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# How is CORSIA going to help the Air Cargo industry to reach their 2050's carbon reduction goals?

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# Executive Summary

Aviation, alike every other energy intensive industry, is under pressure to reduce their emissions of carbon dioxide. The air Cargo sector is a part of the aviation industry and it is also an important carbon emitter. In order to address this, the UN have reached an agreement through the ICAO to set up a carbon trading program, namely CORSIA, which will require companies from 2021 to offset the residual share of carbon above the baseline which is the 2019 level. On top of that, the industry has largely committed to another objective which is to halve emissions in 2050 compared to the levels of 2005.

This paper researches the extent to which CORSIA is going to help the cargo industry to switch towards greener technologies. In this regard, experts from different perspectives and different interest in the industry have been interviewed. Their opinions were convergent for the short-term impact of CORSIA. Indeed, the price of carbon on voluntary markets is too low to make an impact on an airline's financials. However, there is much discussion about its potential impact on the longer term. Most likely, CORSIA will not be able to push companies towards greener technologies even in the longer term, mainly due to the likelihood of carbon pricing to remain low and to the conflicts of interest as the controllers of the program have also as mission to sustain the aviation's growth.

# Contents

# I. Introduction

This thesis is introduced in four steps. First, the context of the research, which gives importance and relevance to the study, is explained. Then, the objectives as well as the research question are defined. It is followed by a description of the methodology that is used in the paper and its structure. This part aims at rationalizing the approach of this paper to address the question at hand.

## A. Context

During the COP21 conference of Paris 2015, 195 countries have adopted the first universal agreement on an action plan to limit the climate warming to 2°C. Every country has signed off on a proper National Determined Contributions (NDC), which are the minimum objectives of the country. (European Commission, 2020a) This agreement is supposed to be legally binding, however, it only contains a part of obligations in reporting. Most of the agreement is about recommendations and suggestions for actions. (Climate Home News, 2017)

These NDC's are country specific, and precisely the NDC objectives are set by the country themselves. In this context, international transportation has long been escaping from every carbon mitigation programs as it isn't directly linked to a country's program. Both international maritime transport and air transport have benefited from that situation for a while. But at a certain point, it was time for them to get on board with climate action.

This paper is focusing on the air transportation industry, and more particularly the air cargo transportation. Although representing a small share of the current worldwide GHG emissions, as air transportation represents 2% of the global emissions and air cargo is only a portion of it, it is an important sector in terms of positive value it brings to society and it has been illustrated recently with the Coronavirus crisis. During these troubled times, the air cargo companies are insuring the access to medicines, medical equipment, and other valuable and time sensitive equipment for countries. (IATA, 2020c) The value of this industry in ordinary times is also important as with a 1% share of global trade in volume, the industry transports 35% of the global trade in value. (IATA, 2020c)

Still, the air cargo industry has to meet the requirements in terms of global warming like every other industry, regardless of their importance in value for the society. In this regard, the

International Civil Aviation Organization (ICAO), an affiliated group of the United Nations, has launched the CORSIA program to offset the gap emissions between the potential technical improvements and the targets of the ICAO which is to cap the emissions at the 2020 level. (ICAO, 2020c) There are some emission reduction opportunities lying in aircraft efficiency improvements or in sustainable alternatives for fuel, but those aren't enough yet to mitigate the opposite effect of growth in terms of activity, CORSIA is there to fill this gap. Companies can join this program on a voluntary basis from 2021 until 2026, from there on, the program will become mandatory for every company reaching some specific criteria.

## B. Objectives & Research question

There are two different targets for ICAO, on one hand, they aim to reduce the emissions as mentioned above, and on the other hand, they want to "connect the world", which means they want to support the growth in activities in the industry. (ICAO, 2020b) But to what extend are those two goals combinable? Is CORSIA going to help the industry to attain the 2050 goals?

In 2010, 300 industry leaders met with state representatives for a summit on global aviation & environment in Geneva. The outcomes of this summit are the three objectives that are quoted on the figure below which are the fuel efficiency improvement of 1.5% that has to be reached for 2020, the capping of the emissions from 2020 onwards and finally the halving of the emissions based on the 2005 level. The first objective has been filled on time. CORSIA is there to help reaching the second goal which is to cap the net emissions at the 2020 level, this is represented by the red part on the graph.

**Carbon Emission Projections of the aviation industry**

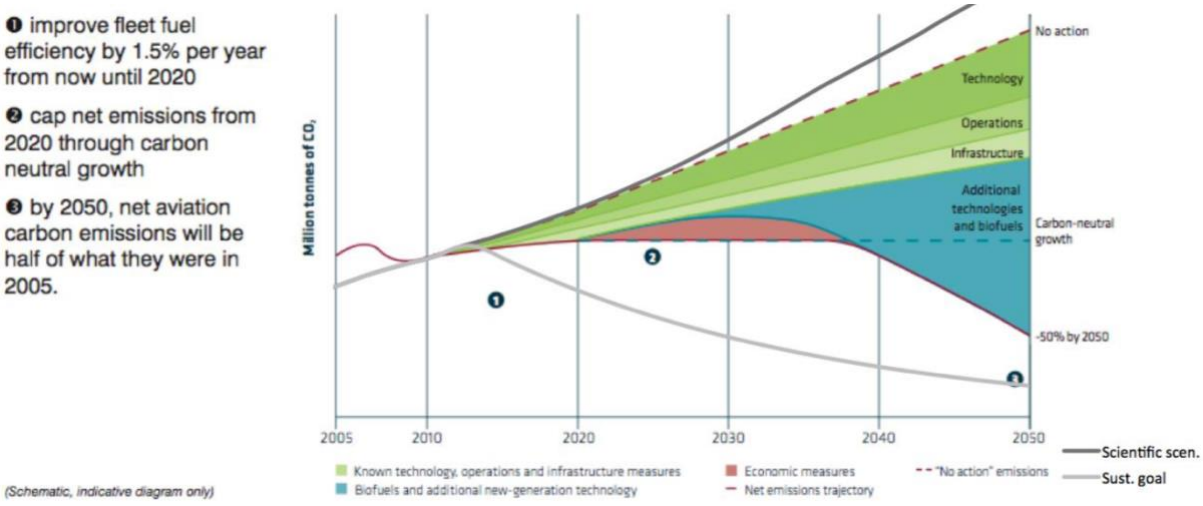


*Figure 1: Emission evolution forecasting in 2010 by the ATAG (Peeters et al., 2016)*

Additionally, the recent events related to the coronavirus have risen other concerns. Indeed, the CORSIA program is supposed to use as a baseline the average emission level of 2019 and 2020, as the level of 2020 is far lower compared to the expectations, there are discussions about changing the baseline. This thesis will also detail the arguments for and against the shift for the baseline.

The absolute goal of the air transport industry is the third one, in line of the Paris agreement and the maximum of 2°C of warming, to halve the emissions of the industry by 2050 compared to the level of 2005. (ATAG, 2019) However, the only binding tool that has been set in place is the CORSIA program, which has been developed by the ICAO. Hence the question:

**"Is CORSIA going to help the Air Cargo industry to reach their 2050's carbon reduction goals?"**

This paper aims at answering this question by highlighting the potential strengths and weaknesses of the CORSIA program related to its ability to address carbon mitigation in the air cargo sector. Additionally, the paper aims at discussing the way CORSIA could improve its effectiveness in carbon reduction and especially how it could be adapted to the coronavirus crisis.

## C. Structure & methodology

This paper is divided in three main sections. First, the context of the study as well as the necessary theorical background is clarified. Tackling the three main focus points which are the CORSIA program, the air cargo industry as well as the carbon mitigations options for airlines. As to build a relevant and non-biased background, scientific literature is preferred to articles from the industry players. When it was not possible to rely on scientific research, different opinions have been gathered in order to critically review and assess the information.

The second part is dedicated to a qualitative research about the stakeholder's opinions on the impact of CORSIA on carbon reduction in the sector of interest. This research is conducted through semi-structured interviews with industry experts. In order to avoid the bias of taking only one perspective, this research has interviewed people from different positions in the industry and outside the industry, in order to grasp the core of the problem while avoiding conflicts of interest. Obviously, every interview has been conducted based on a different interview guide (can be found in appendix A.a.) as the interviewee's knowledge of the industry and of CORSIA are different.

Finally, the outcomes of those interviews are used to frame a discussion on the effectiveness of CORSIA to address the global warming. It summarizes the key findings of both the theorical study and the field research. Finally, to conclude the paper, a reflection on the topic and its ethical implications is carried out. Followed by the limitations and leads for further research.

# II. Context & Background

In order to build a relevant background knowledge for understanding the impact of CORSIA on carbon reductions in the air cargo industry, the three composing elements of this question are developed.

First, the CORSIA program is detailed. Starting with the reasons for its creation which is mainly the need for a global scheme in international aviation has it couldn't be tackled with national policies. The features of the scheme are explained, and some relevant aspects are discussed. On one hand, CORSIA is a market-based measure, the efficiency of such a scheme compared to a carbon tax is a relevant aspect to dig deeper into; on the other hand, the control aspect of CORSIA and the inherent conflicts of interest are clarified.

Secondly, an overview of the air cargo industry is provided. The expectations for the future of the industry can largely be debated, as the industry players tend to be optimistic and foreseeing a doubled market size in 20 years, while other factors in the macro-economic environment are not especially going into that direction.

Lastly, in terms of carbon reduction, three areas of action can be distinguished for an industry wide reduction. Carbon emissions can be reduced in case of a global activity level drop. Furthermore, improving the energy efficiency for every ton kilometer of freight will also reduce carbon emissions, the primary factors impacting this area are the aircraft efficiency. The last area is the energy vector which can be changed. The sustainable alternatives for fuel are likely to reduce the amount of carbon per liter of burned fuel in the short to medium term while electrification might only be possible in 2050.

# A. CORSIA

This part starts with an explanation of the issues at stake, the global warming and the lack of control on international air transportation, then it explains how CORSIA is set to be working and implemented. It is concluded by a discussion on the differences between carbon taxes and carbon offsetting schemes, with a focus on the efficiency of carbon offsetting schemes in general.

## *a. Why CORSIA?*

CORSIA has been developed by the ICAO for three official reasons. First, the global warming is an issue that concerns every human living on earth, there is no reason why the international transportation shouldn't have its path towards greener skies. Secondly, it is proven that aviation could be compatible with the environmental targets if the right measures are taken. Lastly, the only scheme that is regulating the airlines on a carbon aspect is the EU ETS, however, this scheme is covering only the EU internal flights, and therefore lacks a global reach. On top of official reason, one could speculate on other drivers for such a program. Those are developed in the results from interviews in the next section.

### Global warming

The greenhouse effect is a natural phenomenon which is regulating the temperature of the earth at temperatures as we know them today. Without this effect, the temperature on earth would be far colder, around -19,15°C according to theoretical estimations. (Benestad, 2017) This natural phenomenon is vital for the survival of the humankind as it regulates the air temperature on Earth. Scientist have concluded that the climate change and warming was due to this phenomenon and more precisely, to the increase in concentration of greenhouse gasses in the atmosphere. Indeed, different human activities such as transport or agriculture, have as side-effect to release large quantities of greenhouse gasses which in turn enhance that greenhouse effect and increases the air temperature. (European Environment Agency [EEA], 2020)

Since the start of some international measures such as the Paris agreement, a result is observable in Europe regarding domestic greenhouse gas (GHG) emissions as the global emissions decreased from 5 657Mt to 4 300 Mt in 26 years which is almost a 24% reduction. This general trend is not observable in every sector nor every country, industries such as transport, air conditioning and refrigeration are still on an upward emission curve. This is countered by other

industries such as manufacturing and construction, electricity and heat production which have significantly decreased their GHG emissions. Lastly, this graph doesn't consider international aviation nor maritime transport as those emissions can't be attached to one specific country.

