April 2024 (queried on March 26, 2024) indicate available return flight prices between 832€ and 1,499€

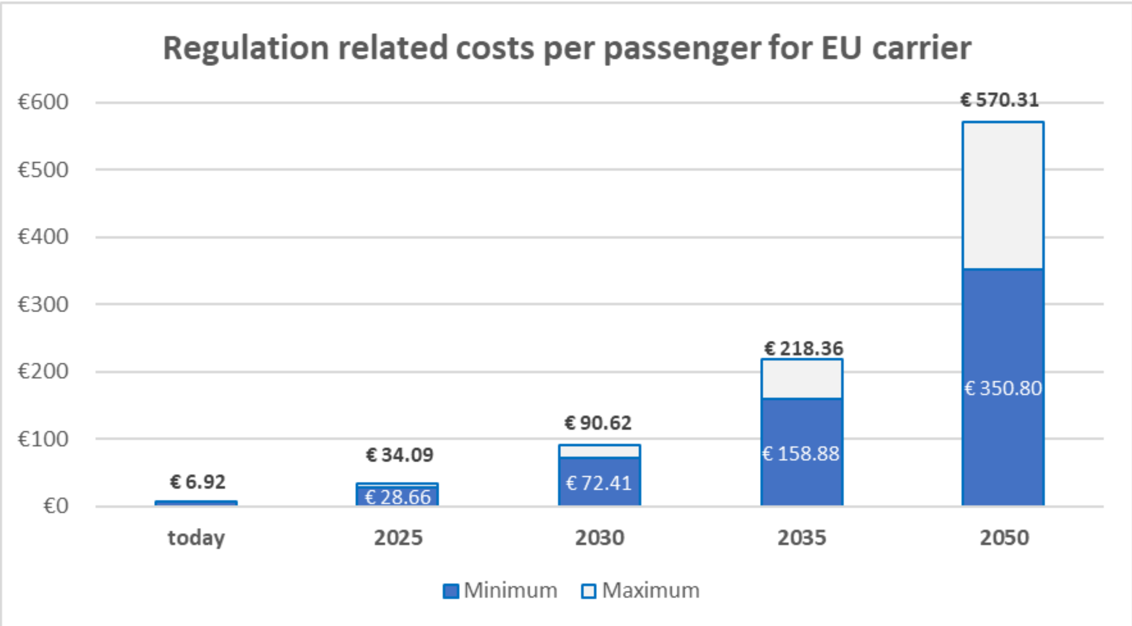
3.8 Example for an African long-haul route: Hamburg-Johannesburg v.v., comparison of transfer in Paris versus transfer in Istanbul

With a great circle distance of 9,011 km, this route stands for a typical connection between Europe and Africa's largest economy. We calculated the following operation, using average data of the respective subfleet of BDL member airlines.

The EU regulations apply for the routing via Paris on all segments, while for the transfer in Istanbul just the feeder flights from/to Hamburg are contained.

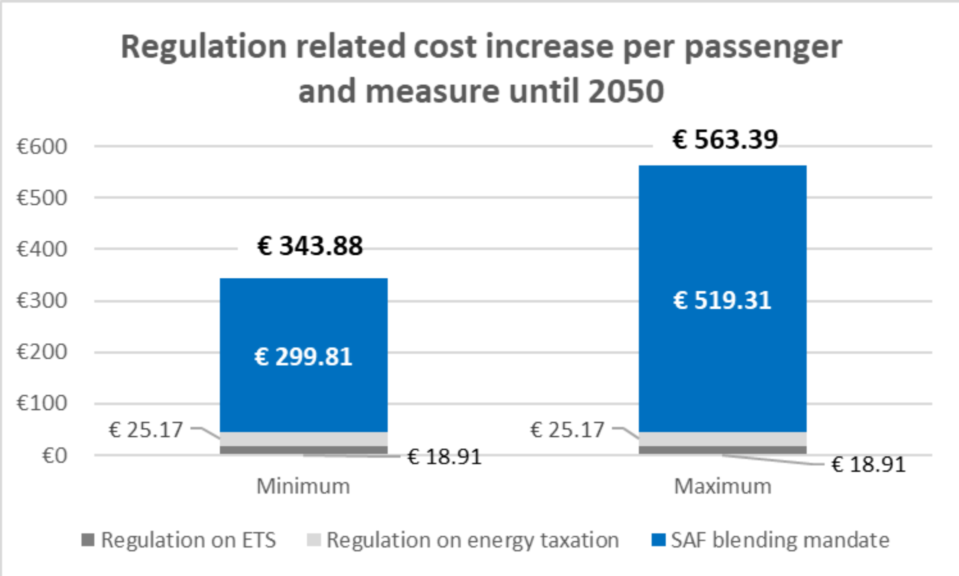
3.8.1 Cost development

For an airline operating a hub in Europe (here: Paris), the regulation related costs per passenger and round trip of today € 6.92 (EU-ETS) will be increased by the „Fit for 55" regulations (SAF blending mandate, EU-ETS, energy taxation) to € 350.80 in the minimum and up to € 570.31 in a maximum scenario.



Graph 22: Hamburg–Paris–Johannesburg: regulation related costs per passenger by scenario and year

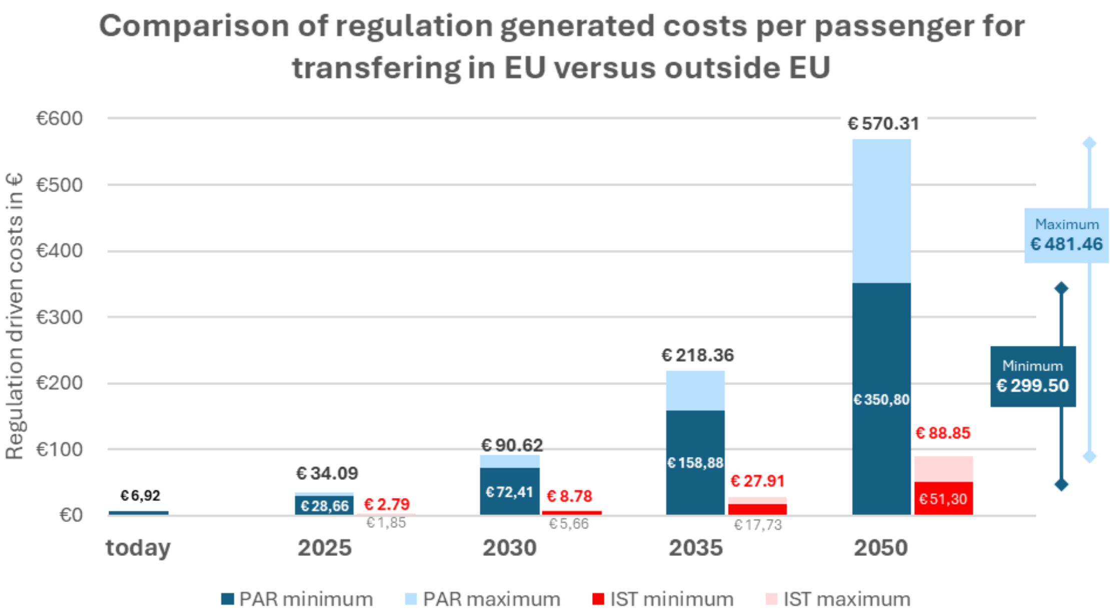
For the routing Hamburg to Johannesburg via Paris, 87.2% of the total cost increase of € 343.88 is resulting from the SAF blending mandate in the minimum scenario. In a maximum scenario, this share grows to 92.2% (€ 519.31 vs. € 563.39).



