Department of Economics and Finance

Course of Corporate Finance

What if the Airline industry Turned Carbon-Neutral Tomorrow? Evaluating the Financial Impacts under EU ETS, CORSIA, and SAF Scenarios.

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Summary

This research delves into some available paths for the aviation industry to reach carbon neutrality. It analyzes the actual carbon impact of those scenarios and their financial implementations on airlines' performances if applied tomorrow. Grounded in historical carbon footprint analyses, the study identifies the rapid growth of aviation's carbon emissions, with the sector currently accounting for 2% of total CO2 emissions worldwide. While the aviation industry has taken steps towards sustainability, notably through fleet renewals and adherence to carbon-neutral strategies like the European Green Deal and IATA's Fly Net Zero, there remains a long road to genuine carbon neutrality.

This paper focused on the elaboration of two specific scenarios. The first imagines the complete carbon offset through the European Union Emission Trading System (EU ETS) and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). In comparison, the second model studies the effect of a complete switch to Sustainable aviation fuel combined with the exact offsetting mechanisms mentioned in the previous scenario. The study underscores the significant financial implications of these transitions, highlighting a potential cost increase of up to 69% for airlines operating within the European Economic Area (EEA) under the SAF model.

Key findings indicate that while actions have been introduced towards a sustainable aviation industry, many are underutilized and not optimized to their full potential. Financial analyses reveal that an immediate shift to either scenario would pose substantial financial stress to airlines, necessitating significant revenue growth to maintain operational expense ratios (OER).

In closing, the research advocates for collaborative efforts between policymakers and industry stakeholders. The overarching goal is to expedite the shift towards carbon neutrality in aviation, emphasizing the need for uniform policies across regions, innovative financing mechanisms, and a balanced approach that upholds both environmental and economic imperatives.

1. Introduction

This chapter will introduce this paper's topic of discussion: Carbon neutrality in the aviation industry, scenarios to reach such neutrality, and the financial impact on airlines' performances to fulfill those scenarios.

To grasp the full scope of this paper's research, the introduction will first touch on the history and concerns around carbon footprint in the aviation sector. Understanding the current state of mind around carbon emissions in the aviation industry and what led there will contextualize the relevance of the research in today's world. Moving from the context, the chapter will briefly introduce the why and the pertinence of neutrality for the aviation sector. Without exposing every angle of climate urgency, it will discuss the rationale behind carbon neutrality, which will enable to attribute the weight of airlines' role in current carbon emissions and climate impact.

Finally, before delving into the paper's core, the introduction will overview the purpose of the study and what it tries to achieve. This will closely be followed by a review of the questions that guide this paper and that it aims to answer.

1.1. History of Aviation's Carbon Footprint

The carbon footprint of aviation has always continued to increase throughout its history. From 1960 to this day, carbon emissions have roughly septupled[1]. The first noticeable increase appears between 1960 and 1990, during which one can notice a 2-2.5 times[2] increase in emissions, with the 1990 level tripling by 2019.

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[1] *Climate change and flying: What share of global CO2 emissions come from aviation?* (n.d.). Our World in Data. Retrieved 3 September 2023, from https://ourworldindata.org/co2-emissions-from-aviation

[2] *Ibid*

On a global scale, today, aviation represents 2%[3] of total CO_2 emissions, which may seem low, but it is also usually considered one of the fastest-growing sectors for GHG[4] and CO_2 emissions. This exponential rhythm of expansion is the actual danger and threat of aviation's impact on climate.

Early on, the aviation industry and its actors understood the need for a sustainable strategy to mitigate the environmental effects and hedge against the risk of energy price volatility. As early as the 1990s, airlines began to lean on the questions and devised different ways to remedy the problem. Today, airlines have taken massive steps to reduce the fuel burned by passengers by renewing their fleet with more modern and less fuel-consuming aircraft.[5] This allows airlines to lower fuel bills in a growing market, constantly transporting more passengers. COVID and the drop in airline operations were an exception to that almost never-ceasing growth.

More recently, different organizations elaborated carbon-neutral strategies looking towards the 2050 horizon to attain carbon neutrality in the industry, such as the *European Green Deal* adopted by the European Union or *Fly Net Zero* from the IATA. Each plan elaborates its paths to reach its objectives and will approach the problems from different angles and solutions, which will be discussed later in the paper.

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[3] *Aviation*. (n.d.). International Energy Agency. Retrieved 2 September 2023, from https://www.iea.org/energy-system/transport/aviation

[4] Greenhouse gas

[5] *Climate change and flying: What share of global CO2 emissions come from aviation?* (n.d.). Our World in Data. Retrieved 3 September 2023, from https://ourworldindata.org/co2-emissions-from-aviation

1.2. Rationale for Carbon-Neutral Aviation

The sets of reasons leading aviation to target zero carbon emissions lie in the consequences of a scenario of inaction. In Europe alone, the industry saw its share of carbon emissions tripling from 1990 to 2019, from 1.5% to 4.9%.[6] This gigantic boom could even double by 2050 if no measures are taken to reduce carbon emissions in one way or another and take up to 10% of the carbon budget available to stay under a 1.5 °C degree increase.[7] This paper does not review extensively the numerous impacts the increase of carbon emissions has on climate, but those represent the rationale for targeting a carbon-neutral industry.

Canceling the carbon emissions generated by the airline industry represents a massive step to mitigate the effects of global warming, improve air quality, and act toward a healthier environment. Considering the stakes involved with this challenge leads to understanding the rationale for carbon-neutral aviation.

1.3. Scope and Purpose of Study

The scope and purpose of this study lie in today's stake regarding the evolution of climate and the conduct of businesses impeding the quality of environment and life for future generations. This paper tries to estimate the impact of a carbon transition toward neutrality from a monetary point of view and, in fine, evaluate its feasibility. The paper pursues two estimations, each based on a specific scenario. Both scenarios pretend to reach complete carbon neutrality through their respective scheme and to come up with a relevant figure that would approach the actual cost of a complete transition under the terms of each scenario. Those scenarios have been chosen for their immediate feasibility in action and implementation. Therefore, for this

[6] *Airplane pollution*. (2007, April 23). Transport & Environment. https://www.transportenvironment.org/challenges/planes/airplane-pollution/

[7] *Ibid*

reason, and because of calculation limitations of return on investment under a whole industry scope, this paper won't deal with aircraft fleet renewal[8] or air traffic management software,[9] even though they also appear to help lower carbon emissions.

The core purpose of this paper is to come up with a numerical value for one of the biggest challenges of our time: the cost and its implications for the industry and the consumers of an inevitable transition whose horizon always seems to get closer. Estimating such a figure allows to deem its feasibility as of today and highlight the areas needing to be boosted to meet ecological objectives while assuring a prosperous and fair marketplace.

The first scenario chosen to reach a carbon-neutral aviation industry is under a full carbon offset through the EU ETS (European Union Emission Trading System) and CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation). Under this scenario, the airlines will have to pay the offsetting fee for all their carbon emissions at the price set by the EU ETS or CORSIA scheme, depending on the area of flight operation. The paper will later approach the specifics of each system with a detailed view of their geographical area of action, their mechanisms, their current offsetting quota already in place, and the pricing evolution of both schemes. The methodology chapter will also explore the logic behind data collection and research design that motivated the transition figures.

The second scenario involves a complete conversion to SAF (Sustainable Aviation Fuel) combined with the EU ETS or CORSIA scheme to offset the remaining carbon emissions. It is

[8] Eurocontrol. (2022). *Aviation Outlook 2050.* Eurocontrol Group. https://www.eurocontrol.int/sites/default/files/2022-04/eurocontrol-aviation-outlook-2050-report.pdf

[9] Airlines, A. (2023, June 28). Alaska Airlines' 2022 sustainability report shares strides forward, key learnings and challenges faced. *Alaska Airlines News*. https://news.alaskaair.com/alaska-airlines/alaska-airlines-2022-sustainability-report/

essential to address that this scenario involving SAF might appear counterintuitive given that the feasibility of implementation was one of the filters for elaborating strategies. Indeed, it is factual that the production capacity of SAF is insufficient to supply the global demand for aviation fuel. Still, it is also of substantial knowledge that SAF does represent the most significant resource to this day to cut down on emissions in a considerable manner and, therefore, couldn't not be explored through this research. The use of SAF enables an 80% reduction in carbon emissions.[10] Later, the paper will delve into the capacity restriction and realistic pricing estimate chosen for the calculation in this scenario.

Both scenarios and the associated costs and figures are elaborated from a base year, usually the most recent relevant data. Therefore, those estimations are anchored in time and do not reflect the potential expansion growth of the airline market.[11] Those estimates reflect the current transition cost given the current market.

1.4. Research Question

In the spirit of steering and delimiting the scope of the research, a series of initial questions were listed. Those allowed to orient the process when delving into sources and data sets at the beginning of the study. Of course, throughout time, as the gathering of data and information evolved, questions appeared along the way, guiding the paper's development and shaping the furthering of the study.

- What is the weight of aviation emissions on a global scale?
- What does carbon neutral mean for aviation?

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[10] *Net zero 2050: Sustainable aviation fuels*. (n.d.). International Air Transport Association (IATA). https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet---alternative-fuels/

[11] Eurocontrol. (2022). *Aviation Outlook 2050.* Eurocontrol Group. https://www.eurocontrol.int/sites/default/files/2022-04/eurocontrol-aviation-outlook-2050-report.pdf

- What does the public opinion think of carbon emissions and aviation?
- When and why did concerns about carbon start? Has it always been the same?
- What are the challenges and limits to the capacity of limiting emissions?
- What are the technologies available against carbon emissions?
- Are those technologies underused today? What does slow their spreading?
- What are the current solutions/measures taken to manage carbon emissions?
- Do all airlines face the same regulations worldwide?
- What is the general strategy of airlines regarding sustainability goals?
- What is being invested to reach better carbon emissions results?
- What impact would a complete ecological transition have on airlines' finances?
- What would it mean for the airline companies and the passengers?
- How do policymakers intervene in the airline market in terms of green initiatives?
- How should policymakers and market regulators act to promote investments towards sustainability?
- How should the optimal policymaking be shaped to meet ecological transition and financial viability?
- Is carbon neutrality achievable for airlines with the current tools and spirit of initiatives?

Nevertheless, it is essential to remember that those questions only served to answer the underlying research question: "What if the Airline industry Turned Carbon-Neutral? Evaluating Financial Impact under EU ETS, CORSIA, and SAF Scenarios."

2. Literature review

This chapter aims to anchor this paper in the existing scholarly discussion about carbon emissions in the aviation industry, its impacts, and the solutions to reduce them. Ultimately, the literature review shall propose the current state-of-the-art on carbon neutrality's stakes and initiatives related to the aviation industry. I will also extensively explain the current state of EU ETS, CORSIA Scheme, and SAF.

2.1. Current Situation of Aviation Industry's Carbon Emissions

A complete understanding of carbon emissions in the aviation industry goes through allocating its correct proportion on a global scale. As of 2022, those carbon emissions accounted for 2%[12] of the global energy-related CO_2 emissions. On a European level, Direct flight emissions represent 3.8%[13] of the total CO_2 emissions and roughly 14%[14] of the transport share of emissions in 2017. Those numbers may seem to relativize the role aviation has on climate change, but its danger lies in the exponential growth the industry has encountered over the past decades. To put values on a timeline, total emissions related to flight operation (broader scope than direct emission from flights) have more than tripled in Europe since 1990, so they now represent 5%[15] of the carbon emitted on the continent.

[12] *Aviation*. (n.d.). International Energy Agency. Retrieved 2 September 2023, from https://www.iea.org/energy-system/transport/aviation

[13] *Reducing emissions from aviation*. (n.d.). Retrieved 2 September 2023, from https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-aviation_en

[14] *Ibid.*

[15] *Airplane pollution*. (2007, April 23). Transport & Environment. https://www.transportenvironment.org/challenges/planes/airplane-pollution/

Over the years, concerns about environmental quality increased as living standards also improved.[16] This observation can seem counterintuitive at first. The portion of the population demanding the most in terms of sustainability solutions is also the one who flies the most and is usually the least impacted by environmental pollution. Those concerns resonate with that. Until the 1990s, aviation was viewed as an industry that would never have a sustainable future as there was no alternative fuel to oil fuel.[17]

The situation has changed today, and the industry aims to reach net zero carbon by 2050. Different plans have been elaborated at different levels. On the governmental side, the European Union, motivated by Ursula Von Der Leyen, developed the European Green Deal in 2019 and follows the historical climate change strategy introduced in 1992.[18] The Green Deal aims to reduce the aviation industry's carbon emissions to 90% of what they were in 1990 by 2050.[19] To reach such an objective, the commission plans to develop CORSIA worldwide and that all flights shall be considered the same regardless of the routes they operate and, therefore, install a common carbon offsetting regulation for all airlines.[20] To complete this ecological transition on all fronts, the commission communicated that the InvestEU Fund will stimulate 650€ Billion in investment over 2021-2027 to fight climate change[21]. In addition to the Green Deal, *Destination 2050* was developed on the European side as a roadmap for airlines and

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[16] Graham, B., & Guyer, C. (1999). Environmental sustainability, airport capacity, and European air transport liberalization: Irreconcilable goals? *Journal of Transport Geography*, *7*(3), 165–180. https://doi.org/10.1016/S0966-6923(99)00005-8

[17] *Ibid*

[18] Sidde, M. (2020). *The European Green Deal: Asseasing its current state and future implementation*. Finnish Institute of International Affairs.