**Evolution of GHG emissions in the EU and in Iceland (excluding aviation)**

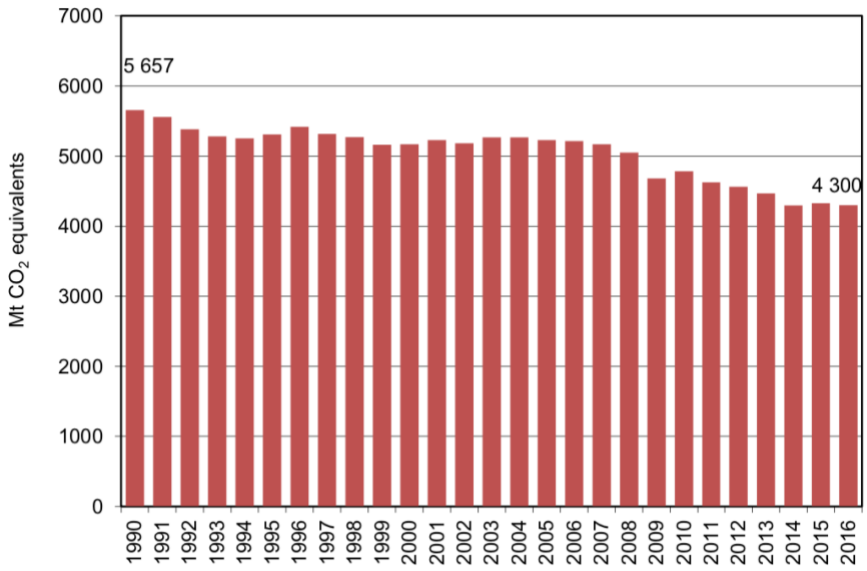


*Figure 2: GHG emissions in EU + Iceland (excluding LULUCF, international aviation and maritime transport)*

Regarding the GHG emissions of the international aviation, they are not following this downwards trend at all. Indeed, this sector has increased by 115% his GHG emissions between 1990 and 2019 to reach a total emission of 915 Mt of $CO_2$. Nowadays, the industry is responsible for 2% of the total carbon emissions in the world. The targets that the industry is looking to achieve is a carbon neutral growth from 2020 and a 50% decline in emissions by 2050 compared to the 2005 levels. (IATA, 2019b) This target is still to be taken with precaution as the 2020 level is not representative anymore of the intentions of the industry when they have set the goals in 2010. Still, in order to tackle global warming, air cargo companies have to assess their main carbon emissions sources, which is the fuel consumed by the aircrafts.

**Decoupling of Air transportation revenue and carbon footprint**

First, there are no clear signs of a disconnection between the global GDP and the global GHG emissions. As we observe an increase in total value of the world's economy, from 63,61 Trillion$ in 2008 to 85,91 Trillion$ in 2018, which represents a 35% growth on 10years. (The World Bank, 2019) We also observe a sharp increase in $CO_2$ emissions over the last 10 years, reaching 36 150Mt of $CO_2$ in 2017 from 31 150Mt of $CO_2$ in 2007 which represents a 16%

growth. Although the growth of carbon emissions is substantially lower than the growth of the economy, we can't conclude that there is a global decoupling.

**Evolution of worldwide carbon emissions**

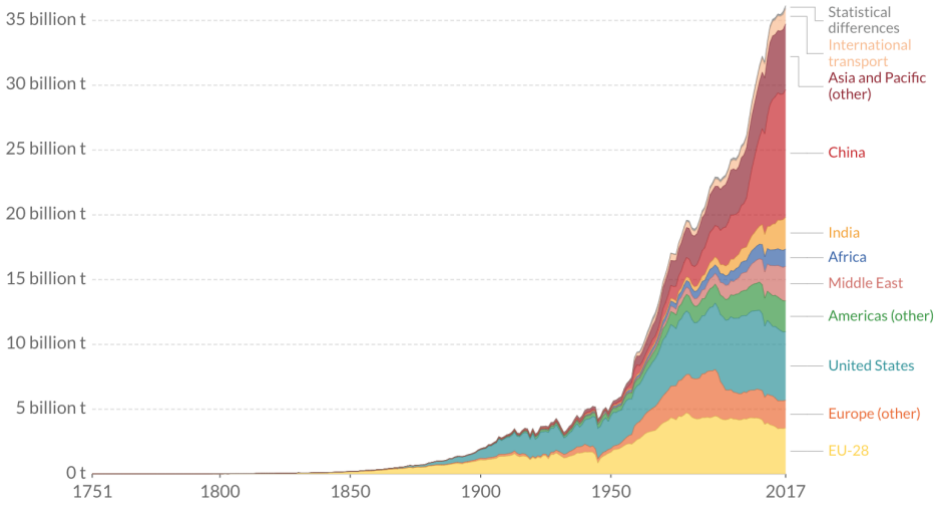


*Figure 3: Evolution curve of the emissions of Carbon worldwide (Ritchie et al., 2020)*

**Evolution of Worldwide GDP in $**

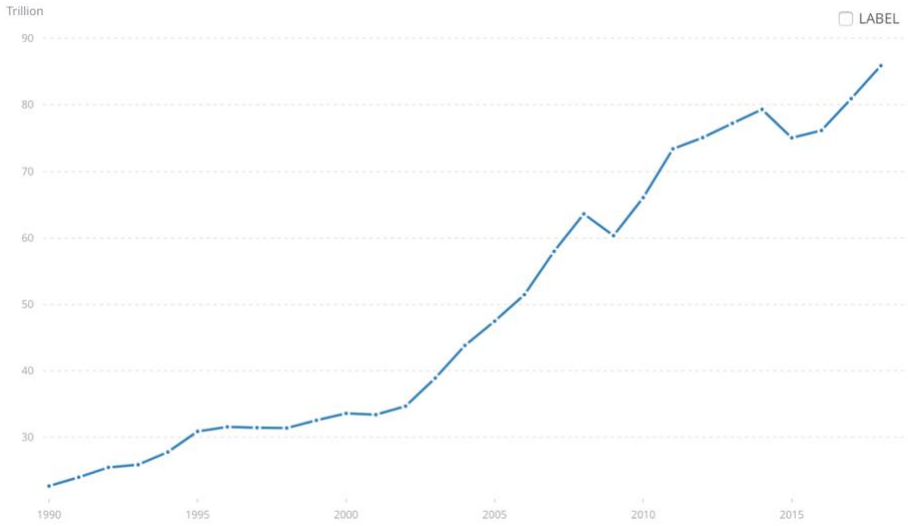


*Figure 4: World GDP evolution in US$, The World Bank (2019)*

However, it could reflect that certain industries or certain countries are in advance in terms of decoupling their economy from GHG emissions. According to a McKinsey report (2019), the decoupling of those two curves is going to be driven by four main tendencies:

- *The shift from industrial to service economies:* A service economy has 90 to 95% reduced impact on the environment compared to an industrial economy. In the US, this shift has already happened as around 80% of their GDP income is service based which allows this

part of the economy to grow without impacting the energy curve too much. This movement is also happening in the Asian economies such as China, where the share of service economies will be growing by 10 percentage points in the coming twenty years.

- *Energy efficiency:* The energy demand is not expected to decrease in the coming years as the population is growing and the world is digitalizing. However, both the consciousness of behavior and the innovations will decrease the energy intensity of certain tasks. By reducing energy waste and improving the efficiency, the energy needs per capita is expected to be reduced by 10% in 2050.
- *Electrification:* The efficiency of a traditional combustion motor has a maximum at 40% conversion whereas electric motors can push this limit to 90%. The battery prices and capacities are expected to allow this growth is the near future.
- *Renewables:* As the source of renewables is infinite, the current measures of energy input to create electricity will be totally replaced by the sole indicator of energy output. Furthermore, the energy won't be created in big and centralized factories but will be completely decentralized and locally produced. Depending on the size of the businesses, some will be in under-capacity which will oblige them to stay on the grid, but some might be in over-capacity, fueling this grid.

In the case of Air transport, it hasn't been studied specifically on a global scale yet. However, Yu et al. (2020) studies the evolution of the Air transport emissions in China and compares it to the economic growth. It appears that the main driver of the carbon emissions is also the main driver of the economic revenue, namely the number of transported products. In order to counter this contributing factor, there are several factors such as the technology of transportation, the alternative fuels solutions and the energy consumption efficiency of aircraft. In China, the speed at which carbon emission reductions are happening is decreasing due to the limitations in aircraft efficiencies. Indeed, the average age of the airplanes used in China is of 5 years which means that those are fuel efficient planes. (Yu et al., 2020) Therefore, China requires to find other areas of technological innovation to keep on driving this carbon emission curve downwards.

In conclusion, the decoupling between the air transportation sector's emissions and the economic growth depends on the energy that is used. The air transport can't logically be dissociated from the energy curve, but it could be decoupled from the carbon emissions in the long term.

**EU ETS limitations**

The European Union Emission Trading System (EU ETS) is a policy put in place in 2005 in order to cap and trade the carbon emissions in Europe. This policy has two different goals. On one hand, it aims at a global reduction of the carbon emissions as the caps will be progressively lowered. On the other hand, it aims at supporting the clean companies by giving indirect incentives for turning green. (European Commission [EC], 2020) Yearly, companies acquire emissions allowances (for free or pay) and trade those allowances according to their needs. Another solution as to increase the carbon allowances is to invest according to the Kyoto protocol, in carbon offsetting projects and companies which are having a positive impact on the carbon emission balance. (EC, 2020) If this policy is not respected, the European Commission is empowered to request heavy fines to the companies.

In 2012, the European Commission has included the aviation industry in the scheme. This implies that every airline operating in the EU has to monitor and report on its carbon emissions. (EC, 2020) This process is called compliance cycle (annual) and requires from all aircraft operators to have an approved monitoring plan as to get a permit to operate from the European Commission.

The EU ETS program is limited on three aspects which are the trade of carbon system, the geographical scope and the environmental targets. (Scheelhaase et al., 2018) In a "cap-and-trade" system such as the EU ETS, only the share of carbon emissions which is above the cap have to be traded. In the aviation case, the cap being defined at 95% of the average emissions of the years 2004 to 2006, only the exceeding share of carbon has to be purchased. The emissions below this cap are granted for free by the European states. Second, it only covers the EU internal flights and couldn't broad the scope as it faced strong international opposition. (Bartel, 2012) The opposition came from the fact that this scheme would apply to non-EU carriers travelling to Europe, and therefore, it would be international companies paying for entering the European skies. This was seen as violating different treaties of free-trading and countries such as Canada for example went in front of the Court of Justice of the European Union. This later has judged the ETS to be conform to international laws and agreements. Lastly, in the aviation sector, it is not clear that those measures are having an impact on carbon emission reduction. (Malavolti, 2015) There are signs that operators with efficient technologies increase their activities as they get a competitive advantage over the other players, but it doesn't result in a total decrease of emissions.