Graph 23: Hamburg–Paris–Johannesburg cost increase until 2050 by measure

3.8.2 Impact on competition

Today, the routing via Paris sees EU-ETS costs per passenger of € 6.92. The substantial cost increase for EU carriers to between € 350.80 € and € 570.31 applies for the routing via Paris only, while for the routing via Istanbul the values grows to only € 51.30 (minimum) respective € 88.85 (maximum), which is illustrated in the following graph:



Graph 24: Hamburg–Johannesburg cost comparison for transferring in Paris versus Istanbul

The „Fit for 55“ regulations in their current form would establish a competitive advantage for transferring in Istanbul of € 299.50 up to € 481.46 per passenger versus a transfer in Paris. Translating the gap into accordingly lower pricing and considering the existing price levels[6], such advantage will lead to a remarkable shift of demand in favour of hubs outside of the EU/EEA.

[6] A spot check with various flight search engines for April 2024 (queried on March 26, 2024) indicate available return flight prices between 746€ and 946€

3.9 Example for a North American long-haul route: Frankfurt–Seattle, comparison of Nonstop flight versus transfer via London

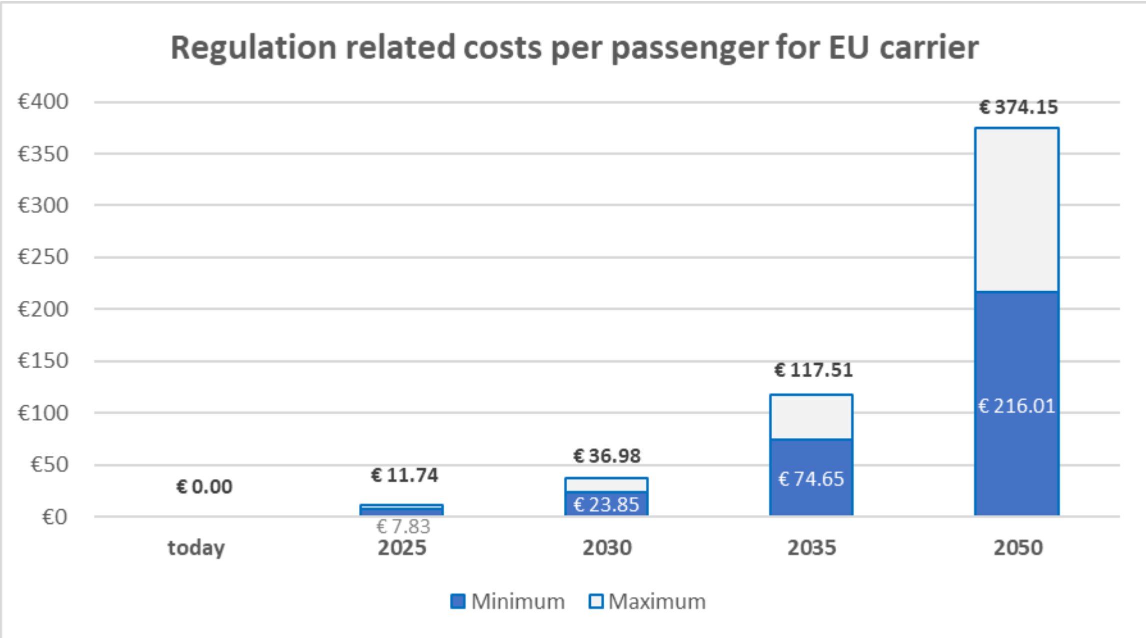
We expect that UK will establish a regulation on SAF blending which will be comparable to „Fit for 55“. If this assumption is confirmed, airlines from UK would face a situation comparable to the carriers from EU member states. However, as such government decision has not yet been made binding, we show the following scenario to illustrate the impact of a potential regulation where Great Britain would waive the blending mandate.

The route distances between Europe and North America shows a broad scope. We chose the route between Frankfurt and Seattle with a gross distance of 8,222 km, which is intended to be between New York (6,206 km), Los Angeles (9,344 km) and Dallas (8,277 km) and Miami (7,778 km). We calculated the following operation, using average data of the respective subfleet of BDL member airlines.

The EU regulations apply for the nonstop routing completely, while for the transfer in London just the feeder flights from/to Frankfurt are contained. In this scenario we assume that UK would not apply the EU regulation to analyse a "worst case".

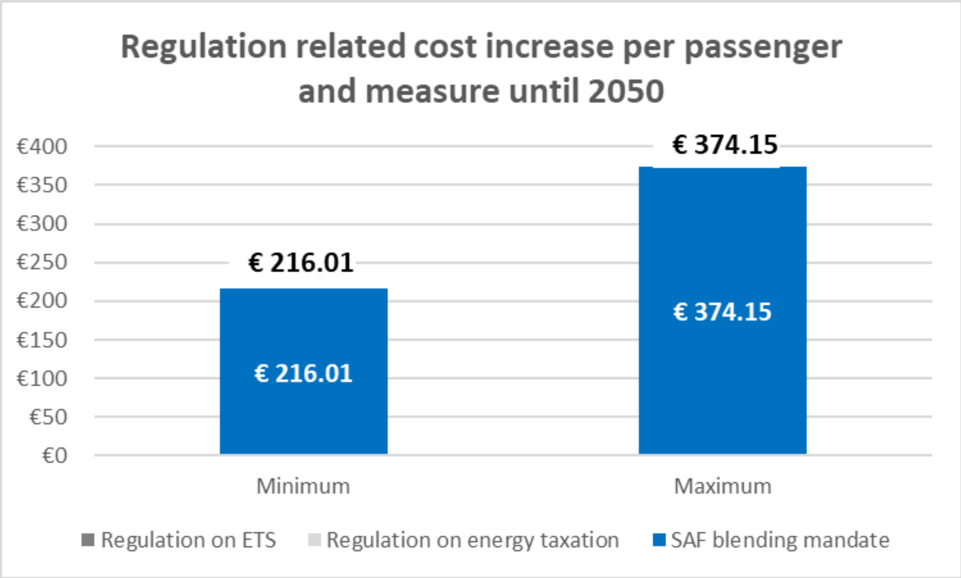
3.9.1 Cost development

For an airline operating direct services, no regulation related costs per passenger and round trip apply today. The „Fit for 55“ regulations (SAF blending mandate, EU-ETS, energy taxation) would establish additional burdens of between € 216.01 and € 374.15 per passenger.