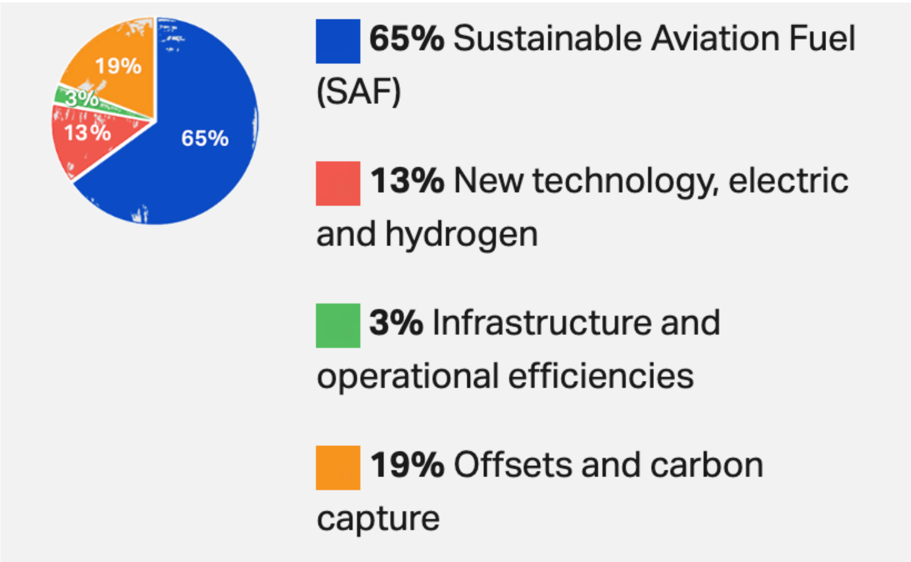
[19] *Aviation and the eu ets*. (n.d.). Retrieved 4 September 2023, from https://climate.ec.europa.eu/eu-action/european-green-deal/delivering-european-green-deal/aviation-and-eu-ets_en

[20]*Ibid*

[21] Sidde, M. (2020). *The European Green Deal: Asseasing its current state and future implementation*. Finnish Institute of International Affairs.

politics to reach carbon neutrality for all flights within and departing from the EEA[22]-EFTA[23] zone[24].

On the industry and international level, to comply with the Fly Net Zero commitment to reach zero emissions by 2050, IATA's members (International Air Transport Association) agreed on the Net Zero 2050 at the 77th IATA Annual General Meeting in Boston in October 2021. States adopted this plan at the 41st ICAO (International Civil Aviation Organization) Assembly held in October 2022. This plan contains a precise calendar of deadlines to fulfill their carbon neutrality objective.[25] In addition, it also details the projected impact each solution will have on the lowering of carbon emissions to zero.[26]



[22] European Economic Area

[23] European Free Trade Association

[24] Royal Netherlands Aerospace Centre (NLR), SEO Amsterdam Economics. Destination *50.* Royal Netherlands Aerospace Centre (NLR), SEO Amsterdam Economics. https://www.destination2050.eu/wp-content/uploads/2021/03/Destination2050_Report.pdf

[25] *Net-zero carbon emissions by 2050*. (n.d.). Retrieved 4 September 2023, from https://www.iata.org/en/pressroom/pressroom-archive/2021-releases/2021-10-04-03/

[26] *Net zero 2050: Sustainable aviation fuels*. (n.d.). International Air Transport Association (IATA). https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet---alternative-fuels/

It is possible to understand the weight given to each solution in the problem-solving process by looking at the magnitude of the impact that each brings. Using SAF alone would represent a reduction of 80% of emissions. Although, SAF faces a lot of capacity constraints. Namely, its production cost constrains it to remain economically nonviable until significant policy incentives are introduced to put the transition in motion.[27]

As for the use of technology, it englobes a series of solutions. The two most explored are air traffic management software and aircraft fleet renewal. Even though their effect is significantly lower than the expected impacts of an SAF transition, their contribution is non-neglectable. That said, the consensus is that the return on investment for a greener fleet would be positive. The cost saved on fuel compensates for the cost incurred by a new fleet. The only remaining obstacle to airlines massively investing in new aircraft lies in the risk carried by the low-profit margin airlines operate on.[28] To cover the risk, loan arrangements shall be elaborated in common with sovereign states to help airlines mitigate risk exposure and transit towards green and more fuel-efficient fleets.[29]

Finally, the third option expected to impact neutralizing carbon emissions significantly is the offsetting mechanisms and carbon trading scheme. One of the most established trading platforms was introduced by the European Union and is the EU ETS. Constantly being reviewed and revised, the platform is currently in the revision of its 4th phase.[30]

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[27] Shahriar, M. F., & Khanal, A. (2022). The current techno-economic, environmental, policy status and perspectives of sustainable aviation fuel (Saf). *Fuel*, *325*, 124905. https://doi.org/10.1016/j.fuel.2022.124905

[28] Adler, N., Martini, G., & Volta, N. (2013). Measuring the environmental efficiency of the global aviation fleet. *Transportation Research Part B: Methodological*, *53*, 82–100. https://doi.org/10.1016/j.trb.2013.03.009

[29] *Ibid*

[30] *Eu emissions trading system (Eu ets)*. (n.d.). Retrieved 5 September 2023, from https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

Another trading scheme planning to act on a broader scale than the EEA-EFTA space is the CORSIA scheme. Only adopted by the ICAO in 2018, the international scheme began its first phase in 2021 and is expected to play a significant role in the uniformization of carbon offsetting globally.

2.2. Existing Studies on Carbon-Neutrality in the Aviation Industry and The Financial Implications

A series of scholarly works have studied the path toward zero carbon emissions. A good part of those papers explored ways to enhance the mechanisms and the constraints the industry faces.

One study explored the possibility of funding fleet renewal by a carbon tax. This measure would produce a double effect by motivating airlines to renew their fleet to avoid carbon taxation and create a financial fund to help airlines acquire greener aircraft. It is essential to note that this taxation would also impact the consumers.[31] The rise in costs would also imply a rise in the airline's price to cover their extra expenditures.

Other studies have examined this last aspect: the return on investment of fleet renewal. One study's findings conducted in the Netherlands at Schiphol Airport led to believe that the extra cost that the fleet modification engenders was covered by the savings made on fuel consumption.[32] Although this is an encouraging prospect, this cannot be taken for generality.

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[31] Dray, L., Evans, A., Reynolds, T., Schäfer, A. W., Vera-Morales, M., & Bosbach, W. (2014). Airline fleet replacement funded by a carbon tax: An integrated assessment. *Transport Policy*, *34*, 75–84. https://doi.org/10.1016/j.tranpol.2014.02.021

[32] Adler, N., Martini, G., & Volta, N. (2013). Measuring the environmental efficiency of the global aviation fleet. *Transportation Research Part B: Methodological*, *53*, 82–100. https://doi.org/10.1016/j.trb.2013.03.009

Indeed, fuel volatility, local taxes, and circumstantial variables play a massive role in determining the return on such investment.

Another paper similarly explored the scenario in which the EU ETS offsetting requirements were brought upon African Airlines. It discussed the financial impact of new carbon expenses on Kenya Airways. The main finding was the carbon price's role in the strategy decision about fleets. There appears to be a carbon price threshold above which the fleet renewal would make financial sense for a firm.[33] This highlights a key element crucial to determining and setting the effectiveness of carbon reduction measures: carbon emissions pricing.

2.3. Background on EU ETS, CORSIA Scheme, and SAF

As of today, a limited number of tools, regulations, taxes, and propositions exist to reach the ecological goals of carbon neutrality. This paper mainly focuses on the EU ETS, Corsia Scheme, and the use of SAF.

Concerning the EU ETS, The European Union (EU) addresses aviation emissions through the Emissions Trading System (EU ETS), as outlined in Directives 2008/101/EC and 2009/29/EC.[34] Under these rules, European and external aircraft operators must secure and submit CO2 allowances for most of their flights to, from, and within Europe.

[33] Miyoshi, C. (2014). Assessing the equity impact of the european union emission trading scheme on an african airline. *Transport Policy*, *33*, 56–64. https://doi.org/10.1016/j.tranpol.2014.02.010

[34] Oberthür, S., & Pallemaerts, M. (2010). *The new climate policies of the European Union: Internal legislation and climate diplomacy*. VubPress. p65.

From 2013 to 2020, these allowances were restricted to 95% of the historical aviation emissions average from 2004 to 2006.[35] While these allowances are specific to the aviation sector, airlines have the flexibility to purchase supplementary permits from external markets. They can also use a small percentage of permits from initiatives of the Kyoto Protocol, like the "Clean Development Mechanism" and "Joint Implementation."[36]

A few notable exemptions exist in this framework. Firstly, flights serving public service obligations in Europe's outermost regions or those on routes with fewer than 30,000 seats annually are not bound by these rules. Secondly, carriers with limited operations in Europe—either by conducting fewer than 243 flights over three consecutive four-month periods or emitting under 10,000 tons of CO2 yearly—are exempt.[37]

In 2013, a "Stop the Clock" decision[38] was introduced, temporarily narrowing the EU ETS's application to flights solely within the European Economic Area (EEA). This decision was initially meant to last from 2013 to 2016 but was extended to at least July 2017 as the EU awaited further details on the CORSIA's global implementation.[39]

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[35] *Allocation to the aviation sector*. (n.d.). Retrieved 7 September 2023, from https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/allocation-aviation-sector_en

[36] Scheelhaase, J., Maertens, S., Grimme, W., & Jung, M. (2018). EU ETS versus CORSIA – A critical assessment of two approaches to limit air transport's CO 2 emissions by market-based measures. *Journal of Air Transport Management*, *67*, 55–62. https://doi.org/10.1016/j.jairtraman.2017.11.007

[37] *Ibid*

[38] *Press corner*. (n.d.). [Text]. European Commission - European Commission. Retrieved 13 September 2023, from https://ec.europa.eu/commission/presscorner/home/en

[39] *Eur-lex—32013d0377—En—Eur-lex*. (n.d.). Retrieved 6 September 2023, from https://eur-lex.europa.eu/eli/dec/2013/377(1)/oj

Concerning the CORSIA global scheme, the Kyoto Protocol (1997) extended the United Nations Framework Convention on Climate Change, setting emission reduction goals for developed countries but not explicitly addressing emissions from international aviation. The task of handling aviation emissions was delegated to the International Civil Aviation Organization (ICAO) under Article 2 of the Protocol.[40]

Since 1997, ICAO has been working on policies to mitigate international aviation's greenhouse gas emissions, albeit with slow progress due to complex negotiations. Key ICAO milestones include Assembly Resolutions A37-19 (2010), A38-18 (2013), and A39-3 (2016).[41]

The 37th ICAO Assembly established the goal of carbon-neutral growth from 2020 onwards (CNG 2020 goal), aiming to keep aviation's carbon emissions post-2020 below that of the year 2020. The intention is to decrease aviation's environmental impact. This commitment was strengthened in the 38th Assembly, where the development of a global market-based measure (GMBM) was decided upon, recognizing that existing technical and operational measures might be insufficient to reach the CNG 2020 goal.[42]

The 39th ICAO Assembly introduced CORSIA, a global GMBM (Global Market Based Measure), in the form of an offset scheme. In CORSIA, airlines would buy carbon credits that represents the right to emit a certain amount of CO2 or its equivalent. These credits are

[40] UNDP. (2022). *Report on CORSIA implications and carbon market development (Deliverable 3.2.).* United Nations Development Program. https://www.undp.org/sites/g/files/zskgke326/files/2023-02/Report%20on%20CORSIA%20implications%20and%20carbon%20market%20development%20%28Deliverable%203.2.%29.pdf

[41] Schinas, O., & Bergmann, N. (2021). Emissions trading in the aviation and maritime sector: Findings from a revised taxonomy. *Cleaner Logistics and Supply Chain*, *1*, 100003. https://doi.org/10.1016/j.clscn.2021.100003

[42] IACO. (2019). *Climate Change Mitigation: CORSIA*, *Chapter 4.* International Civil Aviation Organization.https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg111-115.pdf

achieved by projects that reduce carbon emissions. The CORSIA initiative is truly an intriguing approach to address the environmental impact of aviation. Essentially, it operates as an offset scheme. This means that airlines must counterbalance their emissions by investing in various projects aimed at reducing CO2 or greenhouse gas emissions in sectors outside of aviation. It's worth noting that several quality standards are in place to ensure the legitimacy of these offsets, with the Gold Standard[43] being a prominent example.[44]