### *b. What is CORSIA?*

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) has been implemented by the International Civil Aviation Organization (ICAO) which is a United Nations (UN) agency. The main responsibility of the ICAO is to ensure a responsible civil aviation industry by focusing on security and safety, economic viability and environment responsibility. (ICAO, 2020b) They have worked closely with the 193 state members to reach consensuses which are translated into Standards And Recommended Practices (SARP) and policies. In 2016, the CORSIA program was agreed after more than 10 years of negotiation with the international carriers. (ICAO, 2016a) This achievement was also a response to the conflicts caused by the EU ETS regulation, where the IATA is looking for a global and independent scheme rather than a controlled by the EU program. (this topic is discussed in section III.B.c.)

The goal of CORSIA is to achieve carbon neutral growth in aviation from 2020. Concretely, in any year from 2021, the difference in carbon footprint will have to be mitigated through carbon offsetting programs. This program is happening in different phases:

- 2021 to 2026: qualified as a "pilot phase", the members states can volunteer to take part in it or not. During this phase, the distribution of the offsetting requirements will be fully sectoral approached. This means that every year, the total emissions growth rate will be calculated on the basis of the 2020 level, this rate will be multiplied by the total emissions of a company to get to the amount of carbon that has to be neutralized by a company.
- 2027 to 2035: the scheme will be applicable to every state which has more than 0,5% share in the total Revenue Ton kilometer (RTK), some developing countries would be taken as exceptions. There will be a shift in the allocation of carbon to offset as it will become gradually more individual (based on internal growth rate of carbon emissions) then sectorial.

**Scheme for CORSIA implementation**

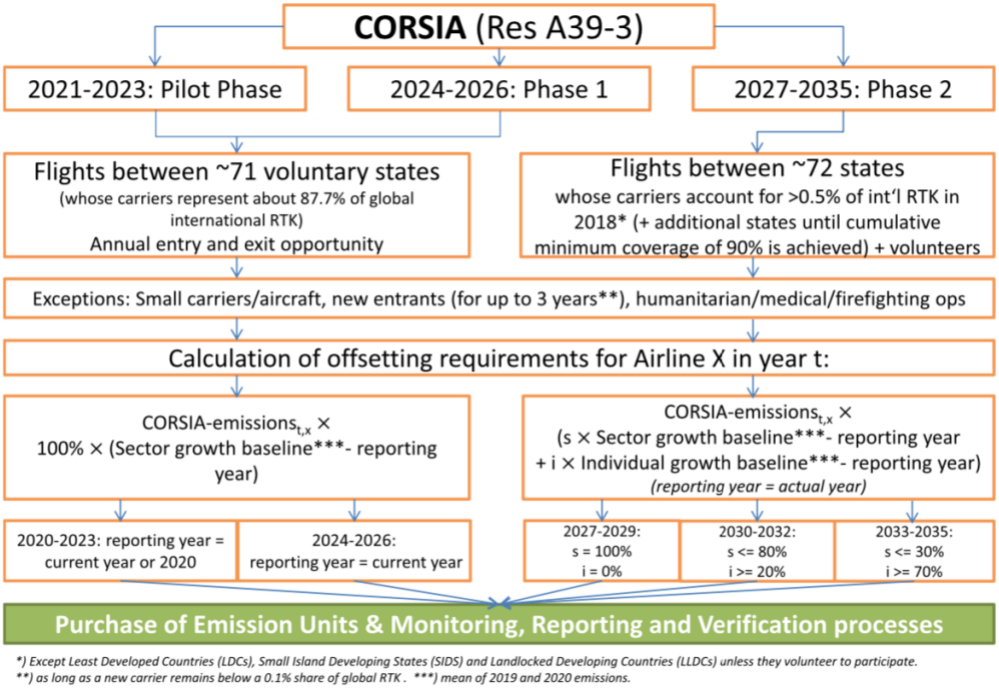


*Figure 5: Timeline and functioning of CORSIA (Scheelhaase et al., 2018)*

This system has some important implications concerning transparency for the airline companies as they will need to disclose their carbon emissions. This confidential information is considered to be of strategical importance as competitors could deduct take-off weights from those emissions. (Zanin et al., 2016) Some systems such as the multi-party computation system are in development phase and try to address this confidentiality problem. (Zanin et al., 2016) However, this won't affect the launching period for CORSIA for the 1st January 2021.

CORSIA and EU ETS are both market-based measures and guarantee the achievement of ecological goals as it incentivizes carbon emitters to alleviate their emissions. (Scheelhaase et al., 2018) Currently, there is no decision about the co-existence of the two schemes in Europe, this subject though is discussed in section III.B.c..

### *c. Offsetting scheme vs carbon tax*

A Carbon tax applied to the air transport industry is a tax that would be paid by the aircraft operators which would be directly proportional to the amount of carbon released by the aircrafts. (Abeyratne, 2019) The optimal level of the tax is set to a level which attains an optimal socially desirable level. (Ptak, 2013) Although the reasoning is logical and followed by Abeyratne (2019), it still requires that public entities define precisely to which extend air

transport is socially necessary, which would probably be a political debate prone to tensions. Furthermore, in the case of unsuccessful agreement on the global level, every country would be competing against each other on tax levels for gaining the tax revenues, called carbon leakage.

The carbon tax also raises the question about the usage of this revenue by the states. In order to enhance the acceptance of a tax, the money should be allocated to environmental investments. (Wallart, 1999)

There are several important discussion points between the two approaches such as the predictability of the carbon cost, the control on emissions, the competition or the effectiveness of investments.

The major argument against the carbon markets are the lack of control and predictability of the market. Indeed, prices could be driven up or down depending on the supply and the demand, which would impact drastically the companies as at both ends. In the case of a tax, the cost would be fixed, or at least controlled, over long periods of time which would allow companies to have a more predictable long-term plan. (Ptak, 2013) On the other hand, this uncertainty of the future might drive companies towards cleaner energy, just to avoid uncertainty. This argument is weak if we put it in the context of oil price uncertainty. Airlines are facing this for a long time through financial mechanism, those could be adapted and used on the offsetting market as well.

Secondly, in a carbon tax environment, there would be no competitive gaps between the companies as the price for carbon emissions would be the same for everyone. This induces a lack of competitiveness for the offsetting of carbons, and which might in turn be negative for the environment.

The last important argument for a carbon tax is the transparence, or supposed transparence, of the investment in carbon offsets. Indeed, the control mechanisms that have to be set up in the case of trading systems are huge and are subject to leakages. Whereas a state could benefit from having a large pool of revenue to invest, and maybe benefit from scale economies and improved rentability in terms of carbon reduction.

There has been lots of discussions about the tool that should be used in order to reduce the carbon emissions. ICAO has finally opted for a market-based instrument which is a carbon offsetting market.

The characteristics of a market based approach are as follows, in the short term, as most probable scenarios are forecasting a global carbon emissions growth of 3,2% on average per year for the next 20year period, aircraft operators will have a large quantity of carbon to offset in order to comply with the policies. (Scheelhaase et al., 2018) This will have the effect of increasing the offsetting price of carbon according to basic economic rules of supply and demand. Currently, the allowance prices are low (5€/ton of $CO_2$), but when the prices will rise it will impact the competitiveness of the industry. (Scheelhaase et al., 2018) In the section III.B.a., the sensitivity of the airline companies to this allowance price is discussed.

The potential for deviation of the policies, called carbon leakages, is limited as companies would need to modify their routes which would impact negatively their costs as well as their customer satisfaction rates. Therefore, the main risk for the airlines is to see the price of the offsetting plans or the price of the carbon allowances rise. On top of that, the geographical restrictions of the CORSIA scheme will make some destinations temporarily less expensive and give a competitive advantage to companies operating partly in domestic markets as CORSIA doesn't apply to them directly. (ICAO, 2020c) Developing economies might benefit from this temporary advantage as they can avoid CORSIA for economic development reasons.

In the long term, carbon offsetting is not a viable solution for two main reasons. Firstly, there is a lot of questioning about the availability of such carbon mitigating projects as of 2030, because the demand for such kind of projects would only be increasing. (Hermwille, 2016; Cames et al., 2015) Secondly, the scientific approach argues that a carbon offsetting project doesn't result in a carbon neutral activity. Indeed, there are three different types of offsetting projects, and none of them results in zero $CO_2$ emissions. (CDP, 2019) For example, one type of project is to generate an equivalent of 1ton of $CO_2$ of clean energy. This result still in 1ton of $CO_2$ being released by the airline, for this reason this solution can't be considered as a long-term sustainable solution. Another example would be an investment into cleaner energies, for example investing in carbon reduction from coal to gas, this can't be a sustainable alternative in the long term although it is in the near term. Therefore, the focus should be set on actions decreasing really the emissions of carbon in the industry. This could be translated by a reduction of total volume transported, or improvements in carbon efficiency. (CDP, 2019)

### *d. Control & interests*

The industry can be divided into three main visions in terms of interest. Those three have different goals and ambitions for the sector, which can be conflicting or not, and participated in the elaboration of CORSIA. The first group are the industry actors themselves, the airlines and airports, which are represented at the political level by the IATA, a lobbyist group. A second group of significant importance for the industry are the national and international representatives, precisely, the political groups and politicians which have responsibilities for transport and mobility. Finally, the last relevant actors that impact the industry are the NGO's. Their impact is far from being as important as the one of the previous two groups, however, they have a significant role to play in term of carbon reduction.

**IATA (International aviation transport association)**

The IATA is a group of representant of airlines, controlled by airline leaders. It has been created in order to stand for the industry on a political level and to guide the airlines on a strategic or operational level by setting best-practice recommendations. (IATA, 2020d) This is translated in their vision as stated by their current Director General and CEO Mister Alexandre de Juniac: "Our vision is to work together with our almost 300 member airlines to shape the future growth of a safe, secure and sustainable air transport industry that connects and enriches our world". (IATA, 2019d) Concretely, they have three core activities defined in their mission statement: "represent, lead, and serve the airline industry". (IATA, 2020e) First, they advocate for the best-interest of the industry in front of regulators and governments, striving for an adequate regulation. Second, they assist airlines by developing commercial standards which aims to reduce costs and improve efficiencies. Finally, they propose products and service to airlines to share their expertise.

An important point to notice though is where IATA gets its money from. As a lobbying group, they are mainly funded by the airline's member of the group. A second source of revenue is their range of products and services proposed to airlines, so it is the airlines which are the clients again. Therefore, we can take as a conclusion that the IATA is acting according to the best interests of the airline companies in order to maintain their economic profitability.

**ICAO (International Civil Aviation Organization)**

The ICAO is a United Nation's agency. Therefore, it is an agency where country representatives define and set new standards and recommended practices (SARP's) for the industry, internationally. The Chicago convention on civil aviation was the launching point of the ICAO in 1944, regrouping 193 member states. (ICAO, 2020b) The vision of the ICAO is: "Achieve the sustainable growth of the global civil aviation system" (ICAO, 2020d), this vision supports the industry's growth. In order to accomplish that, they focus on five different dimensions which are called strategic objectives, namely safety, air navigation capacity and efficiency, security and facilitation, economic development of air transport and finally environmental protection. (ICAO, 2020e)

The last dimension is the one with major interest in this paper. It is interesting to notice that the ICAO describe their intentions in terms of environment using the word "minimize". (ICAO, 2020e) This is in line with their vision of growth of the industry but on the opposite from the industry's target of halving emissions in 2050 compared to 2005. In an attempt of understanding the reason behind this positioning of the ICAO, we can argue that countries have significant interest in the growth of the aviation industry, economically, while having little environmental downsides as the industry isn't included in the NDC's. For example, in Europe, the aviation industry represents 2.1% of the total GDP and almost 5M jobs. (European Commission, 2020c) Those figures are likely to be refraining the ICAO to go on the path of an activity reduction.