Graph 25: Frankfurt–Seattle: regulation related costs per passenger by scenario and year

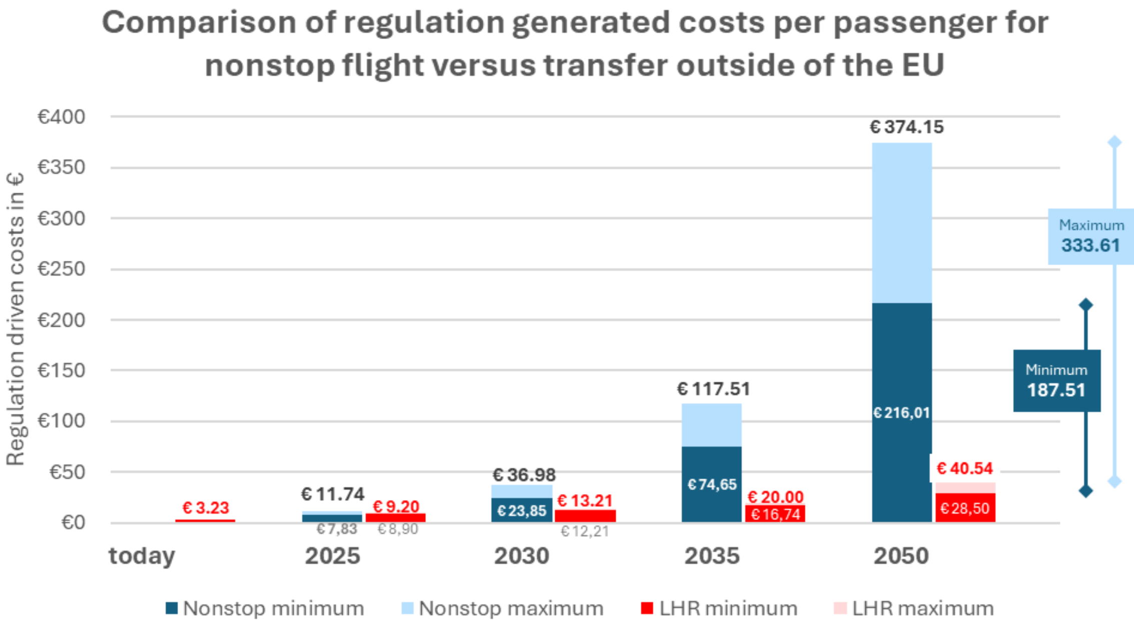
The full increase arises in this example from the SAF blending mandate, as the EU-ETS regulation as well as the energy taxation do not apply to flights with destinations outside of EU27+EFTA.



Graph 26: Frankfurt-Seattle cost increase until 2050 by measure

3.9.2 Impact on competition

The EU regulation would until 2050 establish a significant disadvantage for nonstop flights from/to the EU27+EFTA compared to hubs outside, as the following graph illustrates:



Graph 27: Frankfurt–Seattle cost comparison for direct flight versus transferring in London

The „Fit for 55" regulations in their current form would establish a competitive advantage for transferring in London of between € 187.51 and € 333.61 per passenger until 2050 versus the nonstop service. Translating the gap into accordingly lower pricing and considering the existing price levels[7], such advantage will lead to a remarkable shift of demand in favour of hubs outside of the EU27+EFTA.

[7] A spot check with various flight search engines for April 2024 (queried on March 26, 2024) indicate available return flight prices between 458€ and 637€

3.10 Example for a freighter service: Frankfurt-Shanghai, nonstop service versus reloading in Istanbul

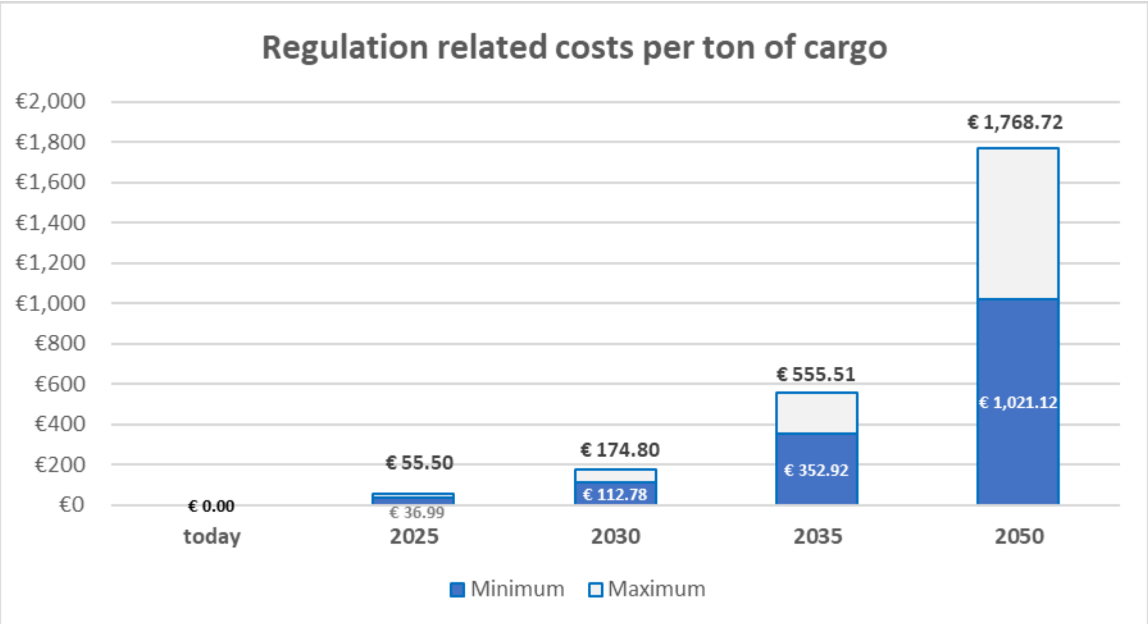
The regulation for cargo transportation from its nature differs from passenger flights. We selected the route Frankfurt-Shanghai in a comparison to a reload in Istanbul in order to reflect the impact of the intended measures on this traffic.

The EU regulation applies for the complete nonstop routing, while for the transfer in Istanbul just the feeder flights from / to Frankfurt are contained.

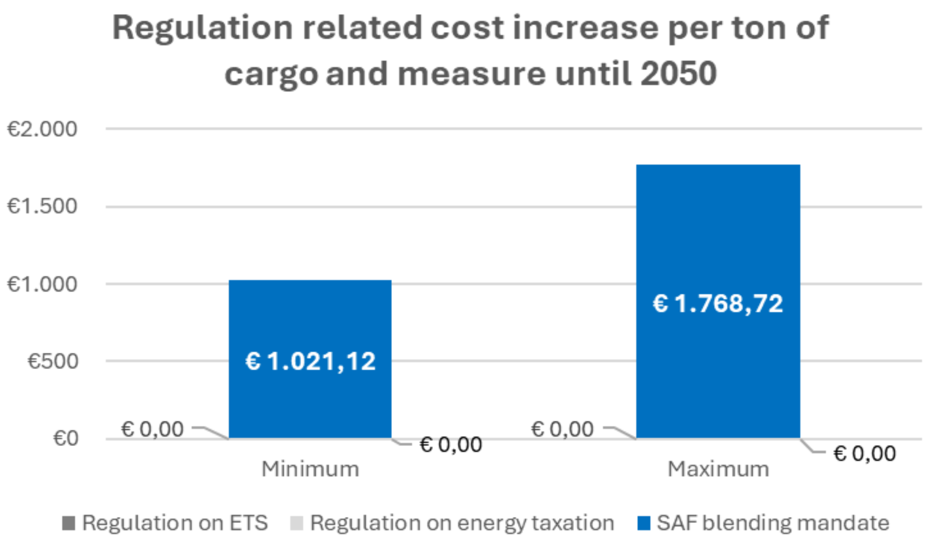
The effects of flying around Russian airspace are not included in this calculation. They are discussed in the following chapter.