In terms of its structure, CORSIA is divided into three distinct phases. The Pilot Phase spans from 2021 to 2023, Phase 1 from 2024 to 2026, and Phase 2 from 2027 to 2035. The intricacies lie in the routes; the obligations depend on the routes between states that have agreed to participate in CORSIA, and these specific routes have been aptly named "CORSIA routes." Participation in the program varies according to the phase. For the Pilot Phase and Phase 1, it's not obligatory for states to join. As of mid-2017, there was an expectation that 71 states would volunteer. But come Phase 2, the game changes -- it becomes compulsory. However, there are exceptions in place for Least Developed Countries and a few others unless they opt to join voluntarily.[45]

Now, an interesting aspect of CORSIA is its emphasis on sustainable fuels. If airlines incorporate these into their operations, they can actually reduce the number of offsets they need to purchase. But, while CORSIA pushes for wide participation, it does recognize the need for

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[43] The "Gold Standard" for climate denotes rigorous, verifiable carbon offset projects ensuring genuine emissions reductions

[44] *ICAO. (2016). Report Of The Executive Committee On Agenda Item 22 (ASSEMBLY — 39TH SESSION A39-WP/530 P/59). (International Civil Aviation Organization.* *https://www.icao.int/meetings/a39/documents/wp/wp_530_en.pdf*

[45] *CORSIA explained*. (n.d.). Retrieved 7 September 2023, from https://aviationbenefits.org/environmental-efficiency/climate-action/offsetting-emissions-corsia/corsia/corsia-explained/

certain exemptions to ensure the market remains balanced. Therefore, while all airlines operating on CORSIA routes need to buy offsets, there are a few exceptions. Small airlines emitting less than 10,000 tons of CO2 annually, aircraft with a Maximum Take-Off Mass below 5.7 tons, humanitarian, medical, and firefighting operations, and new market entrants (for a limited time) if they account for a minuscule share of the total RTK (Revenue Tone Kilometers), all fall under this category. Delving into the calculations behind the emissions, each airline's offset requirement hinges on its emissions on CORSIA routes and the overall sector's growth. As time progresses, the calculations will gradually emphasize the growth rate of each airline.[46]

Finally, to complete the background of the tools used toward carbon neutrality, SAF, an intriguing contender, needs to be detailed thoroughly. It isn't merely a substitute. It's an intricately woven tapestry, marrying traditional jet fuel with eclectic elements sourced from beyond the realm of petroleum - think bio-waste and even the seemingly otherworldly algae.[47]

What strikes a chord about SAF isn't just its innovative nature and potential environmental prowess. To paint a picture, under the right circumstances, SAF might slash greenhouse gas emissions by a staggering 75% throughout its lifespan compared to its conventional counterparts. Switching to SAF from conventional jet fuel is much like the global shift we've witnessed from coal to cleaner energy sources; the ultimate winner in both scenarios is the environment.[48]

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[46] *ICAO. (2016). Report Of The Executive Committee On Agenda Item 22 (ASSEMBLY — 39TH SESSION A39-WP/530 P/59). (International Civil Aviation Organization. https://www.icao.int/meetings/a39/documents/wp/wp_530_en.pdf*

[47] Gegg, P., Budd, L., & Ison, S. (2014). The market development of aviation biofuel: Drivers and constraints. *Journal of Air Transport Management*, *39*, 34–40. https://doi.org/10.1016/j.jairtraman.2014.03.003

[48] Capaz, R. S., & Seabra, J. E. A. (2016). Life cycle assessment of biojet fuels. In *Biofuels for Aviation* (pp. 279–294). Elsevier. https://doi.org/10.1016/B978-0-12-804568-8.00012-3

While the potential of SAF is undeniably compelling, we must first address a fundamental inquiry: From what is it derived? This question parallels the rigor with which one would inquire into the foundational elements of a critical scientific process. Delving into the intricacies of feedstocks, the spectrum ranges from established sources to emerging alternatives. These investigations elucidate both the environmental and economic dimensions intrinsic to each feedstock.[49]

Like many groundbreaking endeavors, the pathway toward SAF innovation isn't straightforward. It's punctuated with significant economic hurdles and challenges in achieving scale. Studies have delved into these intricacies, drawing attention to the oscillating financial dynamics, the intense competition for feedstock, and the capricious nature of market forces that could accelerate or stymie SAF's pivotal emergence.[50]

Taking a broader perspective, one cannot overlook the critical framework of regulations and standards. Venturing into SAF's integration in aviation goes beyond mere innovation. It's about seamless incorporation into an established framework. Central to this is the mandate for unequivocal compatibility and demonstrable reductions in emissions.[51]

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[49] De Jong, S., Antonissen, K., Hoefnagels, R., Lonza, L., Wang, M., Faaij, A., & Junginger, M. (2017). Life-cycle analysis of greenhouse gas emissions from renewable jet fuel production. *Biotechnology for Biofuels*, *10*(1), 64. https://doi.org/10.1186/s13068-017-0739-7

[50] Staples, M. D., Malina, R., Olcay, H., Pearlson, M. N., Hileman, J. I., Boies, A., & Barrett, S. R. H. (2014). Lifecycle greenhouse gas footprint and minimum selling price of renewable diesel and jet fuel from fermentation and advanced fermentation production technologies. *Energy Environ. Sci.*, *7*(5), 1545–1554. https://doi.org/10.1039/C3EE43655A

[51] *Press corner*. (n.d.). [Text]. European Commission - European Commission. Retrieved 7 September 2023, from https://ec.europa.eu/commission/presscorner/home/en

Looking ahead, discerning the trajectory of SAF presents complexities reminiscent of the challenges faced by long-term strategists. The roadmap is informed by many factors, from groundbreaking scientific insights to the ebb and flow of political priorities. It provides a comprehensive overview, capturing the dynamic interplay of research trends, policy adjustments, and market responses, shaping the future of SAF.

To wrap it up, as the aviation world stands on the cusp of a green revolution, SAF beckons like a lighthouse. But its journey isn't a solo flight; it requires a concerted effort, blending research, policies, and industry maneuvers into a symphony of sustainability.

3. Methodology

This chapter presents the process used to select the appropriate data, the method of collection, and the shaping process of the airline's financial and corporate data to extract solid observations on the current state of carbon neutralization and its economic implications.

This section will also detail the financial tools and ratios used to assess the current situation of airlines. Those set numbers will then enable comparisons between pre- and post-implementation scenarios. Those comparisons shall lead to identifying the impacts of those scenarios on airlines' financial performances.

Finally, this chapter shall present an extensive explanation of both scenarios. It will review the assumptions made and the fixed variable chosen that allowed to elaborate a realistic as to what the transition cost of the current airline industry would entail.

3.1. Research Design and Data Collection Method

The first step was to decide on the relevant data to look for and how to find those. The first data needed was the current carbon emissions to calculate the impact of the carbon-neutral transition on airlines' performances. For most airlines, 2022 was a year back to normal, close to 2019 activities, and therefore a relevant base year.[52] The volume of flights and passengers carried in 2022 appears to be close to the data from 2019. In most cases, the 2022 data about carbon emissions was available, and in the rare case it wasn't, 2019 was taken as the proxy to fill in the gap. Each airline's representative carbon emission quota is taken from the scope 1, 2,

[52] *Airlines cut losses in 2022; return to profit in 2023*. (n.d.). Retrieved 2 September 2023, from https://www.iata.org/en/pressroom/2022-releases/2022-12-06-01/

and 3 of GHG emissions present either in the annual report, sustainability report, or climate compliance report.

The analysis was conducted among a sample pool of 35 airlines: 15 based in Europe and 20 based elsewhere in the world. (See Appendix 1.) This aspect matters regarding carbon offsetting requirements. Indeed, only flight operations within the EEA-EFTA states are subject to offset their emissions through the EU ETS. Figuring out the proportion of flight operations between the EEA-EFTA and those outside shall then matter to determine under which scheme the carbon emission should be offset.

In addition to carbon emissions, the current fuel cost will be valuable data for the further elaboration of the SAF scenario. This cost will be the basis for the computation of the new SAF cost. Given the price difference between traditional kerosene and SAF, a significant operating expense difference will significantly impact airlines' operating expenses under this scenario.

Operating expenses, revenues, and depreciation are also needed to measure the OER (operating expense ratio), which indicates the cost compared to a company's revenue and informs about the financial viability of its functioning and its capacity to maintain its operation if expenses increase. With scenarios of expense increases, this ratio seemed like a correct marker to measure the impact on operations the transition would incur.

To gather those data, the research was automatized among the same documents and consistent keyword entries to access the relevant information. All were available in annual reports, financial statements, sustainability reports, 10-K (American companies), or climate change compliance reports. The list of key entries was such: “depreciation,” “operating,” “operating expenses,” “Scope,” “carbon,” and “fuel.”

3.2. Financial Analysis Tools and Techniques

The core of the financial analysis was treated with Excel. The research revolves around cost forecasting, financial ratio review, and growth revenue and expenses projection. Each forecasting and projection was adapted and modified to comply with the variables implied in each scenario.

The operating expense ratio (OER) was the financial ratio chosen to analyze the impact of the carbon transition. The choice was due to the budget planning, strategic decision indicators, profit margin insight, and comparative benchmarking quality this ratio can provide to a financial analysis. The ratio is computed in the following way. Gross revenue also refers to gross operating income.

$$OER = \frac{\text{Total operating expenses} - \text{depreciation}}{\text{Gross revenue}}$$

Using the OER, comparisons will be drawn between the different airlines studied and the two scenarios explored. Those apparent differences in ratios will be the basis for discussing observations on the data and the various impacts each scenario has on the finances of each airline. The backbone idea is to understand what revenue growth would be needed under both scenarios with their respective expenditures increases in carbon offsetting or SAF to keep the ratio intact.

Computing the required growth and understanding its impact on the company and the consumer is crucial to discussing the potential financial health following the carbon transition and formulating the possible outcomes of this transition.

The techniques and tools are relatively regular for the rest of the financial analysis. The cost forecasting, growth revenue, and expense projections are all conditioned by the assumptions for each scenario explained in the next section. The calculations follow the requirements of each scenario and are described in detail in each dedicated chapter.

3.3. Scenario Modelling and Assumptions

Each scenario was developed based on assumptions to make the calculation feasible, showcasing a relevant and realistic estimate of what a carbon transition would imply on the airlines' finances. Also, establishing a set of fixed variables in the data enhances the qualitative consistency of observations in a data set populated by individual actors.

Only a couple of assumptions apply to both scenarios and are not individually tailored to each. One of the common assumptions in both scenarios is the repartition of flights between those within the EEA-EFTA states and those outside this zone. Each airline, depending on its operation network and the location of its services, has a specific proportion that is hard to determine and not usually communicated. Therefore, assumptions had to be made based on available information. Concerning European airlines, it all depends on their type. For local low-cost airlines such as Wizz Air or Ryanair, even though they operate flights to Morocco or Israel, outside of the EEA-EFTA zone, it was chosen to attribute to them a 100% proportion of flight operation within that zone given the meager percentage of flights flying outside of it. This attribution also enhances the contrast with the non-European airlines for which it was attributed a 100% operation outside the EEA-EFTA zone and, therefore, not subject to the EU ETS carbon offset. Another category of airlines operating significantly in both airspace zones needed to be determined. British Airways was taken as a proxy for this group, operating 78%[53] of its flights within the EEA-EFTA zone and 22%[54] outside. All similar airlines, in terms of size and type of operations, such as the Lufthansa Group (Austrian Airlines, Brussels Airlines, Eurowings, Swiss Air) or the Air France–KLM Group, were therefore given a 75-25 repartition between the two airspace zones. As for smaller carriers with a limited but still significant operation scope outside of the EEA-EFTA zone, a 90-10 distribution was decided upon.

The previous assumption is essential to address the following shared assumption: the carbon ton price. This critical data determines a significant part of the expenses incurred by airlines in both scenarios to reach carbon neutrality. The price has evolved significantly over the past years and appears quite volatile in some cases. Another critical aspect of the pricing process is to note the significant difference between the different existing carbon trade exchange platforms. The dedicated chapter on the EU ETS and CORSIA scheme will extensively explain the pricing history of both platforms. For now, the figures taken for the pricing assumption were issued from the British Airways 2022 annual report[55]: 22£ (25€)/Ton of carbon for CORSIA, 110£ (130€)/Ton of carbon for the EU ETS.

The combination of the two assumptions explained above, namely the flight distribution and the price of carbon, is the basis for realistic estimates of carbon expenses airlines would

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[53] *Aviation analytics*. (n.d.). Cirium. Retrieved 3 September 2023, from https://www.cirium.com/

[54] *Ibid*

[55] British Airways. (2023). *Annual Report and Accounts 2022*. British Airways. https://www.iairgroup.com/~/media/Files/I/IAG/annual-reports/british-airways-annual-report-and-accounts-2022.pdf

encounter. Indeed, the first assumption would determine the correct weight of the total airline's emissions to be offset through the right platform at the price given by the second assumption.