**ICSA (International Coalition for sustainable aviation)**

As mentioned earlier, the last group which has a role to play in the aviation industry are the NGO's. However, individual NGO's couldn't get a seat at the table of ICAO. Therefore, a group of them have created the ICSA in order to reunite under one appellation and become official observers at the ICAO. (ICSA, 2020) The objectives of ICSA are to reduce the environmental impact of international aviation by working together with the ICAO and the technical groups in the elaboration of the SARP's. In this regard, the ICSA is working on the shaping of CORSIA as well.

**Conclusion**

In terms of control on the aviation industry, the decision makers are the representant of the ICAO, concretely, it is the country's representatives responsible for their national mobility and

transport in most of the cases. Together, they debate on the SARP's that have to be implemented for the industry. This debate is often influenced by the lobbying group IATA and by the NGO's of the ICSA. CORSIA being one of those SARP's that have been decided by the ICAO.

After that decision, the IATA, the ICSA and other experts regroups in technical task forces in order to develop the solutions proposed by the ICAO and put them into practice in the industry.

In terms of interest, we observe that the majority of the actors are focused on the economic aspect rather than on the environmental issues caused by the sector, it raises the question whether it is possible to come out with an adequate plan in terms of sustainability in such conditions. Those concerns will be raised and discussed in the empirical research in the section III. Indeed, countries' representatives are traditionally looking for economic development before opening the environmental issues' chapter. The IATA is as, mentioned earlier, defending the companies in their economic growth. The only actors that really have environmental interest are the NGO's, but there are questions related to their influence on the development of the SARP's in the task force.

## B. Air Cargo

### *a. Industry overview*

This industry supports the global economic activity by easing the international trade and by creating millions of jobs. The sector transports around 6 Trillion USD worth of goods annually which represents roughly 35% of the world trade by value. (IATA, 2020a) These figures are reflecting the importance of this industry in the globalized world.

The products that are shipped by plane are different from the ones shipped by boat or by truck as the price for air shipping is roughly 12 times and 5 times more expensive, respectively. The goods shipped by air transport are therefore high-value to weight and volume products such as diamonds, or high time-sensitive products such as pharmaceuticals, documents or "just-in-time" goods. (The World Bank, 2009)

The demand is significantly randomly spread in the short term though being cyclical on a yearly basis as shown on *figure 1*. The demand is characterized by its inelasticity on the prices. (Yu et al., 2019) Forwarders are price taking, as there isn't any substitute for shipping certain goods. As to optimize the profitability of the company, the air carriers have to be performing in planning and routing, which requires a strong base of demand forecasting. There are plenty of forecasting methods for the air cargo demand, Kupfer et al. (2017) has developed one using the main air cargo demand determinants as the oil price or the air freight yield. Other methods try to estimate the potential revenue from the expected volume and the expected weight to be transported. (Huang et al., 2010) A relevant proxy to estimate the demand for Air freight services is the Purchasing Managers Index (PMI) as it shows the trends in manufacturing and purchasing behavior of companies. (Investopedia, 2019)

The Global Freight Ton Kilometers (FTKs) have declined in the last year (2019) by 3.3%. This decline is observable in every continent around the world, except in Africa. (IATA, 2019b) The key factor behind those facts is the international trade tensions impacting Asia. (IATA, 2019b) However, in the recent years, the industry is being doing well with a steady growth as illustrated in the following figure.

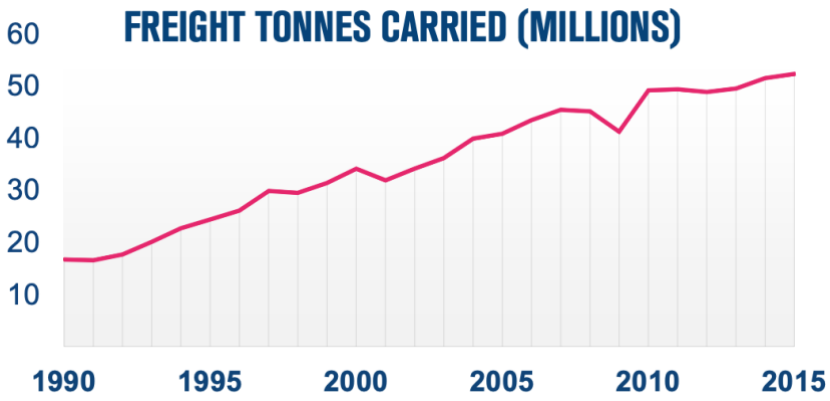


*Figure 6: evolution of freight tonnes carried (IATA, 2020)*

Opposingly, the total air freight capacity, which is defined by the Available Freight Ton Kilometers (AFTKs), has been increasing by 2.1% in 2019. The combined effects of a decreasing demand with an increased supply has impacted the load factor of the planes with a 2.6 percentage point fall. (IATA, 2019b)

The four categories of goods that are transported by air are the following: Time-to-market sensitive goods; goods part of a just-in-time supply chain model; goods with safety concerns; Perishables. (Lufthansa, 2017) In order to make the analysis more relevant, each of those categories was given a certain weight representing the share of importance they have in the market. However, information on the current levels is not available, therefore we used information from Morrell (2011) to come up with an approximative weight.

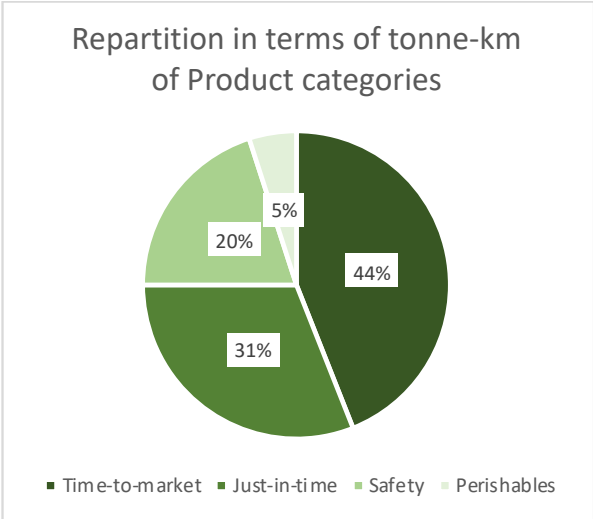


*Figure 7: Repartition based on Morrell (2011) & Lufthansa (2017)*

It is probably not possible to reach a zero-carbon impact on the environment in this industry, the target is more about outweighing the negatives effect through benefits; both environmental,

economic or social benefits. (Woods, 2017) Indeed, the benefits of an air cargo company are diverse. On one hand, it creates jobs in the company itself but all around in the logistic process. On the other hand, it supports international commerce by shipping goods all around the globe. In order to reach those carbon footprint reduction, the most relevant areas of improvement are the efficiency of the airplanes, the packaging of the cargo shipment as well as the routing.

The Air cargo customers being other businesses, it is crucial to understand the attractiveness of a greener product for those businesses. Michael Yee, Gap Inc's global supply chain manager, explains that he is looking to every step of the supply chain in order to reduce emissions, therefore, any emission reduction in the transportation step of his chain is valued. (Woods, 2017) As the forwarders are increasingly interested in their global footprint, they tend to change their selection criteria for the carrier from price-centric to price and efficiency indicators. In order for the carbon reduction to be valuable for a company, it has to be well communicated and transparent. (Babakani et al., 2016)

### *b. Future of the industry*

As the legitimacy of analysis regarding the evolution of the activity level in the air freight sector done by air freight players can be questioned, their forecasting's will be mitigated by the opinion of an expert of the industry, which has no personal interest in the activity growth.

**Industry projections**

Most of the industry players, whether it is the constructors, the operators or the aviation organism are predicting a significant growth of the activities of air freight market. Boeing (2018) estimates the growth to be between 3.7% and 4.7% annually. Similarly, the IATA (2019c) says the activities are likely to double by 2035. On the operator's part, most of them don't advance any figure but refer to those studies from the IATA. However, they rely on three main pillars which are the growth of e-commerce, the globalization of emerging countries and the importance of the high-value-added products. (Fedex, 2019) Lastly, the industry is facing important risks related to trade tensions between important players such as the US and China, related to fuel price volatility or related to complete technological disruption. (Boeing, 2018; BCG, 2020) But this doesn't seem to be too worrying for the air freight companies.

**Forecasted growth of the Air Cargo sector**

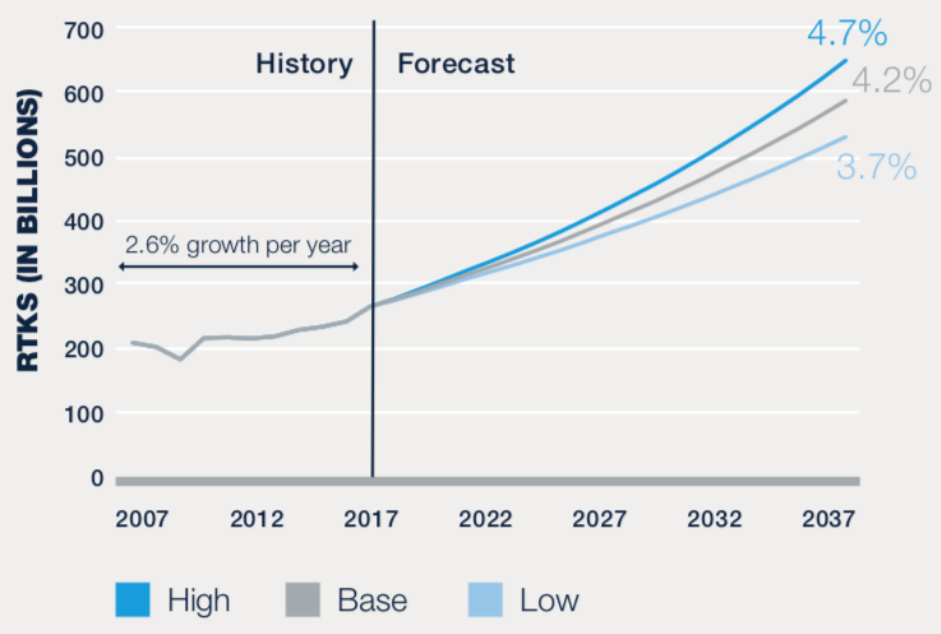


*Figure 8: Projected air cargo growth (Boeing, 2018)*

Globally, there is a projection of important growth in the freight market which is attracting an increasing number of players like passenger companies using belly capacity, which will intensify the competition in the industry and reduce the yields. This pressure on the market is not expected to be eased in the future. (McKinsey, 2017) This increased demand will also lead to an increased complexity in the distribution networks and connections with the customers on both end, which will require the air cargo service providers to become more and more agile. One way to do that is to create alliances as to be a full-service transport provider. (BCG, 2020)