3.10.1 Cost development

The "Fit for 55" regulation – here exclusively applicable the SAF blending obligation – significantly grow costs up to between € 1,021.12 and € 1,768.72 per ton of cargo for a carrier operating the direct route (Frankfurt–Shanghai).



Graph 28: Frankfurt–Shanghai regulation related costs per ton of cargo by scenario year

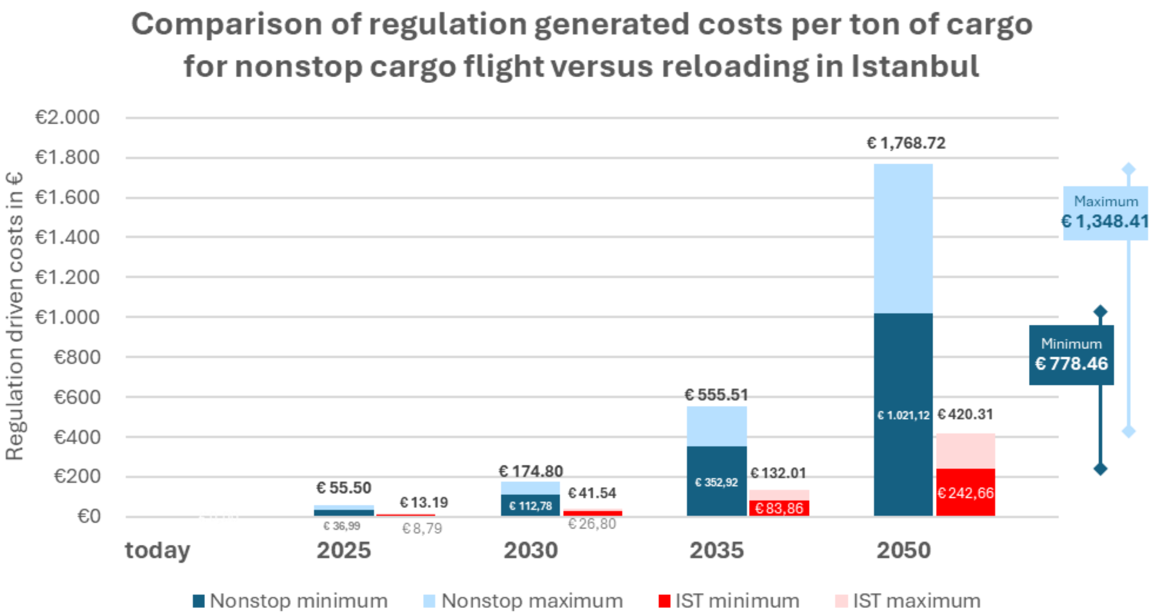


Graph 29: Frankfurt–Shanghai cost increase until 2050 by measure

This increase of costs is to 100% arising from the SAF blending mandate. As this does not apply today, the full amount for 2050 is equivalent to the increase versus today.

3.10.2 Impact on competition

Of the planned regulatory measures, effects arise only from the blending mandate on the nonstop service (Frankfurt–Shanghai). Also for reloading outside of the EU, effects only arise from this measure – but limited to the feeder route to / from Istanbul.



Graph 30: Frankfurt–Shanghai regulation related cost comparison of direct flight versus reloading in Istanbul

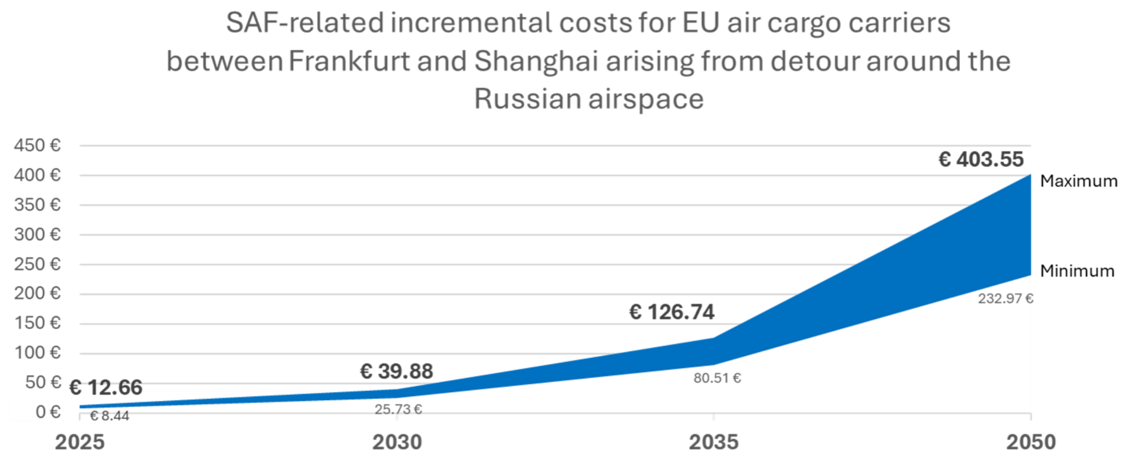
The costs arising for nonstop services to and from Europe between € 1,021.12 and € 1,768.72 per ton of cargo create a significant competitive advantage for reloading cargo in Istanbul of between € 778.46 and € 1,348.41 per ton of cargo.

3.11 Flying around Russian airspace puts a strain on the competitiveness of European airlines

As shown in the previous chapters, the application of European measures structurally already puts a significantly greater burden on EU27+EFTA airlines than on their competitors.

For some economically and politically important air connections, the imbalance even increases. The (absolutely justified) closure of Russian airspace is forcing European airlines to take significant detours on all flights to and from Southeast and East Asia. The thereby increased fuel consumption translates not only into higher total fuel costs, but also grow the additional costs arising from SAF blending.

As the following graphic shows, the requirement for SAF blending results in significant additional costs per ton of air cargo that are solely allocated to EU27+EFTA carriers, as Chinese, Turkish and Arabic airlines still use the short routes via Russia.