Then, moving to assumptions specific to each scenario, the first one explores the option of enabling airlines to reach carbon neutrality through one single expense. By offsetting their total emissions, they would technically become carbon neutral. For ease of computation, it is assumed that carbon neutrality is attained if 100% of the emissions are dealt with. In contrast, the European Green Deal plans on achieving carbon neutrality by reaching 1990 emissions levels and cutting emissions down by 90%.[56] In addition, when adding the carbon expenses to the new total expenditures (see Appendix 2.), it is assumed that airlines have not offset any of their emissions, which is not reflected in their previous total expenses. The new carbon emission expenses due to the offset on the correct trading platform are added to the total previous expenditures.

The second scenario develops an option in which airlines completely switch toward SAF and abandon regular jet fuel while offsetting the rest of their carbon emissions on the correct carbon trading platform. The first assumption concerning the second scenario concerns the SAF price, especially its difference from regular jet fuel. The general estimate places SAF two to six times more expensive[57] than traditional jet fuel. With such a broad span, four times more expensive appeared to be a realistic estimate of what SAF would cost if it were to supply the global demand for aviation. Now, and as it will be explained more in-depth in the dedicated chapter,

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[56] De Bruin, K., & Yakut, A. M. (2022). The impacts of aviation taxation in Ireland. *Case Studies on Transport Policy*, *10*(4), 2218–2228. https://doi.org/10.1016/j.cstp.2022.09.017

[57] *Reducing emissions from aviation*. (n.d.). Retrieved 9 September 2023, from https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-aviation_en

SAF only represented 0.1%[58] of the global supply. Other than its production being physically incapable of supplying such demand if airlines had to switch to SAF tomorrow, the scenario explores the pricing mechanisms SAF would undergo with such a surge in demand and constraint on supply. Four times more expensive seemed a realistic estimate for a set of reasons. It is easy to imagine that the stress on the demand side combined with constraints on the supply side would spike prices up. On the opposite side, if SAF production capacity had to expand fast and become capable of supplying the global demand, we can imagine a relief of pressure on the supply side and a levelling of prices. Four times encapsulates a gross estimate of this process, levelling down mid-way between the current prices of SAF and jet fuel.

Another essential assumption to pursue the second scenario determines the reduction in the percentage of carbon emissions of SAF compared to current jet fuel. Most sources agree that SAF would produce 80% less emissions than traditional jet fuel. Meaning that current emissions could drop to almost a fifth of what they currently are. This assumption comes with another one: the present proportion of use of SAF in airlines. Most airlines studied usually operate around a 10% median of SAF use. Therefore, to compute the correct amount of carbon emissions caused by regular jet fuel, 10% was fixed as the reference for the current use of SAF in all airlines. Once this variable is set, the correct amount of carbon due to jet fuel and the additional expenses on fuel due to the switch can be calculated. As SAF produces 80% fewer carbon emissions, the 10% present in the fuel mix is only responsible for 2% of the total emission; this means that 98% of the current emission could be cut down by 80 percent. Following the same logic, as SAF is four times more expensive than regular fuel, the 10% use

[58] *Aviation*. (n.d.). IEA. Retrieved 2 September 2023, from https://www.iea.org/energy-system/transport/aviation

of it will be responsible for 30% of the current fuel bill; this induces that 70% of the current fuel expense will undergo a quadrupling in price, in other terms a 300% increase.

4. EU Emissions Trading System (ETS) & CORSIA Scheme Scenario

This chapter explores the details and financial impact of the first scenario: offsetting 100% of current carbon emissions on the EU ETS or through the CORSIA scheme to reach a carbon neutral airline industry. It starts by a thorough reminder of what the EU ETS and CORSIA consists of while describing extensively the timeline of both platforms. Finally, it will explain the first scenario financial impact on airlines observed in the study.

4.1. Overview and Mechanism of EU ETS

The European Union Emissions Trading System, commonly known as the EU ETS, stands as a testament to the European Union's proactive stance on climate change. Pioneering the concept of a carbon market, it remains the world's premier example of how economic incentives can be leveraged to curb industrial carbon emissions. The EU ETS represents a flagship for the European Union in its sustainable strategy.[59]

Originating in 2005, the EU ETS was the European Union's answer to the promises made under the Kyoto Protocol – a global pledge to curtail greenhouse gas (GHG) emissions. Since its inception, the system has evolved considerably, with each iteration serving to fine-tune its mechanisms and expand its reach. Fundamentally, the EU ETS functions on the cap-and-trade model. Here's a brief description of how it functions:

- Setting the Cap: A limit on the total amount of certain greenhouse gases is set. This cap gets stricter over time to ensure the reduction of overall greenhouse gases.

[59] Wettestad, J. (2011). Eu emissions trading: Achievements and challenges. In V. L. Birchfield & J. S. Duffield (Eds.), *Toward a Common European Union Energy Policy* (pp. 87–111). Palgrave Macmillan US. https://doi.org/10.1057/9780230119819_5

- Allocation of Allowances: Companies receive or buy allowances that permit them to emit a specific quantity of GHG. Over time, the number of allowances distributed decreases, encouraging businesses to reduce their emissions.
- Flexibility: Firms can buy and sell allowances, providing an incentive for them to reduce their emissions since they can sell any excess allowances for profit.
- Monitoring and Reporting: Companies are obligated to measure and report their carbon emissions and to return an amount of allowances equivalent to their emissions at the end of each year.
- Penalties: If a company does not have enough allowances to cover its emissions, it will face hefty fines.

To complete the understanding of EU ETS mechanisms, it is also helpful to study its implementation plan:

1. Phase I (2005-2007): The pilot phase helped set up the necessary infrastructure for carbon trading and established a carbon price.
2. Phase II (2008-2012): Coincided with the Kyoto Protocol's commitment period.
3. Phase III (2013-2020): Brought an EU-wide cap on emissions, rather than national caps, and introduced auctioning as the primary method of allocating allowances.
4. Phase IV (2021-2030): Aim to achieve a 43% reduction in GHG emissions by 2030 compared to 2005. This phase introduces several reforms, such as a more significant market stability reserve to prevent the accumulation of surplus allowances and adjustments to the cap-setting process.

While the EU ETS has successfully demonstrated the viability of carbon pricing and spearheaded emissions cuts in specific sectors, it has yet to be without its detractors. Some argue that carbon pricing has occasionally been too modest to induce meaningful carbon reduction. Likewise, an overabundance of allowances has sometimes undermined market stability.

The next chapter for the EU ETS is being written under the aegis of the European Green Deal, with the EU's ambitious target of achieving carbon neutrality by 2050 lending the system renewed urgency and relevance. As we move forward, the role and refinement of the EU ETS in this journey will undoubtedly be worth watching.

4.2. Overview and Mechanism of CORSIA

The International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is a testament to global collaboration. Born out of the need to manage the ballooning carbon footprint of air travel, CORSIA embodies the spirit of harmonizing aviation growth with environmental stewardship.

The seeds of CORSIA were sown during the 39th Assembly of ICAO in 2016. As aviation's carbon footprint began casting a longer shadow, there was palpable global anxiety. With the Paris Agreement sidestepping international aviation, ICAO rose to the occasion, vowing to devise an actionable plan targeting this sector's emissions.

At the heart of CORSIA lies its offsetting framework. This plan is laser-focused on ensuring that CO2 emissions from international aviation, from 2020 onward, do not spiral out of control. Instead, the vision is to balance out yearly increases. The breakdown of CORSIA’s mechanics appears this way:

- Monitoring, Reporting, and Verification (MRV): A rigorous process obligates airlines to diligently track emissions from international journeys, relaying this data to their home countries. Before these numbers reach ICAO, an independent entity cross-checks them for accuracy.
- Emissions Units: Should an airline's emissions breach the 2020 marker, it is called to act. The airline must then support projects geared towards carbon reduction, buying emission reduction units as a counterbalance.
- Sustainability Criteria: Ensuring that every measure has a meaningful impact, CORSIA has set stringent guidelines. Whether it is aviation fuel or carbon credits, everything is evaluated through the lens of true sustainability.

CORSIA’s rollout is systematic, unfolding across distinct stages:

1. Pilot Phase (2021-2023): The embryonic stage is where participation is by choice. Offset requirements hinge on the growth trajectory of the aviation industry, with each operator’s duties mirroring this growth.
2. First Phase (2024-2026): Another elective phase aims to polish the practices and strategies seeded during the pilot phase.
3. Second Phase (2027 onward): By this juncture, CORSIA participation becomes the norm, not the exception. However, a handful of nations – chiefly the least developed, smaller island nations, and those landlocked – can opt-out unless they willingly choose to join the fold.

CORSIA stands tall as a pioneer – the first-ever initiative to cap carbon emissions across an entire industry. By doing so, it acknowledges the aviation industry’s distinctive challenges and projected growth. Yet, some voices in the chorus express reservations. For them, CORSIA's reliance on offsetting rather than concrete emission reductions and the optional nature of its early days are potential threats to the actionability of this plan.

The global community watched with bated breath as the curtains rose on the pilot phase in 2021. The coming years will be instrumental in shaping opinions. Key areas of interest include gauging the enthusiasm for voluntary participation, assessing the carbon-reducing projects that airlines gravitate towards, and understanding the ripple effects of CORSIA on aviation's overarching carbon narrative.

4.3. Financial Implications of Carbon Offset for Airlines Under a Carbon-Neutral Scenario

Many observations and comments about the financial impact of this scenario on airlines' performances can be made. It is also interesting to compare the results between the EEA-operating airlines and the non-EEA-operating airlines.

Before offsetting the entirety of their emissions, the average OER of the EEA-operating airlines is 83%, and the average OER of non-EEA-operating airlines is 88 percent. Keeping those ratios in mind, the most significant indicator that reflects the impact of the EU ETS and CORSIA scheme and their carbon price difference is the percentage growth of total expense once airlines have offset their carbon emissions. The effect for EEA-operating airlines is measured at a 14% increase in total costs. This is due to the high carbon trading price on the EU ETS. Airlines subject to offsetting their emissions on that platform encounter a much higher increase in their total expenses than airlines offsetting their emission on the Corsia scheme. The trading price of carbon under the CORSIA is significantly lower. Therefore, non-EEA-operating airlines would experience an increase of 3% of total expenses. Such a gap between the two kinds of airlines observed in the analysis shows an unfair constraint put on European airlines against their concurrence to achieve carbon neutrality and a more significant stress on their financial results.

Those increases in total expenses are reflected in the projected revenue needed to keep their initial OER constant. For EEA-operating actors, their income would need to increase on average by 29%; for the non-EEA-operating actors, by 19 percent. Both those projected increases showcase the magnitude of the cost involved with sustainability challenges. It is realistic to expect airlines to charge their passengers a higher price, hindering their willingness to fly, to boost their operating revenue and hopefully regain financial health while assuring environmental welfare. Nevertheless, both the high cost of carbon and the need to offset the entirety of carbon emissions motivate airlines to plan a renewal of their fleet to reduce their emissions and, therefore, offset expenses.

In conclusion, the financial impacts of the method in the first scenario to reach a carbon-neutral aviation industry are non-neglectable. Even though non-EEA-operating airlines experience a lesser increase in their expenses than EEA-operating airlines, it remains a great added financial stress for an industry operating on thin profit margins. Considering the magnitude of the cost combined with the urgency of the stakes,
it is imperative for stakeholders, governments, and international bodies to collaborate on sustainable financial solutions that promote carbon neutrality and ensure the economic viability of the aviation industry.

5. Sustainable Aviation Fuel (SAF) Scenario

This chapter explores the details and financial impacts of the second scenario: a complete switch toward SAF and offset of the remaining emissions on the EU ETS or through the CORSIA scheme to reach a carbon-neutral airline industry. It first introduces SAF with an extensive reminder of its mechanisms, provenance, and value for a sustainable future. It then presents the result of the financial analysis conducted in the study.

5.1. Overview and Mechanism of SAF

Sustainable Aviation Fuels (SAF) is a transformative approach to decarbonizing the aviation sector. Comprising non-fossil-based fuel alternatives, SAF has the potential to reduce the aviation industry's carbon footprint significantly.

The SAF chronicles begin in the fledgling years of the 21st century as the clamor over aviation leaving dark carbon trails in the sky reached a crescendo. Answering this call, 2008 saw a plane taking off powered by an innovative concoction – a mix of traditional and sustainable fuel. That flight was not just covering distance; it was the industry's first step toward a greener horizon.

SAF englobes more than a single solution. It is an array of alternative fuels from different origins:

- Biofuels: Think fuels with life. They hold the potential, whether the green algae from water bodies or residues left after crop harvest.
- Synthetic Fuels: An alchemical mix. Carbon wrested from the atmosphere gets friendly with hydrogen, borrowed from green sources, to form these fuels.