**Mitigations of these projections**

First of all, looking at historical trends of the market from the IATA, we see a tendency for growth during the last 30 years. However, in the short term, these recent years haven't been good mainly due to trade wars. (IATA, 2019b)

**Growth rate of the Air Cargo sector between 1991 and 2019 is predominantly positive**

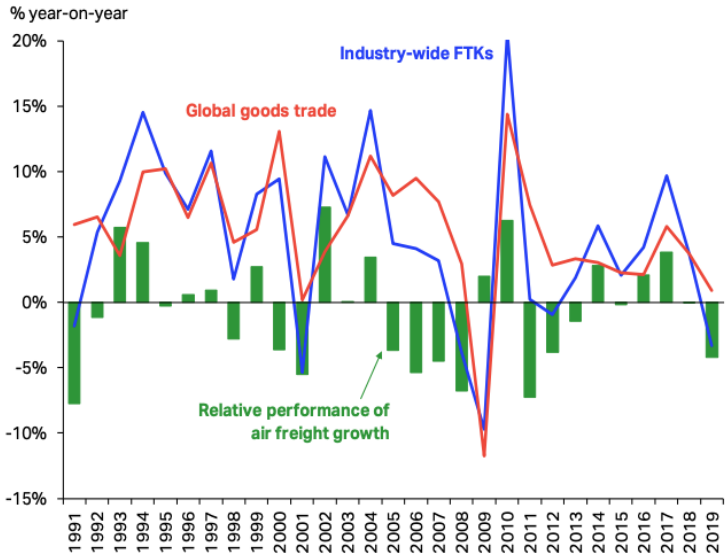


*Figure 9: evolution of the growth rate IATA (2019b)*

Furthermore, the Coronavirus is raising another point of significant importance for the future of the market. It is the localization of production of certain goods. (N. Meunier, personal communication, April 16, 2020) Indeed, countries are looking to secure the supply of some important products and therefore localize their production. An important one is the pharmaceutical sector in which the US and EU largely depend on China and India (Euractiv, 2020) If countries where to relocalize the production in these sort of industries, it would have a direct and significant impact of the global air freight market as those products are often high added-value products, important products which are air transported. Furthermore, PwC (2018) estimates that the maturity of 3D-printing could reduce the share of air transported goods by 41%. This 3D-print technology is expected to be maturing over the next 10 years (Smithers, 2017).

**Black Swan approach**

Nicholas Taleb (2010) has developed a theory about uncertain events in 2010 which are called Black Swans, those are events that are defined by three characteristics. First, it is an event that is hard to predict based on historical data. Secondly, this event has important consequences on the object. Lastly, it can be explained on a retrospective way. To illustrate, the Harry Potter books are Blacks Swans, no one could predict that those books would become best-sellers based on the history of J.K. Rowling, it became a best-seller which is an important impact. Retrospectively, it is possible to argue and to find reasons for such a success. (Taleb, 2010) On

the other hand, the actual Coronavirus crisis is not considered as a Black Swan. Indeed, this crisis was predictable and preventable, both Nicholas Taleb (Bloomberg, 2020) and Bill Gates (Ted, 2015) warned that such a crisis could happen.

Nicholas Taleb also argues that everything that is fragile is more subject to Black Swans. (Taleb, 2010) His definition of fragile is as follows, it is something that doesn't like variability nor volatility and is subject to a negative acceleration of harm. For example, a negative acceleration means that if someone jumps ones from 10ft, he might die, however, if that person jumps ten times from 1ft, he won't be even affected.

Accordingly, the air freight industry can be defined as a fragile industry. As on one hand, volatility and variability in the business is what operational efficiency a key area of competitivity. On the other hand, we see that major events such as the Coronavirus can have tremendous impacts on the industry, more than a thousand small diseases. In the case of the Coronavirus's impact on air freight industry, it is too soon to draw conclusions, but some leads have already been highlighted as the reduction of demand for air shipping between Asia and the rest of the world, or the reduction of capacity in belly (=cargo space in a passenger flight, literally in the "belly" of the aircraft) cargos from passenger airlines as those companies are close from bankruptcy. (Supply Chain dive, 2020)

### *c. Air cargo companies*

There are four different categories of actors in the Air freight market, acting through different business models. (Morrell, 2011) Contrary to popular beliefs, the most important actors on the freight market are the combination carriers, operators which do pax (=passenger transportation) and cargo, and by far. The combination carriers are divided in two groups, the companies that operates freighters aircraft to transport the freight versus the ones that operate through belly space in pax aircrafts. The two last groups are also using freighter aircraft for their operations, as they are doing cargo-only. On top of that, the distinction is made between the integrators (ex: DHL) which have a whole network for transportation, and the airlines which only focus on air transportation (ex: Cargolux).

**Before Coronavirus distribution of Freight in the Air Cargo segment**

| | Freight (tonne-kms (m)) | % total |
|---|---|---|
| Freighter flights of combination carriers | 74,071 | 44.8 |
| Passenger flights of combination carriers | 65,364 | 39.5 |
| Integrators | 13,133 | 7.9 |
| Freighter-only airlines | 12,745 | 7.7 |
| Total international | 165,313 | 100.0 |

*Figure 10: distribution of freight service between the different categories (Morrell, 2011)*

Out of this graph, we can observe that 60,4% of the freight is transported by freighters which leaves a large share to the belly methodology. This share looks to have swollen down to 50% according to Air Cargo News (2019b). From this point, it is likely to remain stable as the belly operators have grabbed every part of the market which they could serve, and the remaining 50% are not profitable for them as they concern non-pax routes or too much volume for the belly. (Air Cargo News, 2019b)

**Aviation industry repartition of carbon emissions**

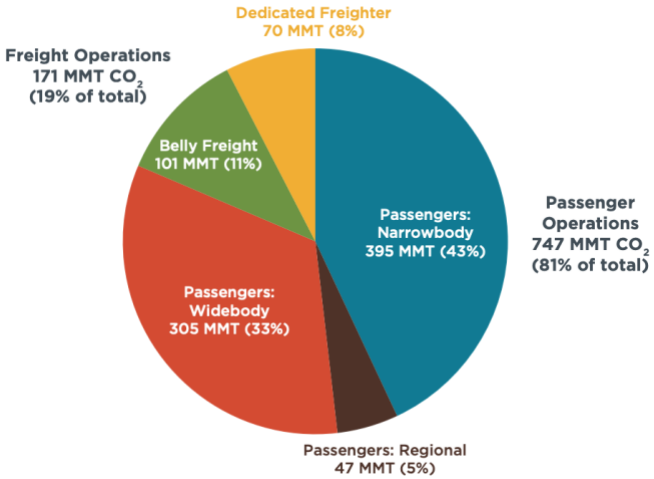


*Figure 11: Carbon emissions repartition into the industry (Graver et al., 2019)*

The emissions from the air transportation sector has been clustered between pax (passenger) and cargo. We can see here that there is the distinction that is made between freight from belly and from dedicated freighters. As we assume that the quantity of freight transported by the two means is similar (close to 50-50), we observe that the belly freight is slightly less efficient on a carbon basis. (Graver et al., 2019)

## C. Carbon mitigation in aviation

Ricardo Energy & Environment (2017) has evaluated the cost of abatement of GHG in the UK airline industry for seven relevant strategies or action points which are considered as technically feasible. His evaluation has been done through a model called DfT aviation modelling framework. This section presents four of those mitigation strategies around two aspects, first, their relevance for air cargo companies, second, their cost effectiveness along with their total impact on carbon reduction. His findings are adapted to the situation of an air cargo's opportunities and its impact on global emissions rather than civil airlines impacting the UK emissions, therefore, three strategies have been dropped as they are linked to the UK government or UK airports and not adaptable to this research.

### *a. Increased R&D in engines & aircrafts*

Air cargo companies could start investing into R&D programs which focusses on fuel efficiency, on their own or in cooperation with energy and construction companies. However, by doing so, the company faces a lot of risks as intrinsically an investment into research is uncertain about the outcomes. According to Ricardo Energy & Environment (2017), a doubling of the investment on a European scale could improve the efficiency level of aircrafts and engines by an additional 7,5%, on top of the current expectations. However, this outcome is not to be expected before 2040 as this program would take time before being impactful on the market.

This option looks to be more viable through a joint effort of airlines, orchestrated by a global organism such as the ICAO or the IATA.

### *b. Accelerated fleet lifecycle*

The study is focused on the UK; therefore, the carbon abatement and the cost are related to a local optimization of the fleet through early replacements of aircrafts flying to and from the UK. However, the accelerated fleet lifecycle in one region of the world is likely to induce positive effects on the other region of the world by providing them with newer aircrafts as well. This strategy can be considered as a global optimization rather than a local one, even though the measure is local. (N. Meunier, personal communication, April 16, 2020) There is an important point to mention still, the accelerated lifecycle of aircrafts would increase the amount of aircrafts in retirement every year which will need to be taken care of. In terms of priority,

this comes second as the carbon emissions from a plane during its lifetime are far outweighing its production emissions. (N. Meunier, personal communication, April 16, 2020)

**Lifecycle of an aircraft**

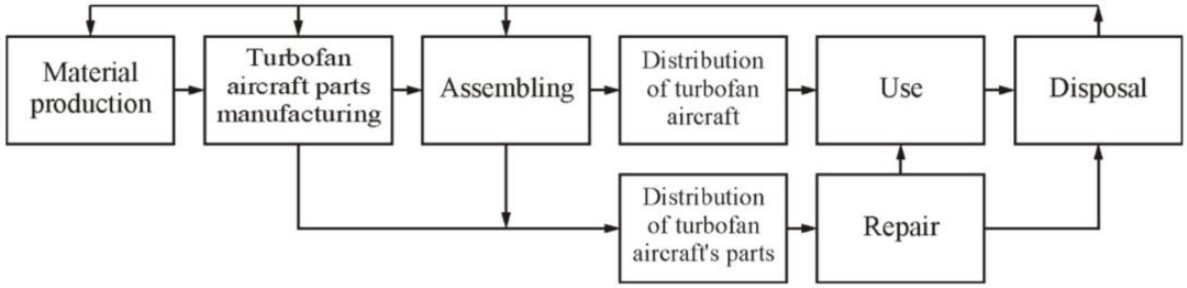


*Figure 12: Aircraft lifecycle flowchart (Jakovljevic et al., 2018)*

Jakovljevic et al. (2018) constituted the lifecycle of the plane in order to show where the costs and the emissions rely. In the appendix B., you can find the detail of each box and how to calculate the emissions coming from each step. Based on those, we could confirm that the "use" box is the most impactful one on carbon emissions therefore it should be the first one to be tackled.

This strategy relies on the assumption that aircrafts of the future will be more and more efficient. As to check this assumption, the next part starts with a brief overview of the history of the airplanes and the evolution of their efficiency carbon wise until nowadays, followed by a roadmap on the future developments in the aircraft manufactory industry.