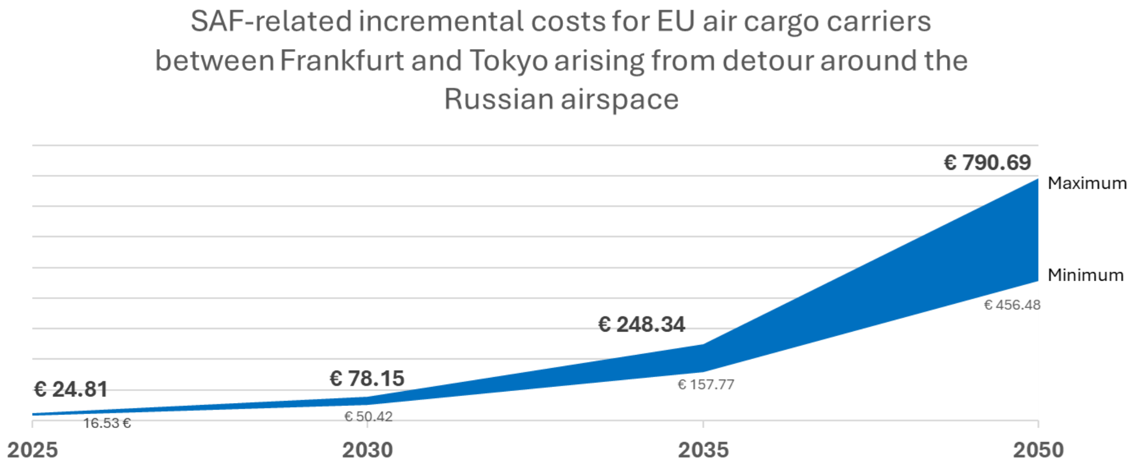


Graph 31: Frankfurt–Shanghai costs arising for EU27+EFTA carrier from detour around Russia

Subject to the scenario, the application of the SAF blending regulation on a route between Frankfurt and Shanghai increase the cost per ton of cargo by € 232.97 to € 403.55.

The value of such additional burden is related to the required detour. While this is already relevant for routes between Europe and Southeast Asia, it grows to extremes on flights to Japan and South Korea.

The cost increase on a cargo flight from Frankfurt to Tokyo is about two times as high as on the route to Shanghai. A major part of flights from Europe to East Asia used the Russian airspace. Accordingly, the detour to fly around Russia is extraordinarily big.



Graph 32: Frankfurt–Tokyo costs arising for EU27+EFTA, Japanese & Korean carriers from detour around Russia

A special problem arises here as the EU regulation imposes competitive disadvantages on companies on both sides – in Europe as well as in Japan and South Korea. The competitive benefit arises for airlines in China, the Gulf and Turkey, as they will be able to gain significant market shares due to significantly more favourable production costs.

Such simple cost comparison does still not consider that the arising disadvantages cause further decrease of competitiveness:

- on flights to **Southeast Asia and Southern China**, European airlines face a significant detour which reflects in **longer flight times and increasing costs** arising from fuel consumption, staff and aircraft utilisation. Many airlines registered outside of the European Union (Asia, Turkey, Gulf) operate the direct way via Russia and benefit from shorter flight times and lower costs.
- the detours **eliminate Europe's geographical advantage to East Asia** (Japan, South Korea, and Northern China). The longer flight duration significantly strengthens competitors in Turkey and the Gulf, who had previously only marginally participated in this traffic.

4 Summary and conclusion

The route examples in the previous chapter illustrate, that EU's "Fit for 55" legislation in its current form (in force respectively still in the making), set incentives for passengers and cargo forwarders to avoid direct flights out of airports in the EU as well as transfer flights via airports in the EU. In addition, such incentives are set without considering any emission related criteria.

Airlines outside of Europe gain cost advantages over providers from EU. Because of the liberalisation of air traffic, the industry is well trained to identify and utilise such opportunities as competitive advantages. Translating lower costs into lower prices and a related shift of demand is to be expected.

As a consequence, the „Fit for 55" regulation in its current form leads to significant Carbon Leakage. Not only do European providers loose demand and revenue, at the same time the EU loses control over a relevant portion of emissions of air traffic related to air transportation to and from its territory.

The disadvantages and negative impacts affect mostly airlines and airports operating hubs, but other European providers will also not be protected from experiencing economic disadvantages.

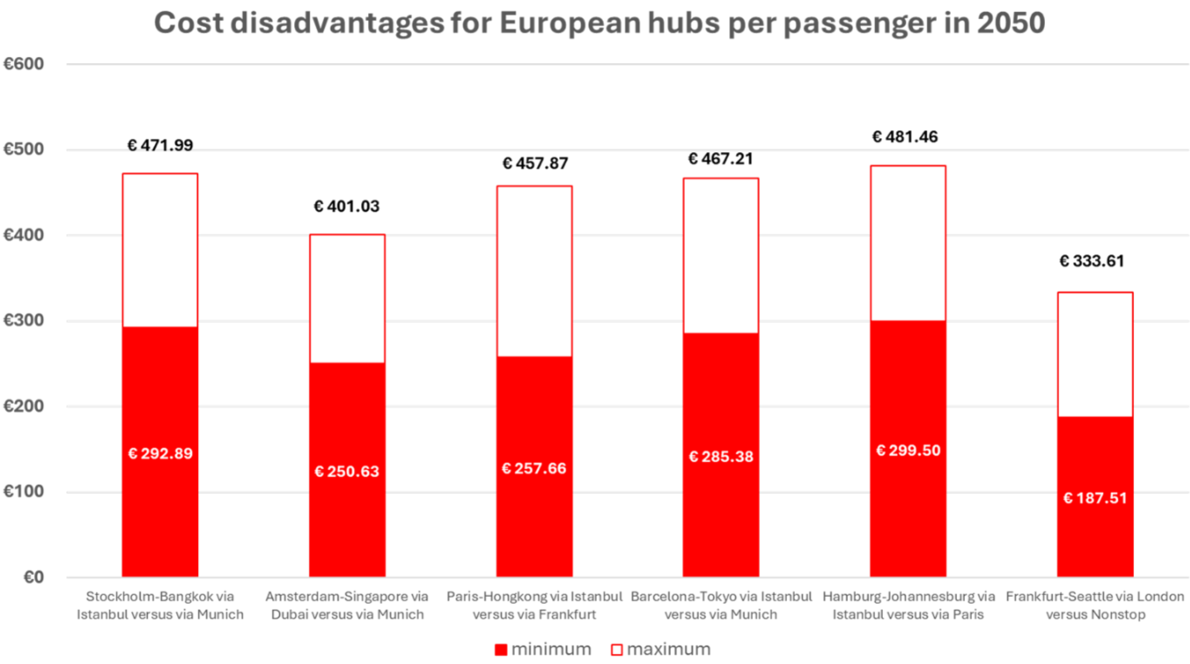
4.1 European hubs and network carriers would suffer from Carbon Leakage effects

Both EU-ETS Aviation and the proposal on kerosene taxation do not reflect the fact, that inner-EU-feeder traffic is addressed by the legislation whereas feeder traffic via non-EU-hubs is not.

RefuelEU Aviation applies for routings from all European airports. However, for routings via hub airports outside of the EU it applies only for traffic to this airport, but not for a then following leg to any destination beyond.