- Hybrid Fuels: When bio meets synthetic, what is obtained is a fuel blend embodying the best of both worlds.

Now, the beauty of SAF is its simplicity. One of the main advantages of SAF lies in the ease of implementation. SAF can be directly poured into the existing engines without any technical adaptation to receive this other type of fuel. Today, SAF is usually mixed with traditional fuel, but the first commercial flight with one of the engines 100% fueled with SAF took off in 2021.[60] The flight operated by United Airlines flew one of their Boeings 737-800 on a domestic route to test the capacity of SAF when not blended. In November 2023, the first transatlantic flight 100% powered by SAF operated by Virgin Atlantic is planned.[61] Those milestone events represent a step towards the greenest version of aviation realistically accessible in the near future. They also deeply resonate with the topic and scenarios developed in this paper.

Taking a glimpse at the SAF timeline also helps understand its evolution.

1. Research & Demonstration (Early 2000s - 2010): The years of tinkering in labs and successful maiden flights powered by SAF.
2. Early Adoption (2010 - 2020): SAF wasn't just a prototype anymore. Commercial planes embraced it, factories mushroomed, and industries took the green oath.
3. Scaling Up (2021 and beyond): Production scales are tilting upwards, regulations are crystallizing, and airlines are expanding and experiencing more and more greener operations.

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[60] *United flies world's first passenger flight on 100% sustainable aviation fuel supplying one of its engines | ge news*. (n.d.). Retrieved 9 September 2023, from https://www.ge.com/news/reports/united-flies-worlds-first-passenger-flight-on-100-sustainable-aviation-fuel-supplying-one

[61] Vitale, C. (2023, July 24). Rolls Royce engine to be used in world's first full SAF flight. *Airport Technology*. https://www.airport-technology.com/news/rolls-royce-engine-used-worlds-first-full-saf-flight/

Even though SAF's main direct benefit is the reduction of carbon emission, by almost 80% for some, they still have numerous obstacles to overcome so they will become the norm for aviation fuel:

- The Money Game: SAF represents a significant increase in fuel expenditures for airlines compared to the traditional kerosene.
- Feedstock Fretting: There's a cloud of anxiety around the sustainability and availability of sources, particularly those breathing ones for biofuels.
- Infrastructure Intricacies: To welcome SAF with open arms, our current fuel channels need some rejigging.

Recently, the ultimate concept involved with SAF is "Power-to-Liquid" (PtL) fuels. Imagine harnessing renewable electricity to craft synthetic aviation fuel. Combine it with carbon capture, and we would be reaching the utopia of carbon-neutral fuels.[62]

5.2. Financial Implications for Airlines Under a Carbon-Neutral Scenario Using Full SAF

The switch towards full SAF use impacts airlines' financial performances in a significant manner. In this scenario, 100% of the fuel burned by airlines for their flight operations would be SAF. This would cut down on emissions and, therefore, there would be a significantly lesser amount of carbon emissions left to offset. The main problem is the price difference between traditional jet fuel and SAF.

In this scenario, as the emissions do not represent the principal expense to achieve carbon neutrality, the trading platform and, hence, the geographical location of operations do not

[62] *Initiatives & projects*. (n.d.). Retrieved 9 September 2023, from https://www.icao.int/environmental-protection/GFAAF/Pages/Project.aspx?ProjectID=46

matter as much. Emissions are much lower because of SAF, and the offset becomes marginal compared to the cost incurred by this type of jet fuel. SAFs are considered four times more expensive in this study as explained in the methodology chapter.

As in the first scenario, the initial OER are respectively 83% and 88% for EEA-operating airlines and non-EEA-operating airlines. As for the other financial indicators, they differ from the previous scenario. The switch to SAF, combined with the carbon offset cost, provokes an increase in fuel expenses of respectively 220% and 213% for EEA-operating airlines and non-EEA-operating airlines. This translates into the total costs by an augmentation, respectively measured at 92% and 87% from their initial level for EEA-operating airlines and non-EEA-operating airlines. Total expenditures have almost doubled simply because of the SAF transition. Realistically, airlines would be incapable of absorbing such an expense shock alone. The revenue needed for their OER to return to their average level pre-SAF are respectively 69% and 63% higher than they are currently generating for EEA-operating and non-EEA-operating airlines.

Given the current cost of SAF, airlines cannot realistically consider entirely switching to more modern, less polluting fuel. In addition to their capacity production not being capable of supplying such demand, it would also be a disastrous strategy for their financial viability that would have grave consequences on the whole economy. Airlines and the aviation industry are a pillar of modern economies and participate actively in countries' development. Therefore, it is crucial to work toward SAF price democratization and create incentives to use them, as they represent the most impactful and efficient solution to reduce emissions directly and tangibly.

6. Comparative Analysis

This chapter bridges and compares the two scenarios this paper has elaborated on. Comparing them enables understanding, which would significantly impact airlines, consumers, economies, and the environment.

6.1. Direct Financial Comparison Between EU ETS & CORSIA and SAF Scenarios

Both scenarios stress the airlines' financial performance, but it is evident that using SAF leads to even higher costs. This is because fuel is a significant part of airlines' expenditures, and SAF is four times more expensive than regular jet fuel in our study.

One of the most interesting results from the analysis results is the difference between EEA-operating and non-EEA-operating airlines. Indeed, under the scenario using the EU ETS & the CORSIA scheme, airlines, depending on their zone of operation, face a disparity in the cost necessary for carbon neutrality. Aviation actors such as Ryanair, which is considered to have 100% of their operations in the EEA zone in this study, encounter a much higher price of carbon on the EU Emission Trading System than actors operating outside of this zone that do not need to go through the European trading platform. Those airlines would offset their emissions on CORSIA, which proposes a lower price for every ton of carbon.

This disparity does not appear in the second scenario because the main cost involved in this model is the SAF switch and not the offset of the remaining emissions. This more egalitarian approach covers the need for competition fairness between all airlines and reinforces the idea of a global carbon trading platform at a standard trading price. This standardized procedure would benefit the health of market concurrence, competition fairness, and the environment, given that carbon is priced correctly. This way would allow airlines to share the burden equally and uniformly without creating market winners or losers through this external cost.

Finally, even though one model causes more significant stress than the other, both scenarios, as it stands, are incompatible with the real-life market. Such increases in expenditures in both cases would have catastrophic effects on the consumers, the industry, and, in fine, the economy. The most crucial challenge today is to mitigate all those effects so that the adverse impact of airline activities on climate is reduced.

6.2. Risks and Opportunities for Airlines

Both scenarios studied contain risks and opportunities for airlines. Sometimes, an opportunity can also be a risk. The level of carbon price on trading platforms is a good example. A high price represents an opportunity and an incentive for airlines to renew and modernize their fleet for a more fuel-efficient and, therefore, less polluting one. Still, it also induces a higher offsetting price, which impacts the total expenditures of each airline to a point where it threatens their very survival.

In the same vein, switching toward SAF represents a significantly higher expense increase that creates a problem for the financial health of airlines, which is a real risk for market participants. Still, it also represents a unique opportunity to act positively and concretely towards reducing carbon emissions. SAF is a gateway to greening the airline industry and making the industry a flagship sector of the ecological transition, which would be in great contrast with the actual image aviation has.

Even though this strategy represents a real opportunity for airlines to reinvent themselves and become sustainable, those cost increases could cause significant harm before the benefit of such a transition could be visible. The impact of a declining aviation industry would have substantial effects on the global economy. Not only is it essential to the development of modern economic systems, but 87.7[63] million people worldwide depend on airlines directly or indirectly. In 2019, the aviation industry weighted 3.6% of the global GDP and contributed an impact of over 2700 billion USD to the world economy.[64] In addition to seriously damaging the world economy, the first effect of an expenditure increase would be the price rise of airline services. Airlines would need to compensate for their growth in expenses with an increase in revenue. This would, therefore, damage consumers' purchasing power in their ability to consume airline services.

[63] *Employment*. (n.d.). Retrieved 10 September 2023, from https://aviationbenefits.org/economic-growth/supporting-employment/

[64] Chiambaretto, P. & Combe, E. (2023). I / L'évolution du transport aérien et ses différents impacts. Dans : Paul Chiambaretto éd., *Le transport aérien* (pp. 5-28). Paris: La Découverte.

7. Discussions and Implications

This chapter discusses the findings' value of this paper in the existing scholarly discussion about environmental transition and the meaning and impact attached to this paper's analysis results from both a financial and ecological point of view.

7.1. Position & Contribution of the Data Findings in Current Literature

The added value of this paper is to give a numerical figure to what sometimes can appear to be a very abstract journey: carbon neutralization. This study contributes to demystifying the carbon transition by illustrating the challenges it represents for industries in the current landscape. The unique contribution of this paper lies in its pragmatic and realistic approach to the cost of such a transition and a discussion of the potential impact it would engender.

This paper takes a pragmatic position towards the carbon-neutral path. It underlines the urgent need for its deployment while assessing the risk it represents for the business involved. This paper's findings reinforce that more than individual efforts will be needed and that decisions need to be taken at a higher level of organization and power so that market fairness and competition remain a core competency of the aviation market while promoting a cleaner version of the industry.

Overall, this paper remains in a neutral position without leaning towards any of the two extremes: hard-leftist ecologism and pro-aviation. The tone of the paper and its findings reflect that aviation is an essential part of our society and economy. Still, it must be regulated for societal welfare's common good. The findings' paper interrogates how to conciliate economic and environmental goals given the magnitude of the cost and impact on both components.

7.2. Potential Broader Impacts on Global Aviation, Passenger Costs, and Industry Dynamics

The exact impacts our scenario could cause are delicate to assess and predict, as many variables could lead to different consequences. We can only talk in generality and assumptions. Any current scenario promoting carbon-neutral aviation would require massive amount of money in terms of expenses or investment. Either way, this is a starting point to imagine those models' broader impacts on their journey to reach carbon-neutral aviation.

A global increase in expenses or required investment would cause great stress on all airlines needing to neutralize their carbon emissions. Not all airlines would react the same way, depending on the magnitude of the money involved. Considering the increase implied in our models, we can imagine that most airlines would not survive independently if that transition were so sudden. The impact would be slower but still significant in a more progressive setting. The amount of money needed by airlines, except if given through state loans or other financial arrangements, would cause a decrease in the number of airlines operating and probably a reduction in airline traffic worldwide.

That said, it is essential to distinguish the long-term effects, as described in the paragraph just above, and short-term effects. Even though some bankruptcies or cease of activities could be immediate, the first effect would be an increase in airlines' proposed services. The airline's mainstream income is passenger revenue. Therefore, raising ticket prices is the primary option to increase revenue and compensate for their financial results. As it is a global issue, all airlines would raise their prices, and passengers would have no choice but to pay a higher price. Even though this would have a limited short-term impact, it would cause people to fly less and maybe opt for cheaper travel options. This effect would even enhance the previously described reduction in airlines due to the cost increase and bankruptcies.

In terms of market setting, another real danger, besides the apparent loss of millions of jobs, is to see some oligopoly market setting appearing. It is realistic to imagine that only a few firms could survive those shocks and then have abnormal market power and share as all other market participants would have disappeared. This is a real risk for consumers. Airlines could keep prices up even after absorbing carbon neutrality costs in such a setting.

Of course, other scenarios would involve state loans and financial arrangements that would mitigate the effects carbon transition would have on airlines and preserve those businesses. Although this would positively affect economic sustainability, it is not unrealistic to expect the previously exposed consequences to happen still but to a lesser degree.

7.3. Environmental Implications Alongside Financial Implications

It is essential to understand the tangibility of financial impacts on the environment through our analysis. The positive consequences of carbon neutrality are numerous. Not only would it enhance the air quality and therefore participate in the reduction of health hazards linked with this problem, but it would also significantly reduce the GHG emissions, which mitigate global warming and all the effects attached to it.

Even though both the scenarios explored in this paper reach carbon neutrality in technical terms, they do not have the same direct impact on their environment. Even though offsetting carbon emissions does induce carbon neutrality, it does not improve the direct actual emissions. Therefore, all the environmental impacts airlines cause are continued through that method. In contrast, the use of SAF does cover those adverse effects. Through the SAF model, emissions are effectively reduced and, therefore, would have a more positive impact on the environment.

8. Recommendations and Future Research

It is recommended to consider this paper as a trustworthy source to showcase the effect of two specific types of carbon-neutral transition under specific assumptions: 100% carbon offset and SAF combined with carbon offset. Even though the calculations are relevant and appear to be correct, they reflect the beliefs made in our model and shouldn't be taken out of their context. Therefore, this paper can be used as an argument to describe the cost and financial impact of those two solutions to reach carbon neutrality. Still, the figures it contains are influenced by the assumptions of each model and can be adjusted if some other choices are made in the shaping process of the data.