Between 1960 and 2000, energy efficiency was not the only strategical goal for the aircraft designers. During this period, manufacturers were primarily looking to increase the cruise speed of the planes. (Peeters et al., 2005) Therefore, the main engine technology shifted from pistons towards gas turbines as it had more potential for range and speed. Overtime, this change has allowed for fuel consumption reductions but, according to Peeters et al. (2005), the assumptions of constant reduction in fuel usage is rather optimistic as the asymptote of the regression can't be zero and the reduction rate is already declining. Additionally, next to the theorical emissions of a plane, there are some extra emissions that are caused by the gradual degradation of the aircraft which affect its performance on a fuel efficiency point of view. The degradation that are considered are the normal issues affecting an airplane and causing damage, dirt, impurities and aerodynamics imperfection due to repairs. As to assess the degradation level of an airplane, different methods have been developed such as the thermal method (Tadini et al., 2017), the

micro-structural method (Tong et al., 2017) and the airbus method (Airbus, 2002). Some of those analysis highlights some parameters which helps in locating the source of the degradation, which could lead to maintenance efficiency gains. It is important to mention that degradation can't be removed completely, set to zero from an in-use plane, there is a residual limitation on repair. (Jakovljevic et al., 2018)

Recently, we have observed a boom in the sales of new airplanes. Between 2014 and 2018, around 1700 new commercial aircraft have been sold each year. (IATA, 2020b)

Nowadays, the new airplanes entering the market will be able to save around 20% of fuel compared to the 2010 models of reference. (IATA, 2019) On top of those savings, the remaining 80% can't be saved with the current structure of airplanes. After 2035, it is expected that revolutionary technologies in materials and propulsion systems as well as the sustainable fuels (which are detailed in the next section) will help the industry to reach their targets of sustainable development. (IATA, 2019)

**Forecasting of fuel efficiency gains of new generation aircrafts**

| Seat category | Aircraft Category | 2010 reference | New generation (examples) | Entry into service | Fuel saving vs reference |
|---|---|---|---|---|---|
| 51 – 100 | Regional jet | ATR/CRJ | MRJ | 2020 | 20% |
| | | E-Jet | E-Jet E2-190/-195 | 2018/19 | 17%–24% |
| 101 – 210 | Narrow body | A320/B737 | A220/A320neo/B737 MAX | 2016/2017 | 15%–20% |
| 211 – 300 | Wide body | B767 | A350/B787 | 2015/2011 | 20%–25% |
| 301 – 400 | | A330/B777 | A330-800neo/B777X-8 | 2020/23 | 14%–20% |
| 401 – 500 | | A330/B777 | A330-900neo/B777X-9 | 2018/2021 | 14%–20% |

*Figure 13: fuel efficiency improvement for the current generation of new aircrafts (IATA, 2019)*

The future of the industry is uncertain regarding the technologies development post-2030 as drivers are pushing the industry in opposite directions. On one hand, the technology improvement potential (IATA, 2020b) as well as the targets about carbon emission reduction are driving the aircraft manufacturers to innovate and grab extra-market share. Boeing is confident to be the one grabbing those shares as shown by their predictions of the market in the following graph, but still, they do not believe that new aircraft will grab more than 37% of the planes entering the cargo market.

**Projections of aircraft fleet in the air Cargo segment**

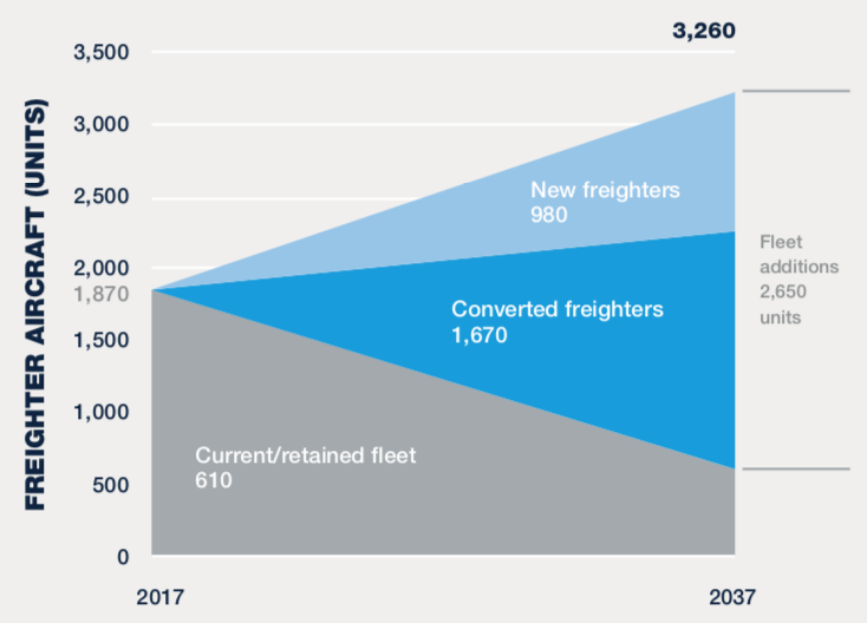


*Figure 14: Projected freighters fleet growth (Boeing, 2018)*

On the other hand, the same sustainability goals are creating new markets in air transportation such as the "small electric vertical take-off" vehicles market. Those emerging markets are appealing to the classic aircraft manufacturers as they have a competitive advantage over the players on those market regarding knowledge and capacity. (McKinsey, 2018) On top of that trend, there is a significant financial barrier to innovation as the capital requirements for launching a new project from scratch are equivalent to betting the company's survival. (McKinsey, 2018)

Ultimately, such an accelerated lifecycle for aircrafts will increase the amount of retired aircraft available for recycling. This can be seen as an issue as the amount of aircraft to recycle has to be assumed by the recycling market. But, according to the AFRA which is the non-profit organization that provides a code of conduct for best practices to the companies performing dismantling and recycling activities in exchange for an AFRA accreditation (Aircraft Fleet Recycling Association [AFRA], 2020), The recycling capacity on the market nowadays is growing as the technology and know-how has reach a level that makes this operation profitable on an economic and environmental point of view combined with the fact that there is an increasing number of airplanes reaching their end-of-life. (AFRA, 2014)

On top of improving the global energy efficiency of the economy, the recycling of airplanes also enhances job creation and reduces the usage of other resources. (Asmatulu et al., 2013)

The potential in recycling airplanes is huge in terms of economical profitability and in terms of sustainability impact as it would increase the circularity of the aircraft industry. There exist some companies that are taking advantage of this situation and try to transform the end-of-life planes into cash.

Furthermore, Asmatulu et al. (2013) have assessed the carbon savings that are made when a using recycled materials in the manufacturing of new planes. Those savings are adding up to 61.1 Million kg of $CO_2$/year with the technology level of 2009 which recycles only 20% of an aircraft.

### *c. Reduced aircraft cabin weights*

This measure is directed towards the passenger industry which can reduce the weight of every part of the cabin in order to reduce the total weight of the filled aircraft. This can't be applied largely to cargo as they operate with empty planes which is loaded with merchandise that can't be lighter than what it is.

The weight is also influencing the altitude of flight, the higher the aircraft is the better in terms of fuel consumption, however this has to be balanced with weight as the heavier the plane, the more fuel you need to go upwards. This means that for every route, there is an optimal altitude level which depends on weight, plane features and distance. Though, this optimal altitude is not respected at all time due to traffic or else, this could be improved globally but the savings from that would only be minor and they are limited.

### *d. Usage of Biofuels*

The development of alternative fuels has two different dimensions, on one side there is the security of supply which addresses every concern about economic sustainability; on the other side, there is the safety which considers every environment and social aspect of the alternative. (Rye et al., 2010) The attractiveness of a fuel depends on the raw material used, the production processes and the utilization methods. (Nanaki et al., 2012) Consequently, the decision process related to fuel strategy has to be done in a multi-stakeholder environment involving every step of the supply chain and should maximize a multi-objective function where the weighting of the different considered aspects has to be defined by the stakeholders. (Rye et al., 2010) According to Staples et al. (2018), in the best-case scenarios which are in case of huge governmental

incentives supporting the successful investments, more than 85% of the current GHG emissions could be avoided.

Nowadays, the system used in the industry is that the airports are responsible to manage the fuel providers, and, on that basis, they propose a range of different fuels (typically from different companies) to the airlines for refilling at the airports. (ICAO, 2016b) Therefore, it is impossible for an airline company to be provided by another fuel supplier than the ones available in each airport, logically. In this regard, the first actors playing a role in the evolution of sustainable alternative fuels solutions are the airports. Even though, as final customers, the airlines can definitely influence the supply in the airports.

The following fuels are a sample of solutions on the market or in development:

- *Conventional jet fuels*: Kerosene, derived from a non-renewable energy source, oil. It is the main fuel used since decades and produces an average of 3.15t of $CO_2$ per ton of fuel burned.
- *Synthetic & biomass derived*: F-T (Fisher-Tropsch) is one of them, the production process of this fuel uses natural gas, coal or biomass and is therefore considered as using renewable sources of energy. However, although feedstock being renewable, it is not a socially responsible solution and limits the capacity and the impact on $CO_2$ reduction is not substantial. (Hileman et al., 2010) This fact is shown in the following figure which maps the cost of each alternative compared to its carbon footprint. (Carbone4, 2020) Biofuels produced with palm oil are in this regard worse than kerosene as their production lifecycle is overall emitting more GHG than kerosene.

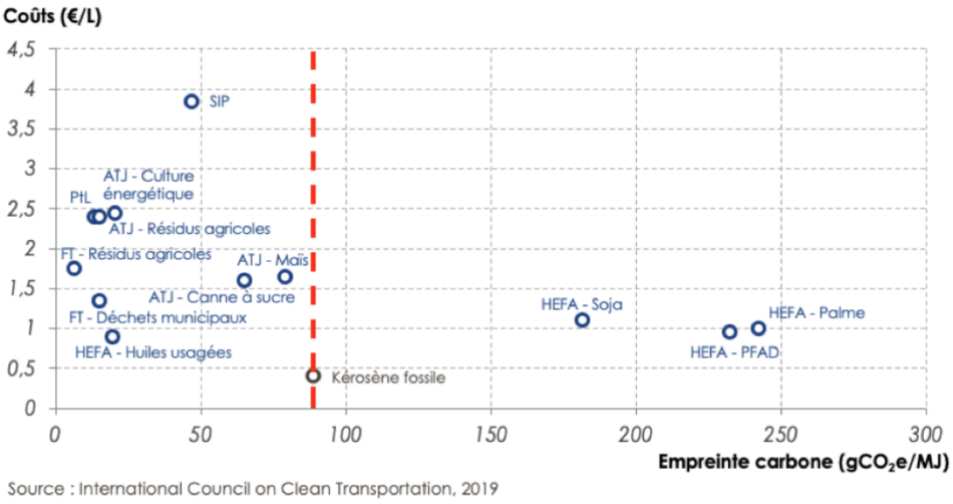


*Figure 15: Map comparing fuel price and fuel carbon footprint (Carbone4, 2020)*

- *Liquid Hydrogen*: LH2 is a long-term project, it has the benefit of being more efficient than conventional oil on a GHG emission criteria, however its performance is not yet good enough and it would require the development of new aircrafts, which is also an important barrier. (Stadler, 2014) Alike the electrification of aircrafts, this fuel is not seen as a good solution as the perspective horizon is too far away for helping the industry to reach the 2050 goals. (Carbone4, 2020)

# III. Stakeholder's opinions

## A. Methodology

This paper is based on a qualitative approach of the CORSIA case in the air Cargo industry. This method is suitable to this paper as it aims to explore how CORSIA is going to influence the industry, in this specific context which is the increasing pressure to reduce the carbon emissions from their 2050 goal of halving emissions compared to 2005. Furthermore, this program is not in application yet, therefore, it makes no sense to analyze its efficiency on a quantitative way. Quite the opposite, Miles & Huberman (2014) states that qualitative exploration is the best way to go for understanding new areas and new cases.