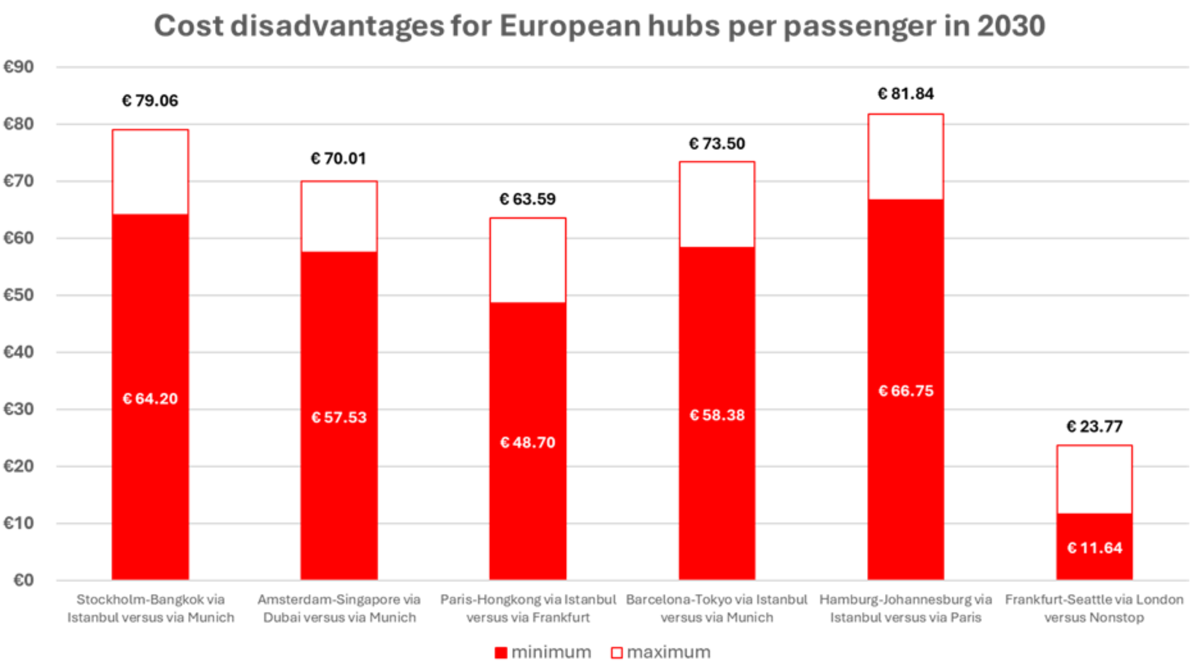
As a result, demand will be incentivised to choose routings where only a minimum distance falls under the European regulations. The cost differences, caused by "Fit for 55", provide the basis for significantly cheaper offers from providers outside Europe.

As the following graph illustrates, the cost disadvantages for European airlines differ by route and scenario (minimum, maximum). For the analysed routes, the lowest gap until 2050 is € 187.51 per passenger in a minimum scenario for Frankfurt–Seattle, the highest would be € 481.46 in a maximum scenario for Hamburg–Johannesburg. Considering the current market price levels, it is obvious that the according cost differences will lead to a massive shift of demand from European to non-European airlines, causing a substantial carbon leakage.



Graph 33: Cost disadvantages per passenger for European hubs (airlines and airports) versus routings via hubs outside of EU27+EFTA in 2050

The cost gap increases gradually until 2050. However, it will already at 2030 show a relevant competitive advantage for non-European airlines, as the next figure shows. This confirms the statement, that not only the later dominating SAF blending mandate discriminates European airlines, but also the ETS aviation and the energy taxation.



Graph 34: Cost disadvantages per passenger for European hubs (airlines and airports) versus routings via hubs outside of EU27+EFTA in 2030

Facing the existing price level and the high price elasticity, particularly of the leisure travel demand, a significant shift in demand to routings via airports outside of Europe has to be assumed. Interpreting the previous route evaluations, we get to the following findings:

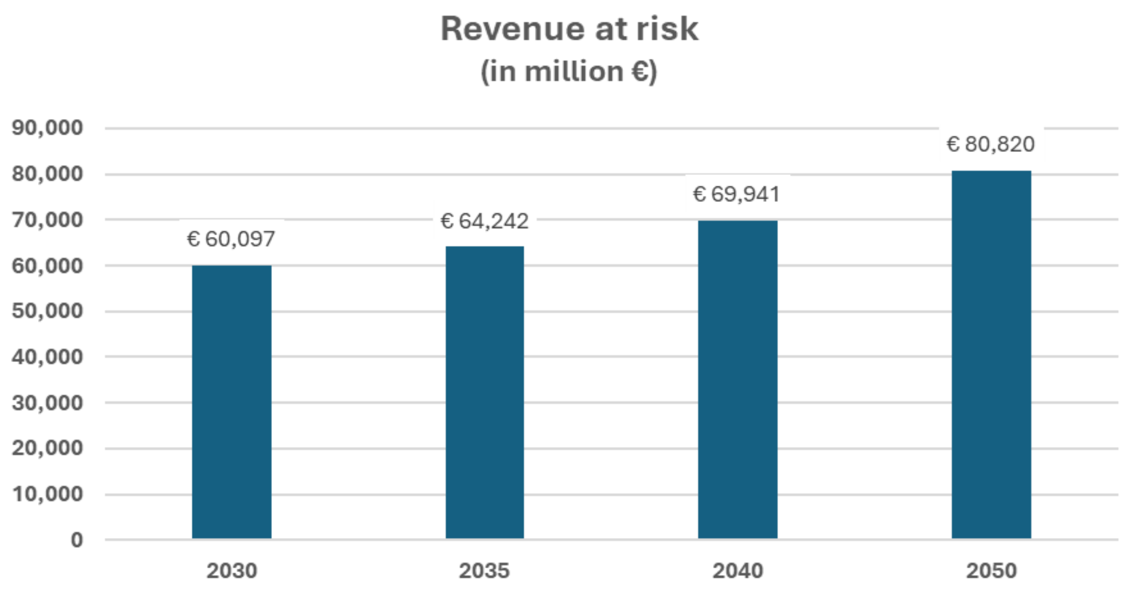
- The disadvantage for European providers arises, wherever they compete with transfer connections via airports out of EU. It occurs without consideration of any emission related factors.
- Such Carbon Leakage increases with the proportion of the route section outside of the EU regulation.
- The detour arising from passenger and cargo flight operation around the Russian airspace significantly grows the burdens for EU carriers to the benefit of their non-European competitors.
- Especially Istanbul with its location close to Europe would be a main profiteer of Carbon Leakage for routings between Europe and Asia, Africa or Australia, but also hub carriers in the Gulf area would. Turkey would for South-eastern EU member states even be an attractive transfer points for routings to North America.
- If UK would not introduce a regulation comparable to EU's "Fit for 55" package, Carbon Leakage for routes to North America, Asia and Africa would severely be increased, as UK's geographical position does not require long detour and related time consumption for most member states.
- Carbon Leakage is for air cargo as threatening as for passenger services. Cost advantages generated by "Fit for 55" in the current form will generate a significant shift of demand in favour of providers outside of the application of EU regulation. For the long-haul cargo market, the blending mandate for SAF determines the cost gaps.

Finally do the competitive disadvantages for European airlines finally not even achieve any positive impact on emissions, as Carbon Leakage via non-European hubs and the related detour (Istanbul and even more Gulf hubs are for most flights not located on the direct routes) even results in additional flight time and increased emissions.