Future research could focus on other ways to reach carbon neutrality and explore and describe the financial impact of those solutions, such as electric or hydrogen aviation, flight management software, and other emerging technologies. The goal would be to propose a holistic estimate of the cost of carbon transition for all airlines, considering all available solutions.

Another topic that would need to be deepened is the financial incentives for fleet renewal and the critical price of carbon emissions tax rate or price on trading platforms above which it becomes more financially beneficial for firms to change their aircraft. In the same direction, the financial impact of fleet renewal should be interesting to look at.

Furthermore, another aspect of carbon neutrality that could be studied is the policies put in place and their impact on airlines' finances. For example, a comparative analysis between countries applying kerosene tax and those that do not could lead to exciting results if the observed terms are chosen carefully. Similarly, analyzing potential policies contributing to reaching carbon neutrality could be an asset policymakers could rely on in policymaking.

9. Conclusion

This chapter summarizes the main findings and explores the critical conclusions on the carbon-neutral transition journey. It closes this paper by elaborating some thoughts about the future of aviation and the path toward sustainable and carbon-neutral aviation.

9.1. Summary of Key Findings

The first important finding this paper brought up is the lack of measures put in place to have an efficient and fast transition. Even though different processes have been introduced, the general observation that can be made about most of them is that they are underutilized, under-optimized, and underperforming. As a unique solution to such a holistic problem doesn't exist, all tools must be used appropriately to attain the objectives set to reach a sustainable aviation industry. The CORSIA scheme illustrates this observation in a very concrete way. Given the urgency of the situation and the rather easiness of implementation of a global carbon offsetting trading platform, it seems out of touch with reality to consider a path of trial-error implementation with some questionably unambitious objectives: 6 years of voluntary participation with meager carbon price compared to other carbon trading platform followed by a mandatory phase whose details about its specifics remain blurry and uncertain.

That said, it is essential to remember that the spirit of the paper sees sustainability as a holistic effort. It considers sustainability in terms of environmental needs but also financial viability. The economic disaster that could cause the collapse of aviation because of overly rising costs is considered and weighted into the equation to determine the degree of sustainability of a measure against carbon emissions.

To follow up on the financial aspect of the study, another significant finding of this paper is the magnitude of the impact that airlines would experience if such a transition were to happen tomorrow. The financial consequences vary significantly depending on the scenarios and the airlines' zones of operations. The solution that had the most direct positive impact on the environment appeared to be the more costly one: scenario 2 (See Appendix. 2). This paper's financial analysis measured an increase of total expenses reaching 69% for EEA-operating airlines and 63% for non-EEA-operating airlines due to the switch to SAF and the offset of the remaining emissions. Those increases translated into needed revenue growth of respectively 92% and 87% to keep their OER intact.

As for scenario 1, the impact is significantly lower but remains a massive financial stress for any business. In such a model through which airlines would offset all their emissions on trading platforms, airlines' total expenses would increase by 14% for EEA-operating airlines and 3% for non-EEA-operating airlines. Even though those results seem relatively much lower than in the previous model, it remains a needed revenue of 29% for EEA-operating airlines and 19% for non-EEA-operating airlines. In addition to this model having an indirect impact on carbon emissions reduction, those numbers would have a tangible impact on the financial health of a firm and cause significant damage to the industry.

With such results, it is hard to declare that, today, the industry is equipped to face the transition awaiting society and that the means are appropriately invested to reach those objectives.

Overall, regardless of the scenarios and models imagined, this paper showcases that the barriers hindering access to durable solutions are not only financial constraints but also production capacity limitations, such as the limited SAF global supply, that slow the process down. But it also conveys the message that the technologies and solutions do exist. It is now a matter of implementation and planning to reach the objective set: carbon neutrality.

9.2. Closing Thoughts on The Journey Towards Carbon-Neutral Aviation and its Financial Implications.

The writing of this paper provoked many thoughts about the costs and benefits of a carbon-neutral airline industry. The central aspect of this paper's analysis findings was the enormous financial impact current solutions to carbon emissions would have on airlines if they needed to be applied tomorrow. Another aspect of the analysis was the disparity between airlines depending on their geographical area of operation and the difference between the different costs of different solutions. This unveils two problems: financing the transition and the need to uniformize the carbon reduction processes.

To complete this transition, policymakers and market decision-makers must develop new realistic funding and investment plans to act on the ecological transition faster and more fairly. Even though airlines set transitional objectives for themselves, they need to be in order with the ecological urgency and need for change. Furthermore, the current measures vary geographically and induce market advantages and disadvantages between participants. This is why uniformizing policies and processes to decarbonize is crucial to ensuring equality amongst aviation actors and ensuring everyone contributes to resolving this global issue and challenge.

Nevertheless, those investment and financing plans shall conciliate the financial well-being of companies for the sake of the economy and the weight the industry has on society while answering to environmental needs. This will require a massive effort from the public institutions but will enact a decisive step towards a durable future. Those efforts represent a long-term bet whose returns are yet tricky to evaluate but whose negative consequences for society, economically and environmentally, are a clear foresight if they didn't see the light of day.

That said, policymakers and airline industry participants shall work more closely to arrange a faster yet feasible path toward a greener aviation industry. This industry being a serious contributor to the economy and environmental degradation, it is crucial to consider all that is at stake to elaborate a holistic plan maximizing the most effective solutions in our possession to act while ensuring financial viability through adequate support.

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Appendix 1: List of Airlines sorted by Continent.

<u>Asia</u>
Air China
Cathay Pacific
Emirates
Japan Airlines
Korean Air
Qatar Airways
Singapore Airlines
Thai Airways

<u>Europe</u>
Aegen Airlines
Aer Lingus
Air Baltic
Air France – KLM
British Airways
easyJet
Finnair
Iberia
Lufthansa Group (Austrian Airlines, Brussels Airlines, Eurowings, Swiss Air)
Pegasus Airlines
Ryanair
SAS Group
Turkish Airlines
Virgin
Vueling
Wizz Air

<u>North America</u>
Air Canada
Alaska Airlines
American Airlines
Delta
Hawaiian Airlines
Southwest Airlines
Spirit Airlines
United

<u>Oceania</u>
Air New Zealand
Qantas

<u>South America</u>
Latam Airlines

Appendix 2: Data Table

Scenario 1

Current Price			
Jet fuel	€ 600,00	Emissions reductions of SAF	Multiplicator factor for fuel
SAF MCL	€ 2.400,00	80%	4
UE ETS €/MT	€ 130,00		
CORSIA €/MT	€ 25,00		

EEA Operating

Airlines	Current Carbon Emission (Tons)	EEA	Non-EEA	Current Portion of SAF	Current Cost of Fuel
Aegen Airlines	1.131.438,00	90%	10%	10%	€ **338.915.690,00**
Aer Lingus	2.637.600,00	90%	10%	10%	€ **539.000.000,00**
Air Baltic	420.924,00	95%	5%	10%	€ **169.927.000,00**
Air France - KLM	28.233.000,00	75%	25%	10%	€ **7.241.000.000,00**
British Airways	14.698.266,00	78%	22%	10%	€ **3.413.890.000,00**
Easyjet	8.081.946,00	100%	0%	10%	€ **1.495.360.000,00**
Finnair	3.274.795,00	75%	25%	10%	€ **836.000.000,00**
Iberia	5.721.099,00	75%	25%	10%	€ **1.313.000.000,00**
Lufthansa group	23.100.000,00	75%	25%	10%	€ **7.601.000.000,00**
Pegasus Airlines	1.795.927,40	75%	25%	10%	€ **500.049.058,39**
Ryanair	11.273.415,00	100%	0%	10%	€ **1.699.400.000,00**
SAS Group	2.446.000,00	75%	25%	10%	€ **720.000.000,00**
Turkish Airlines	13.361.215,40	75%	25%	10%	€ **5.940.000.000,00**
Vueling	3.642.400,00	100%	0%	10%	€ **739.000.000,00**
Wizz Air	6.194.402,00	100%	0%	10%	€ **1.954.400.000,00**

Non-EEA Operating

Air Canada	13.205.187,00	0%	100%	10%	€ **3.590.000.000,00**
Air China	23.248.000,00	0%	100%	10%	€ **2.872.157.700,00**
Air New Zealand	1.822.956,00	0%	100%	10%	€ **305.590.000,00**
Alaska Airlines	6.932.553,00	0%	100%	10%	€ **2.454.000.000,00**
American Airlines	49.000.000,00	0%	100%	10%	€ **12.685.930.000,00**
Cathay Pacific	10.558.132,00	0%	100%	10%	€ **1.238.660.000,00**
Delta	43.246.733,00	0%	100%	10%	€ **11.482.000.000,00**
Emriates	26.966.466,00	0%	100%	10%	€ **8.438.360.000,00**
Hawaian Airlines	2.598.397,00	0%	100%	10%	€ **752.274.620,00**
Japan Ailrines	9.090.000,00	0%	100%	10%	€ **915.790.000,00**
Korean Air	10.649.864,00	0%	100%	10%	€ **2.837.970.000,00**
Latam Airlines	12.985.755,00	0%	100%	10%	€ **3.574.234.100,00**
Qantas	13.705.671,00	0%	100%	10%	€ **1.904.290.000,00**
Qatar Airways	23.011.728,00	0%	100%	10%	€ **6.670.693.430,00**
Singapore Airlines	12.770.000,00	0%	100%	10%	€ **4.830.000.000,00**
Southwest	22.415.018,00	0%	100%	10%	€ **5.498.400.000,00**
Spirit Airlines	4.522.648,00	0%	100%	10%	€ **1.776.025.020,00**
Thai Airways	5.904.734,00	0%	100%	10%	€ **993.950.526,25**
United	43.648.748,00	0%	100%	10%	€ **12.050.000.000,00**
Virgin	4.071.016,00	0%	100%	10%	€ **1.057.955.000,00**

Comparative results			
Average OER for EEA-Operating	83%	Average Offset and Fuel Expense Growth for Non-EEA-Operating	46%
Average OER for Non-EEA-Operating	88%	Average Offset and Fuel Expense Growth for EEA-Operating	12%
Average Needed Growth for OER for EEA-Operating	29%	Average Total expense growth for EEA-Operating	14%
Average Needed Growth for OER for Non-EEA-Operating	19%	Average Total expense growth for Non-EEA-Operating	3%

Current total operating expense	Current Operating Revenue	Depreciation	OER	Offset Expense (EU ETS/CORSIA)	Fuel - Offset Expense	Expense Growth	New Total expense	Growth
€ 906.139.250,00	€ 1.381.434.850,00	€ 127.680.730,00	**56%**	**€ 135.206.841,00**	**€ 474.122.531,00**	**40%**	**€ 1.041.346.091,00**	15%
€ 1.724.000.000,00	€ 1.769.000.000,00	€ 145.587.000,00	**89%**	**€ 315.193.200,00**	**€ 854.193.200,00**	**58%**	**€ 2.039.193.200,00**	18%
€ 421.102.000,00	€ 498.547.000,00	€ 73.585.000,00	**70%**	**€ 52.510.269,00**	**€ 222.437.269,00**	**31%**	**€ 473.612.269,00**	12%
€ 25.200.000.000,00	€ 27.587.194.000,00	€ 2.696.000.000,00	**82%**	**€ 2.929.173.750,00**	**€ 10.170.173.750,00**	**40%**	**€ 28.129.173.750,00**	12%
€ 12.559.000.000,00	€ 12.921.000.000,00	€ 1.268.000.000,00	**87%**	**€ 1.571.244.635,40**	**€ 4.985.134.635,40**	**46%**	**€ 14.130.244.635,40**	13%
€ 6.087.000.000,00	€ 6.740.000.000,00	€ 630.179.234,00	**81%**	**€ 1.050.652.980,00**	**€ 2.546.012.980,00**	**70%**	**€ 7.137.652.980,00**	17%
€ 2.710.700.000,00	€ 2.356.600.000,00	€ 317.100.000,00	**102%**	**€ 339.759.981,25**	**€ 1.175.759.981,25**	**41%**	**€ 3.050.459.981,25**	13%
€ 5.129.000.000,00	€ 5.511.000.000,00	€ 371.000.000,00	**86%**	**€ 593.564.021,25**	**€ 1.906.564.021,25**	**45%**	**€ 5.722.564.021,25**	12%
€ 33.662.000.000,00	€ 35.317.000.000,00	€ 2.478.000.000,00	**88%**	**€ 2.396.625.000,00**	**€ 9.997.625.000,00**	**32%**	**€ 36.058.625.000,00**	7%
€ 1.761.803.639,00	€ 2.449.374.176,00	€ 256.797.020,00	**61%**	**€ 186.327.467,75**	**€ 686.376.526,14**	**37%**	**€ 1.948.131.106,75**	11%
€ 5.140.500.000,00	€ 4.800.900.000,00	€ 719.400.000,00	**92%**	**€ 1.465.543.950,00**	**€ 3.164.943.950,00**	**86%**	**€ 6.606.043.950,00**	29%
€ 2.970.000.000,00	€ 2.680.000.000,00	€ 400.000.000,00	**96%**	**€ 253.772.500,00**	**€ 973.772.500,00**	**35%**	**€ 3.223.772.500,00**	9%
€ 14.440.000.000,00	€ 16.940.000.000,00	€ 1.650.000.000,00	**76%**	**€ 1.386.226.097,75**	**€ 7.326.226.097,75**	**23%**	**€ 15.826.226.097,75**	10%
€ 2.403.000.000,00	€ 2.668.927.000,00	€ 206.000.000,00	**82%**	**€ 473.512.000,00**	**€ 1.212.512.000,00**	**64%**	**€ 2.876.512.000,00**	20%
€ 4.362.500.000,00	€ 3.895.700.000,00	€ 601.100.000,00	**97%**	**€ 805.272.260,00**	**€ 2.759.672.260,00**	**41%**	**€ 5.167.772.260,00**	18%