This method also allows this paper to focus on a deep understanding of the context, the different opinions and viewpoints, by being close to the situation. Logically, this also implies that the results will be less objective and measurable compared to a quantitative analysis. (Lejeune, 2014) The flexibility offered by qualitative comes at a price, indeed, less well-defined frameworks and methods compared to quantitative research implies that it is more difficult to have a valid conclusion. (Miles & Huberman, 2014) Consequently, the analysis of the collected data has required a lot of attention in terms of structure and approach, in order to avoid as much as possible the inherent subjectivity.

### *a. Sampling*

The Air industry has been determined to be the setting of the study which is in line with the research question aiming to dig deeper into the impacts of the CORSIA program on this industry. Furthermore, the actors and participants in this exploration were intentionally selected rather than randomly, based on their relevant knowledge for the research itself. Practically, as this research aims at comparing and exploring the differences and similarities between various actor's opinions about the impact of CORSIA on companies and the industry, it is valuable to have a sample that includes a maximum of heterogeneity inside the sector as to point out a maximum of different point of views. The scope of the sample has been systematically reviewed in order to make certain that every meaningful actor – for the study – is included.

In this regard, this research interviews six different actors. Their situation and their relevance to this case study is explained in the table below. Those interviewees have all different positions within the industry which provide this study with a large panel of visions on the CORSIA

program, while always being experts in the scheme. Therefore, it is estimated that this approach reaches a certain degree of theoretical saturation as an important share of the different actors have been touched and as the arguments of each of those actors are similar if their motivations are similar. Lastly, in order to preserve a certain level of quality and objectivity, no interviewee was an acquaintance of the researcher.

| Company | Contact details | Relevance & Specifications |
|---|---|---|
| ASL Airlines | ndesimpel@aslairlines.com | ASL Airlines is an Air Cargo company, based in Belgium. They are of a relatively small size compared to industry leaders, with a yearly revenue around 580M€. (ASL Airlines, 2019) Still, they are relevant to this research as they participate in the CORSIA pilot phase and in the EU ETS scheme. And as a small company, they might have different opinions than industry leaders about the program. |
| United Airlines | aaron.robinson@united.com | United Airlines is an US based company that is active both in the passenger segment as in the cargo segment. They can be assimilated to industry leaders according to their size with a yearly revenue around of 43.26B$ in 2019. (United Airlines, 2020) They also plan on participating in the CORSIA pilot phase. It is interesting to have the point of view of an US based company as well as of a big player in the industry. |
| IATA | adamm@iata.org | Michel Adam is the responsible person for CORSIA at the IATA. He is the contact person for companies and other stakeholders when it comes to explaining CORSIA or providing guidelines. It is primordial to have his opinion about the scheme as he is influencing the whole industry through its recommendations. |
| Carbon Market Watch | gilles.dufrasne@carbonmarketwatch.org | Gilles Dufrasne is the policy officer of Carbon Market Watch; he is therefore a specialist of the CORSIA program in the airlines industry. Furthermore, he is representing Carbon Market Watch, which is an NGO |

| | | |
|---|---|---|
| | | active in the sector as well but together with the association ICSA as discussed above. His point of view is valuable as for his expertise and his orientation towards sustainability and responsibility rather than for economic motivations. |
| Carbone 4 | nicolas.meunier@carbone4.com | Nicolas Meunier is a consultant specialized in the aviation sector, working for Carbone 4 which is an interesting consulting company led by Jean-Marc Jancovici, a well-known persona claiming for better climate actions. |
| DGTA | morgan.hansenne@mobilit.fgov.be | The industry is ultimately ruled by countries and its politic representatives. Therefore, it makes sense to understand their opinion and motivations. Morgan Hansenne is a Belgian representative of the DGTA (=Direction Générale du Transport Aérien) which represent the country at ICAO assemblies. |

### *b. Data collection*

The data collection process can be divided in three steps which are clearly defined as qualitative methods allows for a large flexibility and adaptability to the case. First, it required a lot of efforts to reach the relevant people, especially in those troubled coronavirus period. Next, interviews were conducted with the respondents which were positive to share their thoughts. Lastly, the interviews were transcribed from audio to text.

As the research's quality and relevance is closely linked to the expertise of the interviewee's, this first step of finding the right person is crucial. Those people were contacted mainly via mail, but also through LinkedIn by using my personal network. The mail template that has been used to contact the interviewees can be found in appendix A.g., although some detail was adapted to the person of interest. This mail specifies the confidentiality of the research as well as the context of the interview in order to start building trust and honesty from the start.

Once we could schedule a meeting, those were organized through the Microsoft Teams platform, which is convenient for its recording feature and easy-to-use aspect for interviewee

wherever they come from. Concretely, semi-directive interviews have been conducted as this method is adapted to understand motivations and positions in relation to a specific topic. The interview guidelines for each interviewee can be found in appendix A.a., those guidelines were used as a roadmap for the interview, but they were not followed strictly during interviews. This because the accent was put on the exploration of the interviewee's thoughts rather than the collection of information. Another specificity of semi-directed interviews is the possibility to incrementally improve and direct the interview roadmaps from interview to interview as I gain more experience and insights about the issue at stake.

Lastly, for transparence and conformity purposes, the interviews recordings were transcribed manually and can be found in the appendix A. In order to make sure the transcripts were reflecting the genuine opinion of the correspondent, the later was send back for final approval by mail as soon as the transcription work was done. This allows to use their arguments without fearing to twist their thoughts, enhancing the validity of the research. As a counterpart to their contributions, this report will be shared with them.

## B. Findings

The interviews were conducted in order to attempt to respond the research question which is:

**"How is CORSIA going to help the Air Cargo industry to reach their 2050's carbon reduction goals?"**

As this question is difficult to ask in an interview, four sub-questions and sub-topics have been defined and discussed during the interviews. Those subjects are the potential of CORSIA to drive the industry towards greener technologies, the CORSIA baseline modification which might occur due to the coronavirus, the outlook on the co-existence of different schemes such as the EU ETS together with CORSIA, and finally, a broader topic to see what industry experts see as a result for the industry in 2050. Through those four sub-categories, this research intends to grasp a maximum of the interviewee's opinion and feeling about CORSIA.

### *a. CORSIA's potential to drive change*

In this section, we define "change" as carbon mitigation actions such as detailed in the Context and Background above. Although CORSIA doesn't have an official goal of reducing emissions as such, one could believe that its cost could influence the company's decision making towards one of the possible mitigation options developed, namely increased R&D, accelerated fleet lifecycle, reduction of weight and the usage of alternative fuels. This reflection was brought to the interviewees, their thoughts can be divided into a short-term vision and a longer-term vision.

#### Short-term potential

First, the short-term in this case is defined as the 10 years ahead. This timeframe is considered as the short-term as the industry can't be considered being mobile and flexible, but it is rather capital-intensive. So, it requires more time to move in term of sustainable strategy. Still, every expert that has been interviewed has the same vision about CORSIA in this timeframe, they all believe CORSIA can't have any impact on the company's strategies or even in their decision making in regard with carbon reductions. The major reason for that is the price of the offsetting programs that will be too low to impact considerably a company.

Although the price of the carbon ton of offset can't be defined yet as the ICAO is still working on the eligibility criteria of the offsetting program, it is forecasted that the price of carbon compensation for CORSIA will be around 5-10$ according to Michel Adam (Appendix A.b.)

knowing that some programs could cost less than a dollar while others could reach 30 to 40$ the ton. According to Gilles Dufrasne from Carbon Market Watch, carbon offsets are likely to be on the cheap side of the IATA's predictions, around 5$ on average. (Appendix A.e.) According to a confidential research of Carbone 4, the price of one ton of carbon offsets should be around 200 to 300$ in order to induce an accelerated fleet lifecycle which is one of the main strategies for decarbonization. (Appendix A.c.)

As an example, Nicolas Desimpel from ASL Airlines shared some figures about their compensation obligations. (Appendix A.d.) According to the CORSIA's scope, ASL has emitted 750 000tons of carbon in 2019. However, only a share of them has to be compensated for depending on the baseline and other sectoral and individual repartition. This repartition has not been made clear by the IATA according to Mr. Desimpel. In the assumption of a rough 10% growth of the industry above the baseline, and a cost of carbon offset at 5$/ton, CORSIA would result in a 375k$ financial charge per year. This figure, compared to the yearly revenues of the company of 583,32M$ is not substantial and is certainly not enough to reshape the business model of the company.

The industry representatives in the interview sample like IATA or United Airlines defend CORSIA and its inability to induce change by saying that it is not its purpose. (Appendix A.b.; Appendix A.f.) Aaron Robinson from United Airlines goes even further by stating that the market will, hopefully, evolve in such a way that green technologies will become economically advantageous.

The NGO's are questioning the relevance of CORSIA's objectives in this regard. As CORSIA is the only tool that has been set in order to tackle carbon emissions, NGO's ask for a more ambitious program. Gilles Dufrasne highlights the lack of ambition through three different aspects: (Appendix A.e.)

- CORSIA's scope is only the growth of aviation's emissions over the average of 2019-2020 level's (might be changed, see next section) which means that it covers only roughly 10% of the emissions.
- CORSIA's scope covers only international flights, which is in fact only 60% of the traffic, the rest being national flights in countries such as the US, China, …
- Compensation of carbon doesn't necessarily mean reduction of Carbon depending on how the money is invested.

This also raises another questioning for the future where CORSIA has an opposite effect, instead of driving the industry towards greener and cleaner operations, it can also be used as a way to escape carbon reductions while benefiting from a green image through offsets. That pervert effect is made possible as it is relatively cheap to become "carbon neutral" for a company by using offsetting programs. An illustration is EasyJet, as mentioned by Nicolas Meunier, which goes far further than CORSIA and has spent around 30M$ on offsetting for their image and their conscience. (Appendix A.c.) Although the idea of offsetting carbon is good, the long-term goal should remain to reduce the emissions within the industry rather than using offsets, and that is also the message of the IATA. (Appendix A.b.)

**Long-term potential**

First, it is important to remind that CORSIA is supposed to be in place until 2035, after that, the program is not supposed to be required as the industry's emissions should be below the baseline as to reach the 2050's objective. However, Michel Adam has admitted that an extension of the program was likely to happen, that the limit of 2035 was rather a political arrangement. (Appendix A.b.)

In terms of potential for CORSIA in the long term, the opinions are divergent. On one hand, Michel Adam is pretty optimistic it will become an incentive tool, whereas the NGO representatives are rather pessimistic.