Carbon Leakage and the loss of demand go along with a significant loss of revenue for the airline industry in Europe. We have developed an estimation to quantify the related effects. The impact evaluation is performed in two steps:

1. First, we sum up passengers and revenues which for geographical reasons have travel alternatives via airports outside of Europe (demand "at risk"). This comprises the traffic between Europe and all other continents. To quantify that volume, we use a verified information on demand and revenues arising from the traffic between Europe and other continents which are revenues by Lufthansa Group, estimates for Airfrance-KLM and IAG based on their Annual Reports plus a capacity-based appraisal for other European airlines operating impacted routes. For the development until 2050, we apply the growth rate percentages used in the model described in chapter 2.
2. In the second step we estimate to what degree this demand would actually be shifting to such alternatives outside of Europe.

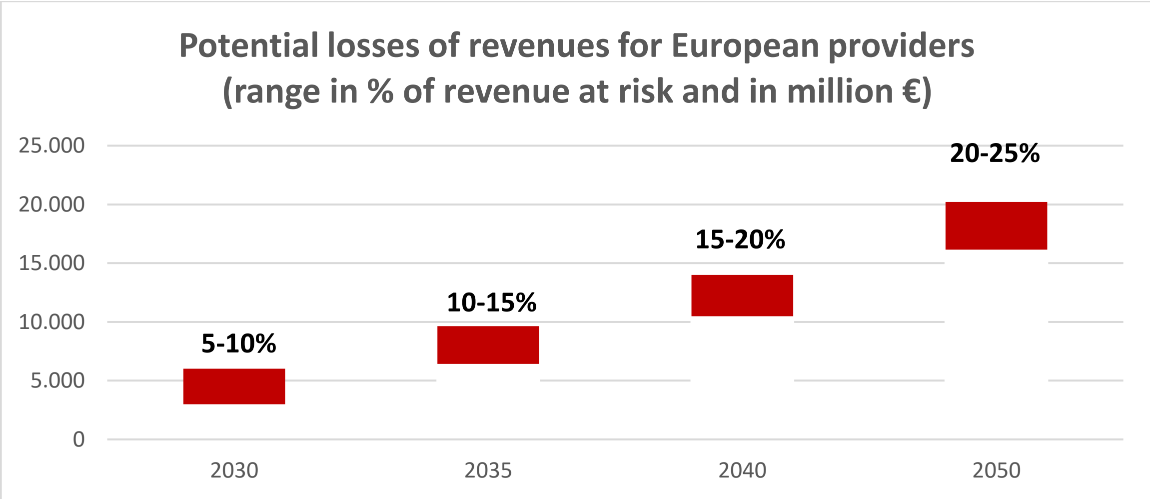
Any flights between Europe and destinations outside of Europe are endangered to be lost to non-European airlines. Graph 35 illustrates the related revenues. 100% of them are “at risk” in step 1, however, we do not expect that actually the full volume will finally be lost. The following graph illustrates the development of the full amount of revenues “at risk” until 2050:



Graph 35: Total revenues of European airlines to worldwide destinations where hubs outside of the EU27+EFTA offer sufficient connections at lower prices

In step 2 we assume a percentage of the complete “Revenue at Risk” that actually will be lost from European to non-European air carriers. Such shift will grow over the time along with the increasing cost advantages and a “learning curve” of the passengers as they recognize such price gaps and intend to benefit.

We expect a range of 5-10% of the full Revenue at Risk to shift from European airlines by 2030. Until 2035, this portion is assumed to grow to 10-15% and at the end of the time horizon of our model at 2050 we see it at 20-25% of the full Revenue at Risk.



Graph 36: Estimation of the share of the revenue at risk (see graph 35 as percentage of revenue at risk and in million €) which would actually be lost for European airlines resulting from Carbon Leakage

In 2030, we estimate a shift of demand and revenue to non-European providers between 5% and 10% of the revenue at risk (see graph 35) which translates into revenue losses of 3-6 billion €. Until 2035, such impact will be increased to 10-15% and a range of 6.4-9.6 billion €. Until 2050, the impact is expected to be 20%-25% and a loss of 16.2 – 20.2 billion €.

The potential losses would along with the increasing effects of “Fit for 55“ in its current form following our evaluation gradually grow from 3-6 billion € in 2030 up to 16-20 billion €. Considering that the total annual turnover in 2019 of Lufthansa Group was 36 billion €, AirFrance-KLM following with about 27 billion and IAG with 26 billion, the endangered revenues by Carbon Leakage are definitely significant.

4.2 European cargo long-haul traffic would suffer from Carbon Leakage

Our impact assessment shows that Long-haul cargo carriage is – comparable to passenger service – in danger of losing demand to providers outside of the EU and suffers significant from Carbon Leakage. The major determining factor is the blending mandate for SAF.

4.3 Competition on inner-European point-to-point routings is not affected

For any connection *within* the EU, most if not all of the regulation is identical. The sole factor that might differ by countries is the Passenger Tax. As long as they are similar, there is no impact on competition and no Carbon leakage.

However, that does not mean that there will be no impact, as the significantly increasing prices will translate into a decrease of demand, which does not only affect airlines and airports, but also the local economy of the destination regions.

Appendix

5 List of figures

List of tables

6 Glossary and list of abbreviations

Available Seat Kilometres (ASK)	Air traffic production is measured and expressed in ASK. The value is calculated by multiplying the number of available (offered) seats by the great circle distance of the flown sector.
Bundesverband der Deutschen Industrie (BDI)	Association that represents the interests of the German industry, the "voice of the German industry". Comissioned BCG to work out the "Climate Path"
Bundesverband der Deutschen Luft- und Raumfahrtindustrie (BDLI)	German association that represents the interests of the German aviation industry.
Bundesverband der Deutschen Luftverkehrs-wirtschaft (BDL)	The German Aviation Association (BDL) was founded in 2010 as a joint representation of the interests of the German air transport industry. Members of the association are airlines, airports, German air traffic control and other service providers in German air traffic.
Boston Consulting Group (BCG)	Global consulting company which worked out the "Climate Path" on behalf of BDI.
Bundesministerium der Finanzen (BMF)	German Federal Ministry of Finance
Bundesministerium der Justiz und für Verbraucherschutz (BMVJ)	German Federal Ministry of Justice and Consumer Protection
Carbon Leakage	Where regulation causes a shift of demand that is driven by cost incentives which are not considering emission criteria. It arises, when regulation applies to providers within the EU/EEC and outside unequally. Such leakage can imply higher total emissions.
CO_2 Emission	describes the extent of emissions from the burning of fossil fuels and sets the base for any calculation in the model that is based on CO_2 emissions. 1 ton of Kerosene translates into 3.15 tons of CO_2.

CORSIA

is an acronym for an agreement of the ICAO member states on a global CO_2 compensation system for air traffic. Stands for „Carbon Offsetting and Reduction Scheme for International Aviation“. The “Standards and Recommended Practices“ (SARPs) set the monitoring, Reporting and verification rules, as well as the rules for deletion of certificates e.g. from offsets.
Growing emissions are to be offset by CO_2 emission certificates. The initial reference year 2019/2020 are expected to be replaced by 2019, as Corona has made 2020 being not representative for air traffic in any way. The revenue generated by the purchase prices of certificates is meant to improve the climate elsewhere, for example by promoting climate-neutral energy generation or means of transport.
During the initial phases, a participation of member states is voluntary. However, amongst many other countries, the European Union has confirmed to participate already in that early stage. That ensures that already by then, 77% of the global air traffic is covered. Still, China, India and Russia will according to the current status not participate during that phase
Phase 2 starting in 2027 sees a mandatory participation for each state whose aircraft operators exceed 0.5% of global air traffic in 2018. It is expected, that by then a coverage of 90% of the global air traffic will be achieved.