€ 11.390.000.000,00	€ 11.260.000.000,00	€ 1.640.000.000,00	**87%**	**€ 330.129.675,00**	**€ 3.920.129.675,00**	**9%**	**€ 11.720.129.675,00**	3%
€ 11.570.000.000,00	€ 6.674.491.250,00	€ 2.679.214.450,00	**133%**	**€ 581.200.000,00**	**€ 3.453.357.700,00**	**20%**	**€ 12.151.200.000,00**	5%
€ 1.494.100.000,00	€ 1.491.920.000,00	€ 364.520.000,00	**76%**	**€ 45.573.900,00**	**€ 351.163.900,00**	**15%**	**€ 1.539.673.900,00**	3%
€ 8.808.000.000,00	€ 8.873.000.000,00	€ 382.000.000,00	**95%**	**€ 173.313.825,00**	**€ 2.627.313.825,00**	**7%**	**€ 8.981.313.825,00**	2%
€ 43.520.890.000,00	€ 45.041.430.000,00	€ 1.818.580.000,00	**93%**	**€ 1.225.000.000,00**	**€ 13.910.930.000,00**	**10%**	**€ 44.745.890.000,00**	3%
€ 5.608.710.000,00	€ 6.027.500.000,00	€ 1.462.895.000,00	**69%**	**€ 263.953.300,00**	**€ 1.502.613.300,00**	**21%**	**€ 5.872.663.300,00**	5%
€ 42.966.000.000,00	€ 50.582.000.000,00	€ 1.930.000.000,00	**81%**	**€ 1.081.168.325,00**	**€ 12.563.168.325,00**	**9%**	**€ 44.047.168.325,00**	3%
€ 23.431.850.000,00	€ 26.910.320.000,00	€ 4.860.130.000,00	**69%**	**€ 674.161.650,00**	**€ 9.112.521.650,00**	**8%**	**€ 24.106.011.650,00**	3%
€ 2.649.965.860,00	€ 2.428.248.060,00	€ 125.370.000,00	**104%**	**€ 64.959.925,00**	**€ 817.234.545,00**	**9%**	**€ 2.714.925.785,00**	2%
€ 5.919.690.000,00	€ 4.298.380.000,00	€ 1.125.630.000,00	**112%**	**€ 227.250.000,00**	**€ 1.143.040.000,00**	**25%**	**€ 6.146.940.000,00**	4%
€ 7.435.766.610,00	€ 10.230.430.700,00	€ 1.131.920.000,00	**62%**	**€ 266.246.600,00**	**€ 3.104.216.600,00**	**9%**	**€ 7.702.013.210,00**	4%
€ 8.872.821.970,00	€ 8.761.172.520,00	€ 1.085.858.750,00	**89%**	**€ 324.643.875,00**	**€ 3.898.877.975,00**	**9%**	**€ 9.197.465.845,00**	4%
€ 9.124.940.000,00	€ 10.051.750.000,00	€ 900.300.000,00	**82%**	**€ 342.641.775,00**	**€ 2.246.931.775,00**	**18%**	**€ 9.467.581.775,00**	4%
€ 16.292.550.070,00	€ 19.186.594.890,00	€ 2.314.946.650,00	**73%**	**€ 575.293.200,00**	**€ 7.245.986.630,00**	**9%**	**€ 16.867.843.270,00**	4%
€ 13.970.000.000,00	€ 16.470.000.000,00	€ 1.857.339.000,00	**74%**	**€ 319.250.000,00**	**€ 5.149.250.000,00**	**7%**	**€ 14.289.250.000,00**	2%
€ 20.978.600.000,00	€ 21.914.480.000,00	€ 1.243.240.000,00	**90%**	**€ 560.375.450,00**	**€ 6.058.775.450,00**	**10%**	**€ 21.538.975.450,00**	3%
€ 5.215.306.710,00	€ 4.664.162.330,00	€ 288.116.380,00	**106%**	**€ 113.066.200,00**	**€ 1.889.091.220,00**	**6%**	**€ 5.328.372.910,00**	2%
€ 2.436.916.458,64	€ 2.690.019.116,97	€ 255.902.411,98	**81%**	**€ 147.618.350,00**	**€ 1.141.568.876,25**	**15%**	**€ 2.584.534.808,64**	6%
€ 39.160.000.000,00	€ 41.310.000.000,00	€ 2.456.000.000,00	**89%**	**€ 1.091.218.700,00**	**€ 13.141.218.700,00**	**9%**	**€ 40.251.218.700,00**	3%
€ 3.431.319.000,00	€ 3.346.087.000,00	€ 279.260.000,00	**94%**	**€ 101.775.400,00**	**€ 1.159.730.400,00**	**10%**	**€ 3.533.094.400,00**	3%

	Revenue to keep OER	Growth Needed
€	1.847.949.176,56	**34%**
€	2.285.417.549,65	**29%**
€	679.442.950,63	**36%**
€	34.482.979.617,00	**25%**
€	16.170.125.846,60	**25%**
€	8.816.082.321,22	**31%**
€	3.003.306.313,42	**27%**
€	6.628.215.704,31	**20%**
€	40.837.687.888,82	**16%**
€	3.170.552.185,02	**29%**
€	7.173.544.230,97	**49%**
€	3.361.754.980,54	**25%**
€	20.961.397.192,80	**24%**
€	3.494.401.703,52	**31%**
€	5.352.286.487,29	**37%**
€	13.535.247.193,90	**20%**
€	9.122.149.850,64	**37%**
€	2.033.561.398,83	**36%**
€	9.457.773.269,55	**7%**
€	48.328.710.621,13	**7%**
€	8.538.122.912,08	**42%**
€	54.293.641.393,29	**7%**
€	34.929.478.121,86	**30%**
€	2.611.314.299,81	**8%**
€	5.511.379.489,87	**28%**
€	12.499.497.096,01	**22%**
€	10.348.139.928,01	**18%**
€	11.570.812.230,91	**15%**
€	23.153.931.741,00	**21%**
€	19.429.582.607,82	**18%**
€	23.917.245.326,13	**9%**
€	5.043.928.596,73	**8%**
€	3.187.713.556,62	**19%**
€	45.302.360.628,19	**10%**
€	3.750.577.397,70	**12%**

Scenario 2

Current Price				
Jet fuel	€ 600,00	Emissions reductions of SAF	Multiplicator factor for fuel
SAF MCL	€ 2.400,00	80%	4
UE ETS €/MT	€ 130,00		
CORSIA €/MT	€ 25,00		

EEA Operating

Airlines	Current Carbon Emission (Tons)	EEA	Non-EEA	Current Portion of SAF	Current Cost of fuel
Aegen Airlines	1.131.438,00	90%	10%	10%	€ **338.915.690,00**
Aer Lingus	2.637.600,00	90%	10%	10%	€ **539.000.000,00**
Air Baltic	420.924,00	95%	5%	10%	€ **169.927.000,00**
Air France - KLM	28.233.000,00	75%	25%	10%	€ **7.241.000.000,00**
British Airways	14.698.266,00	78%	22%	10%	€ **3.413.890.000,00**
Easyjet	8.081.946,00	100%	0%	10%	€ **1.495.360.000,00**
Finnair	3.274.795,00	75%	25%	10%	€ **836.000.000,00**
Iberia	5.721.099,00	75%	25%	10%	€ **1.313.000.000,00**
Lufthansa group	23.100.000,00	75%	25%	10%	€ **7.601.000.000,00**
Pegasus Airlines	1.795.927,40	75%	25%	10%	€ **500.049.058,39**
Ryanair	11.273.415,00	100%	0%	10%	€ **1.699.400.000,00**
SAS Group	2.446.000,00	75%	25%	10%	€ **720.000.000,00**
Turkish Airlines	13.361.215,40	75%	25%	10%	€ **5.940.000.000,00**
Vueling	3.642.400,00	100%	0%	10%	€ **739.000.000,00**
Wizz Air	6.194.402,00	100%	0%	10%	€ **1.954.400.000,00**

Non-EEA Operating

Air Canada	13.205.187,00	0%	100%	10%	€ **3.590.000.000,00**
Air China	23.248.000,00	0%	100%	10%	€ **2.872.157.700,00**
Air New Zealand	1.822.956,00	0%	100%	10%	€ **305.590.000,00**
Alaska Airlines	6.932.553,00	0%	100%	10%	€ **2.454.000.000,00**
American Airlines	49.000.000,00	0%	100%	10%	€ **12.685.930.000,00**
Cathay Pacific	10.558.132,00	0%	100%	10%	€ **1.238.660.000,00**
Delta	43.246.733,00	0%	100%	10%	€ **11.482.000.000,00**
Emriates	26.966.466,00	0%	100%	10%	€ **8.438.360.000,00**
Hawaian Airlines	2.598.397,00	0%	100%	10%	€ **752.274.620,00**
Japan Ailrines	9.090.000,00	0%	100%	10%	€ **915.790.000,00**
Korean Air	10.649.864,00	0%	100%	10%	€ **2.837.970.000,00**
Latam Airlines	12.985.755,00	0%	100%	10%	€ **3.574.234.100,00**
Qantas	13.705.671,00	0%	100%	10%	€ **1.904.290.000,00**
Qatar Airways	23.011.728,00	0%	100%	10%	€ **6.670.693.430,00**
Singapore Airlines	12.770.000,00	0%	100%	10%	€ **4.830.000.000,00**
Southwest	22.415.018,00	0%	100%	10%	€ **5.498.400.000,00**
Spirit Airlines	4.522.648,00	0%	100%	10%	€ **1.776.025.020,00**
Thai Airways	5.904.734,00	0%	100%	10%	€ **993.950.526,25**
United	43.648.748,00	0%	100%	10%	€ **12.050.000.000,00**
Virgin	4.071.016,00	0%	100%	10%	€ **1.057.955.000,00**

Comparative Results			
Average OER for EEA-Operating	83%	Average Offset and Fuel Expense Growth for Non-EEA-Operating	220%
Average OER for Non-EEA-Operating	88%	Average Offset and Fuel Expense Growth for EEA-Operating	213%
Average Needed Growth for OER for EEA-Operating	92%	Average Total expense growth for EEA-Operating	69%
Average Needed Growth for OER for Non-EEA-Operating	87%	Average Total expense growth for Non-EEA-Operating	63%