Deutsche Emissions-handelsstelle (DEHSt)

is the national authority for the Federal Republic of Germany responsible for EU emissions trading. It is an organisation within the responsibility in the Federal Environment Agency (UBA) in Berlin. Its main tasks are allocation and issuing of emission allowances including monitoring and control tasks, management of the national certificate register as well as national and international emissions reporting.

Distribution of Fuel Consumption to types of air services

For the purpose of this evaluation, the total consumption is distributed to passenger flight services by tonne kilometres. Passenger kilometres are translated into weight related kilometres by using a factor of 1 passenger = 100.5 kg. This factor is based on the EASA “Survey on standard weights of passengers and baggage“ (NEA, May 2009), it adds the average annual passenger weight including carry-on luggage and the annual average weight of checked baggage (tables 4.7, 4.9, values for “all adults“).
The traffic values are taken from the German statistics authority (Statistisches Bundesamt/Destatis, publication series 8 row 6.2) for 2019

Emission Trading System (EU-ETS) for Aviation

Since January 2012, Air Traffic within the European Economic Area plus flights from the EEA to Switzerland or UK is included into the European ETS. For each ton of CO_2 emission on such routes, airlines require an ETS certificate.
Today, a portion of such certificates is free of charge, but an increasing part is auctioned.
The “Fit for 55“ proposal intends to reduce the available “free-of-charge“

certificates for airlines by 4.2% p.a.. This will result in a reduction of such certificates to 75% in 2024, 50% in 2025 and 25% in 2026. As of 2027, 100% of certificates distributed to airlines will be auctioned.

Emission, calculation of
CO_2 emissions are based on fossil fuel consumption and calculated using a factor of 3.15.

Energy Tax Directive
The "Fit for 55" proposal for an Energy Tax Directive intends to gradually include air traffic into the energy tax ruling as off 2023. Starting with 0% of the applicable tax, this factor will be increased annually by 10%p – steps to full taxation in 2033.
Sustainable Aviation Fuels are expected to be excluded for the first 10 years in order to set incentives for their utilisation.

European Allowances (EUA)
are emission allowances (certificates) for European plants and the basis of EU-ETS.

European Aviation Allowances (EUAA)
are emission allowances (certificates) issued specifically for aviation companies that are obliged to trade. EUAA can only be used by these companies.
Operators of other plants are not entitled use EUAAs to fulfil their obligations. However, airlines can also use EUAs for their tax obligation.

Fuel Consumption
The initial value used in the model for the kerosene consumption in Germany is based on the publication by the German government ("Amtliche Mineralöldaten für die Bundesrepublik Deutschland" by "Bundesamt für Wirtschaft und Ausfuhrkontrolle", value for heavy air turbine fuel) for the full year of 2019. The consumption is expressed in thousand tonnes, the consumption by military purposes (88 ths. tonnes) is deducted from the total value.
In this evaluation, the fuel consumption of air traffic is assumed to grow in line with the production.
In order to distribute the fuel consumption to the differently handled topics of regulation (passenger services, cargo & rest), we used a distribution key of 75:25.
Based on the traffic performance TKM/PKM for the year 2019 (Federal Statistical Office, domestic and outbound traffic), these assumptions result in the breakdown of 75%/25%.
Based on the year 2019, the amount of fuel is divided into segments and updated according to the traffic development and an efficiency factor, separated into fossil and SAF, in the dimensions liters and tons using a factor of 0.8.

Fuel Efficiency
New technologies and improvements on controlling the operation are essential elements of an efficient utilisation of fuel. In the model, we assume that such measures will enable a reduction of the specific fuel consumption.

Fuel Prices	In the past we saw decreasing oil prices, currently, we face strongly rising oil prices which go along with significantly increasing costs for the airline industry. The forecasts differ in their outlook for the next 15 years. While the American Energy Information Administration (EIA) expects sustainable increase of prices, others expect even temporary decreases in the upcoming years. Amongst various reasons, a political influence on delivery rates cannot be neglected, furthermore the currently still growing consumption is subject to measures and technologies against climate change. Considering this high degree of uncertainty, we calculated our impact assessment on the basis of stable prices on the long run.
German Passenger Tax (“Luftverkehrssteuer“)	The German Passenger Tax has been introduced 2011 and applies for passengers travelling by air from a German airport. The amount is due per passenger, origin to destination and differs by country groups, which approximately reflect the flight distance between Germany and destinations in the respective countries. An adjustment applied as of May 1, 2024: Category 1: € 15,53 Catogory 2: € 39,34 other countries: € 70,83
Kerosene Tax	Taxes on Kerosene, see Energy Tax Directive.
Passenger Kilometres (PKM)	is calculated by multiplying the number of carried passengers by the flight distance (great circle distance). It measures the sold production.
Power-to-Liquid (PtL)	describes the technology that allows to convert electrical power into liquid fuels, where the electrical power is gained sustainably (wind, solar, water etc.). PtL is an essential option to produce Sustainable Aviation Fuel (SAF).

ReFuelEU-Aviation

The ReFuelEU Aviation initiative of the European Union is expected to set up a blending mandate for Sustainable Aviation Fuel (SAF) supplied at EU airports. The obligation would commence from 2025 at 2% SAF, gradually increasing to 70% in 2050.
Considering the current status of decision making, the minimum volume percentages for SAF will be as follows:

	2025	2030	2035	2040	2045	2050
Minimum percentage of SAF	2%	6%	20%	34%	42%	70%
Minimum PtL percentage (included in SAF)	-	1.2%	5%	10%	15%	35%

Standard Passenger Weights

for European air carriers are defined in the "Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Annex IV – Part-CAT" by EASA. We assumed a share of 45% male: 45% female:10% Children, resulting in an net average weight of 75kg. Adding a weight of 15kg of baggage results in a gross weight per passenger of 90kg. This value is considered to be rather conservative, as high portion of travellers travel without baggage, and many others remain significantly below the maximum baggage allowance.

Sustainable Aviation Fuel (SAF)

describes nonconventional, not fossil derived aviation fuels. According to IATA definitions, they must meet sustainability criteria such as lifecycle carbon emissions reduction, limited fresh-water requirements, no competition with needed food production (like first generation biofuels) and no deforestation. The chemical and physical characteristics of SAF are almost identical to those of conventional jet fuel and they can be safely mixed with the latter to varying degrees, use the same supply infrastructure and do not require the adaptation of aircraft or engines.

Ton Kilometres (TKM)

are a value calculated by multiplying the payload measured in tons with the route length (great circle distance) in kilometres.

Traffic Area

is defined as a group of countries. For the purpose of this analysis, we differentiate German domestic, EU, European Economic Area (EEA Norway, Island, Liechtenstein) plus Switzerland, UK and Non-EU.

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