Current total operating expense	Current Operating Revenue	Depreciation	OER	Carbon Emission SAF	Offset Expense (EU ETS/CORSIA)	New Fuel cost SAF	Additional Fuel Expense
€ 906.139.250,00	€ 1.381.434.850,00	€ 127.680.730,00	56%	244.390,61	€ 29.204.677,66	€ 1.050.638.639,00	€ 711.722.949,00
€ 1.724.000.000,00	€ 1.769.000.000,00	€ 145.587.000,00	89%	569.721,60	€ 68.081.731,20	€ 1.670.900.000,00	€ 1.131.900.000,00
€ 421.102.000,00	€ 498.547.000,00	€ 73.585.000,00	70%	90.919,58	€ 11.342.218,10	€ 526.773.700,00	€ 356.846.700,00
€ 25.200.000.000,00	€ 27.587.194.000,00	€ 2.696.000.000,00	82%	6.098.328,00	€ 632.701.530,00	€ 22.447.100.000,00	€ 15.206.100.000,00
€ 12.559.000.000,00	€ 12.921.000.000,00	€ 1.268.000.000,00	87%	3.174.825,46	€ 339.388.841,25	€ 10.583.059.000,00	€ 7.169.169.000,00
€ 6.087.000.000,00	€ 6.740.000.000,00	€ 630.179.234,00	81%	1.745.700,34	€ 226.941.043,68	€ 4.635.616.000,00	€ 3.140.256.000,00
€ 2.710.700.000,00	€ 2.356.600.000,00	€ 317.100.000,00	102%	707.355,72	€ 73.388.155,95	€ 2.591.600.000,00	€ 1.755.600.000,00
€ 5.129.000.000,00	€ 5.511.000.000,00	€ 371.000.000,00	86%	1.235.757,38	€ 128.209.828,59	€ 4.070.300.000,00	€ 2.757.300.000,00
€ 33.662.000.000,00	€ 35.317.000.000,00	€ 2.478.000.000,00	88%	4.989.600,00	€ 517.671.000,00	€ 23.563.100.000,00	€ 15.962.100.000,00
€ 1.761.803.639,00	€ 2.449.374.176,00	€ 256.797.020,00	61%	387.920,32	€ 40.246.733,03	€ 1.550.152.081,01	€ 1.050.103.022,62
€ 5.140.500.000,00	€ 4.800.900.000,00	€ 719.400.000,00	92%	2.435.057,64	€ 316.557.493,20	€ 5.268.140.000,00	€ 3.568.740.000,00
€ 2.970.000.000,00	€ 2.680.000.000,00	€ 400.000.000,00	96%	528.336,00	€ 54.814.860,00	€ 2.232.000.000,00	€ 1.512.000.000,00
€ 14.440.000.000,00	€ 16.940.000.000,00	€ 1.650.000.000,00	76%	2.886.022,53	€ 299.424.837,11	€ 18.414.000.000,00	€ 12.474.000.000,00
€ 2.403.000.000,00	€ 2.668.927.000,00	€ 206.000.000,00	82%	786.758,40	€ 102.278.592,00	€ 2.290.900.000,00	€ 1.551.900.000,00
€ 4.362.500.000,00	€ 3.895.700.000,00	€ 601.100.000,00	97%	1.337.990,83	€ 173.938.808,16	€ 6.058.640.000,00	€ 4.104.240.000,00

€ 11.390.000.000,00	€ 11.260.000.000,00	€ 1.640.000.000,00	87%	2.852.320,39	€ 71.308.009,80	€ 11.129.000.000,00	€ 7.539.000.000,00
€ 11.570.000.000,00	€ 6.674.491.250,00	€ 2.679.214.450,00	133%	5.021.568,00	€ 125.539.200,00	€ 8.903.688.870,00	€ 6.031.531.170,00
€ 1.494.100.000,00	€ 1.491.920.000,00	€ 364.520.000,00	76%	393.758,50	€ 9.843.962,40	€ 947.329.000,00	€ 641.739.000,00
€ 8.808.000.000,00	€ 8.873.000.000,00	€ 382.000.000,00	95%	1.497.431,45	€ 37.435.786,20	€ 7.607.400.000,00	€ 5.153.400.000,00
€ 43.520.890.000,00	€ 45.041.430.000,00	€ 1.818.580.000,00	93%	10.584.000,00	€ 264.600.000,00	€ 39.326.383.000,00	€ 26.640.453.000,00
€ 5.608.710.000,00	€ 6.027.500.000,00	€ 1.462.895.000,00	69%	2.280.556,51	€ 57.013.912,80	€ 3.839.846.000,00	€ 2.601.186.000,00
€ 42.966.000.000,00	€ 50.582.000.000,00	€ 1.930.000.000,00	81%	9.341.294,33	€ 233.532.358,20	€ 35.594.200.000,00	€ 24.112.200.000,00
€ 23.431.850.000,00	€ 26.910.320.000,00	€ 4.860.130.000,00	69%	5.824.756,66	€ 145.618.916,40	€ 26.158.916.000,00	€ 17.720.556.000,00
€ 2.649.965.860,00	€ 2.428.248.060,00	€ 125.370.000,00	104%	561.253,75	€ 14.031.343,80	€ 2.332.051.322,00	€ 1.579.776.702,00
€ 5.919.690.000,00	€ 4.298.380.000,00	€ 1.125.630.000,00	112%	1.963.440,00	€ 49.086.000,00	€ 2.838.949.000,00	€ 1.923.159.000,00
€ 7.435.766.610,00	€ 10.230.430.700,00	€ 1.131.920.000,00	62%	2.300.370,62	€ 57.509.265,60	€ 8.797.707.000,00	€ 5.959.737.000,00
€ 8.872.821.970,00	€ 8.761.172.520,00	€ 1.085.858.750,00	89%	2.804.923,08	€ 70.123.077,00	€ 11.080.125.710,00	€ 7.505.891.610,00
€ 9.124.940.000,00	€ 10.051.750.000,00	€ 900.300.000,00	82%	2.960.424,94	€ 74.010.623,40	€ 5.903.299.000,00	€ 3.999.009.000,00
€ 16.292.550.070,00	€ 19.186.594.890,00	€ 2.314.946.650,00	73%	4.970.533,25	€ 124.263.331,20	€ 20.679.149.633,00	€ 14.008.456.203,00
€ 13.970.000.000,00	€ 16.470.000.000,00	€ 1.857.339.000,00	74%	2.758.320,00	€ 68.958.000,00	€ 14.973.000.000,00	€ 10.143.000.000,00
€ 20.978.600.000,00	€ 21.914.480.000,00	€ 1.243.240.000,00	90%	4.841.643,89	€ 121.041.097,20	€ 17.045.040.000,00	€ 11.546.640.000,00
€ 5.215.306.710,00	€ 4.664.162.330,00	€ 288.116.380,00	106%	976.891,97	€ 24.422.299,20	€ 5.505.677.562,00	€ 3.729.652.542,00
€ 2.436.916.458,64	€ 2.690.019.116,97	€ 255.902.411,98	81%	1.275.422,54	€ 31.885.563,60	€ 3.081.246.631,38	€ 2.087.296.105,13
€ 39.160.000.000,00	€ 41.310.000.000,00	€ 2.456.000.000,00	89%	9.428.129,57	€ 235.703.239,20	€ 37.355.000.000,00	€ 25.305.000.000,00
€ 3.431.319.000,00	€ 3.346.087.000,00	€ 279.260.000,00	94%	879.339,46	€ 21.983.486,40	€ 3.279.660.500,00	€ 2.221.705.500,00

Cost SAF +Offset	Growth	Additional Fuel Expense	**Additonal Cost SAF + Offset**	**New Tot operaring expense SAF**	Growth	Revenu to keep ratio SAF	**Growth revenue needed**
€ 1.079.843.316,66	219%	**€ 711.722.949,00**	€ 740.927.626,66	**€ 1.647.066.876,66**	82%	€ 2.922.847.557,37	**112%**
€ 1.738.981.731,20	223%	**€ 1.131.900.000,00**	€ 1.199.981.731,20	**€ 2.923.981.731,20**	70%	€ 3.277.040.725,39	**85%**
€ 538.115.918,10	217%	**€ 356.846.700,00**	€ 368.188.918,10	**€ 789.290.918,10**	87%	€ 1.132.314.733,81	**127%**
€ 23.079.801.530,00	219%	**€ 15.206.100.000,00**	€ 15.838.801.530,00	**€ 41.038.801.530,00**	63%	€ 50.308.628.658,71	**82%**
€ 10.922.447.841,25	220%	**€ 7.169.169.000,00**	€ 7.508.557.841,25	**€ 20.067.557.841,25**	60%	€ 22.964.566.014,24	**78%**
€ 4.862.557.043,68	225%	**€ 3.140.256.000,00**	€ 3.367.197.043,68	**€ 9.454.197.043,68**	55%	€ 11.677.365.045,86	**73%**
€ 2.664.988.155,95	219%	**€ 1.755.600.000,00**	€ 1.828.988.155,95	**€ 4.539.688.155,95**	67%	€ 4.469.514.166,24	**90%**
€ 4.198.509.828,59	220%	**€ 2.757.300.000,00**	€ 2.885.509.828,59	**€ 8.014.509.828,59**	56%	€ 9.282.884.334,88	**68%**
€ 24.080.771.000,00	217%	**€ 15.962.100.000,00**	€ 16.479.771.000,00	**€ 50.141.771.000,00**	49%	€ 56.787.356.542,04	**61%**
€ 1.590.398.814,04	218%	**€ 1.050.103.022,62**	€ 1.090.349.755,65	**€ 2.852.153.394,65**	62%	€ 4.641.833.984,42	**90%**
€ 5.584.697.493,20	229%	**€ 3.568.740.000,00**	€ 3.885.297.493,20	**€ 9.025.797.493,20**	76%	€ 9.801.169.660,29	**104%**
€ 2.286.814.860,00	218%	**€ 1.512.000.000,00**	€ 1.566.814.860,00	**€ 4.536.814.860,00**	53%	€ 4.730.997.597,20	**77%**
€ 18.713.424.837,11	215%	**€ 12.474.000.000,00**	€ 12.773.424.837,11	**€ 27.213.424.837,11**	88%	€ 36.043.425.859,32	**113%**
€ 2.393.178.592,00	224%	**€ 1.551.900.000,00**	€ 1.654.178.592,00	**€ 4.057.178.592,00**	69%	€ 4.928.681.605,83	**85%**
€ 6.232.578.808,16	219%	**€ 4.104.240.000,00**	€ 4.278.178.808,16	**€ 8.640.678.808,16**	98%	€ 8.949.192.437,11	**130%**

€ 11.200.308.009,80	212%	**€ 7.539.000.000,00**	€ 7.539.000.002,12	**€ 18.929.000.002,12**	66%	€ 21.860.568.207,58	**94%**
€ 9.029.228.070,00	214%	**€ 6.031.531.170,00**	€ 6.031.531.172,14	**€ 17.601.531.172,14**	52%	€ 13.213.822.910,74	**98%**
€ 957.172.962,40	213%	**€ 641.739.000,00**	€ 641.739.002,13	**€ 2.135.839.002,13**	43%	€ 2.820.960.820,89	**89%**
€ 7.644.835.786,20	212%	**€ 5.153.400.000,00**	€ 5.153.400.002,12	**€ 13.961.400.002,12**	59%	€ 14.702.053.432,09	**66%**
€ 39.590.983.000,00	212%	**€ 26.640.453.000,00**	€ 26.640.453.002,12	**€ 70.161.343.002,12**	61%	€ 75.779.188.719,67	**68%**
€ 3.896.859.912,80	215%	**€ 2.601.186.000,00**	€ 2.601.186.002,15	**€ 8.209.896.002,15**	46%	€ 11.936.168.920,45	**98%**
€ 35.827.732.358,20	212%	**€ 24.112.200.000,00**	€ 24.112.200.002,12	**€ 67.078.200.002,12**	56%	€ 82.682.267.094,92	**63%**
€ 26.304.534.916,40	212%	**€ 17.720.556.000,00**	€ 17.720.556.002,12	**€ 41.152.406.002,12**	76%	€ 59.629.609.658,50	**122%**
€ 2.346.082.665,80	212%	**€ 1.579.776.702,00**	€ 1.579.776.704,12	**€ 4.229.742.564,12**	60%	€ 4.068.320.137,24	**68%**
€ 2.888.035.000,00	215%	**€ 1.923.159.000,00**	€ 1.923.159.002,15	**€ 7.842.849.002,15**	32%	€ 7.031.940.629,42	**64%**
€ 8.855.216.265,60	212%	**€ 5.959.737.000,00**	€ 5.959.737.002,12	**€ 13.395.503.612,12**	80%	€ 21.739.388.642,17	**112%**
€ 11.150.248.787,00	212%	**€ 7.505.891.610,00**	€ 7.505.891.612,12	**€ 16.378.713.582,12**	85%	€ 18.427.817.275,43	**110%**
€ 5.977.309.623,40	214%	**€ 3.999.009.000,00**	€ 3.999.009.002,14	**€ 13.123.949.002,14**	44%	€ 16.039.444.204,52	**60%**
€ 20.803.412.964,20	212%	**€ 14.008.456.203,00**	€ 14.008.456.205,12	**€ 30.301.006.275,12**	86%	€ 41.593.191.242,51	**117%**
€ 15.041.958.000,00	211%	**€ 10.143.000.000,00**	€ 10.143.000.002,11	**€ 24.113.000.002,11**	73%	€ 32.787.271.932,64	**99%**
€ 17.166.081.097,20	212%	**€ 11.546.640.000,00**	€ 11.546.640.002,12	**€ 32.525.240.002,12**	55%	€ 36.116.580.671,53	**65%**
€ 5.530.099.861,20	211%	**€ 3.729.652.542,00**	€ 3.729.652.544,11	**€ 8.944.959.254,11**	72%	€ 8.467.450.859,85	**82%**
€ 3.113.132.194,98	213%	**€ 2.087.296.105,13**	€ 2.087.296.107,26	**€ 4.524.212.565,90**	86%	€ 5.580.073.319,63	**107%**
€ 37.590.703.239,20	212%	**€ 25.305.000.000,00**	€ 25.305.000.002,12	**€ 64.465.000.002,12**	65%	€ 72.554.739.267,86	**76%**
€ 3.301.643.986,40	212%	**€ 2.221.705.500,00**	€ 2.221.705.502,12	**€ 5.653.024.502,12**	65%	€ 6.001.001.820,47	**79%**