Michel Adam bases his optimism on two convergent factors. (Appendix A.b.) Both are simple concept in traditional economy. First, the competition on the offsetting market should become denser in the future as the demand will soar. This due to the offsets becoming mandatory in the aviation sector but also as similar norms are likely to push the maritime sector and even countries to buy offsets. And a growth in demand with a stable supply, or maybe even a rarefaction of supply, is likely to drive the price of carbon compensation upwards. On the other side, on the development of new technologies and operational models, the improvements are likely to be reducing the cost for airlines to adopt the carbon mitigation actions. Those two converging forces are, according to the IATA, going to drive the aviation towards change. This vision of the IATA for the long term of CORSIA also appears in their communication, as they used in their latest articles this sentence: *"CORSIA is a critical step towards achieving the industry's long-term strategy to address climate change by reducing its carbon emissions."* (IATA, 2020f)

On the side of the NGO's, those two factors are not seen the same way. The major critic relies on the competition effect on the offsetting market. Indeed, according to Gilles Dufrasne, the supply of carbon compensation programs is likely to be 3 to 5 times superior to the demand during the pilot phase. Furthermore, the eligibility of such programs can be reevaluated over the time, which means that in case of a shortcoming in the supply of such programs, the ICAO is likely to broaden their criteria and soften the competition. (Appendix A.e.) This argument is plausible as both Aaron Robinson from United Airlines and Nicolas Desimpel from ASL Airlines have mentioned during the interviews being constantly contacted by carbon offsetting companies to propose their products, this is not a sign of competitive market on the demand side. Maybe that will change in the future, but the dynamic will have to radically change on that market.

### *b. CORSIA's baseline modification*

ICAO has modified the baseline which define the amount of carbon to be compensated from the average level 2019-2020 towards a 2019 only baseline. This decision has been taken in order to *"avoid inappropriate economic burden on the aviation industry".* (ICAO, 2020f) This decision is supported by a majority of actors around the industry, IATA was strongly supporting this modification (IATA, 2020f), the political world supported it as well. (GreenAir, 2020) The interviews were made before the decision was officially published; therefore, the experts gave their opinions on whether or not the baseline should have been changed or not.

Most of the interviewees believed that this change was completely logical. Nicolas Desimpel from ASL Airlines argued that it was unfair not to do so as the former baseline would have been similar to 2014 levels, which means that six years of growth would have been forgotten. (Appendix A.d.) Aaron Robinson has an even more critical regard. Indeed, as CORSIA's goal was to cap the aviation emissions at the forecasted level of 2019-2020, CORSIA has reached its goal in a certain way. (Appendix A.f.) These answers come with the fact that most likely, companies won't have to pay for CORSIA during the pilot phase as the activity levels are not expected to go above the 2019 levels so quickly. There is a last official argument that was not raised during the interviews but that has to be mentioned, the financial burden that CORSIA would have represented could have impacted its support among countries. (GreenAir, 2020)

Still, this decision was not supported by everyone, and especially by NGO's. Indeed, Gilles Dufrasne is criticizing the industry as they use the coronavirus crisis to soften a program that is

already not too ambitious. (Appendix A.e.) Furthermore, the aviation sector has received a lot of support from governments to get out of the crisis, without having to commit to environmental targets, it is a very easy way out for companies. (Appendix A.e.)

### *c. CORSIA & EU ETS co-existence*

From 2021, both the CORSIA program and the EU ETS will be applicable for the aviation sector in Europe. The way those two programs will co-exist has not been detailed yet, the European Commission still has to statue on it. (European Commission, 2020b) In the meantime, the different actors in the industry do not agree on the way it should be combined.

On one side, the IATA which is backed by the companies claims that the international aviation should be exempted of EU ETS in order to focus on a single regulation and avoid overlapping measures. (Appendix A.b., Appendix A.d., Appendix A.e.)

On the other side, Carbon Market Watch and Carbone 4 are in favor of maintaining the EU ETS in place and to work on a feasible way to merge those two programs in Europe. (Appendix A.c., Appendix A.e.) In fact, both of them agree that CORSIA's ambition is not aligned with the objectives of the European Union. Consequently, the EU can't afford to exempt the aviation from its EU ETS, even more, the EU should review the way they assign carbon credits in order to increase the pressure on industries to reach the Union's environmental goals. (Appendix A.e.)

Nicolas Meunier from Carbone 4 reflected on the control implications this decision had. Indeed, the ICAO is a lot influenced by the IATA, which means that to a certain extent, the IATA controls the CORSIA program. If the EU decided to leave the aviation out of the ETS scheme, that would imply that the aviation would be solely regulated by one scheme, controlled in fact by the industry itself. (Appendix A.c.) Additionally, such an act by the EU would send the message to the industry that the economical perspectives are more important than the environment. For all these reasons, the EU are unlikely to abandon aviation in their EU ETS program.

### *d. Outlook for the 2050's industry goals*

As a reminder, the 2050 goals of the aviation have been set by the ATAG (2019), they are not officially shared by the ICAO but most of the companies as well as the IATA have affirmed their intention on reaching it. (IATA, 2020g) This is the most ambitious goal of the industry, to halve the emissions in 2050 compared to the 2005 levels.

In reality, most of aviation expert agrees to say that it is going to be very difficult to achieve this goal, even an IATA representative, Michel Adam, admits that most likely the industry won't meet the objective. (Appendix A.b.) The position of the IATA is that the level of activity in the sector shouldn't be impacted by environmental constraints. In that regard, if new technologies and especially SAF (sustainable alternative fuels) are not mature enough to supply the industry on a global scale, then the only way forward will be to use compensation schemes such as CORSIA which might be revisited to meet the expectations at that time. Aaron Robinson, although admitting that this objective is extremely ambitious, believes that the free market will act in such a way that an exponential growth of SAF is likely to happen before 2050. (Appendix A.f.) In the case it doesn't happen that way, using offsets is still a good solution as he considers it to be similar to a reduction in carbon emissions.

In the opinion of Carbone 4, the main reason preventing the aviation to reach the objective is the lack of a plan to reach it. (Appendix A.c.) Indeed, as mentioned above, the success or failure of the industry relies in the penetration rate of SAFs on the market, which actors hope will be sufficient. But there is no concrete plan behind that to make sure the industry gets there. The reason for this lack of plan is, according to a confidential study of Carbone 4, that the objective is impossible to reach with the current growth levels of the activity in aviation (before coronavirus crisis), and the IATA doesn't want to hear about a plan which might constrain the activity level.

# IV. Conclusion & Discussion

## A. Conclusion

This last section attempts to answer the research question while keeping an open and skeptic view about the result of the research. It is divided into two parts, a short-term vision as well as a long-term one, and confronts the results of the interviews with some theoretical concepts.

### Short-term

The theory and the field reality are answering the question in the same direction: CORSIA is unlikely to change or impact the industry in such a way that would drive companies towards more sustainable alternatives, in the short term. That for multiple reasons.

First, it doesn't cover the entirety of the world aviation activity but only a share of a share. Indeed, CORSIA covers the international flights only, exempting the domestic part of flights which are subject to domestic laws, and it covers only the residual part of carbon emissions which are above the baseline. This means that the amount of offsetting required for companies will remain low, especially due to the coronavirus hit in the activity level and the baseline change which might cancel any offsetting requirements in the first 2 to 3 years.

Secondly, as mentioned above, this baseline has been changed from a 2019-2020 average level towards a 2019 level, in order to avoid unreasonable costs for companies. This will have as a result that the companies are likely to have no offsetting obligations before 2023 according to IATA, as the level of activities is not expected to surpass the 2019 level before that time.

Lastly, as we mentioned in the background review, the possible alternatives available for the industry are still much more expensive compared to the traditional activities, and the cost of CORSIA is not going to be big enough to fill this gap and make the alternatives financially attractive. This is something that the NGO's and environmental specialists find unfortunate, suggesting that the price of CORSIA should be much more ambitious.

### Long-term

This section is more inclined to debate and opposing views. Indeed, the CORSIA program could lead the aviation industry, including the cargo industry, towards sustainable solutions in the long run. The decisive factor is the future price of the ton of carbon on voluntary markets.

Where the papers about carbon markets forecasted the price of carbon to be likely to raise in the future, which is a view also supported by the industry actors interviewed, this fact has to be mitigated.

Indeed, some scenarios, mainly put forward by NGO representatives, are indicating that the price of the carbon ton is not likely to raise, but rather to stabilize at its current level. Two aspects have to be analyzed in order to understand the factors determining the future price of carbon offsets, the evolution of the demand and of the supply.

On the side of the demand, the industries are working towards achieving carbon performance inside their own industry, by doing real carbon reduction rather than compensation. This because most countries are likely to become more demanding in their domestic economies in term of carbon emissions in the future. If that scenario looks plausible, that would reduce the demand for compensation programs, as those won't be needed as much as today. The view of the IATA is rather to say that industries and countries are going to use more and more offsets as their objectives will be reviewed towards more ambitious ones. Those are two opposing views, having an opposing effect on the demand for carbon offsets.

Regarding the supply of offsets, the quantity of available programs is largely influenced by the eligibility criteria of ICAO, if those are strict it could reduce considerably the availability, and vice versa. In the near term, the supply is going to be way larger than the demand, especially due to the low demand induced by the coronavirus and the baseline change. In the future, the availability of such programs might become scarcer, according to Michel Adam. However, the ICAO is the one deciding on the eligibility criteria, while having as mission to sustain the growth of aviation. Based on that, it is up to discussion whether ICAO would let the carbon price raise without changing their eligibility criteria. Based on the way they have handled the CORSIA baseline, by changing it because it could harm the industry, nothing prevents them from acting the same way if the carbon market is impacting the industry consequently.

**Discussion**

Based on that, it is impossible to predict how the price of carbon will evolve but it is unlikely to be such as it would really make an impact on the industry. Therefore, the industry has adopted a position of waiting for economically sustainable alternatives to come up in order to reach their objectives, while continuing on using compensation to fill the gaps until then. Air Cargo is likely to be adapting those new technologies after the passenger segment, as it is already the

case nowadays. Indeed, those technologies are penetrating the passenger segment before the cargo as the demand/customer is more sensitive to carbon emissions and other improvements in term of security, compared to the cargo sector as the clients are companies and the emissions from their air transportation are usually only included in their second or third scope. Therefore, the odds that the Air Cargo reaches the 2050's objectives are close to zero.

With the coronavirus, the air cargo industry has shown the world the importance they can have in the society. By transporting masks and medicine between continents and countries to help slow down the virus, they showed themselves to be useful for the social well-being. This importance might help the Cargo industry in future argumentation if some new taxes were to be proposed by local governments. For example, in 2019, the Netherlands proposed to establish a tax on freight ton, similar to a tax on passenger, which encountered a lot of discussions. In order to avoid this taxation, IATA has regained some leverage. This tax is something that can significantly impact the companies, as mentioned by Michel Adam, that is something that the IATA is trying to prevent.

Furthermore, the air cargo companies, which have been continuing their activities during the crisis on a similar level, or at least a reasonable level, are going to be exempted from offsetting obligations as the baseline has been changed. In this way, the air cargo companies are benefiting from the situation.

The last discussion point is the feasibility of reaching an international agreement that would harm companies. Those companies being important for their home countries revenue, it looks unrealistic that this country in particular would agree to such terms. A program such as CORSIA which is not going to harm the companies as demonstrated in this paper has already taken 10 years for being developed. Therefore, it sounds close from being impossible to reach an international agreement with more ambitions. In this regard, the solution probably relies in domestic regulation such as the tax on freight tonnage or on kerosene. It is up to the countries as individual actors to decide how they want to balance economic revenues from aviation with carbon reduction goals.

## B. Limitations

### *a. Size of sample*

According to Miles & Huberman (2014), a qualitative research can be valuable from 5 interviews if those are relevant. This study is therefore at the limit. Still, the expertise and the heterogeneity between the interviewees are two factors participating to the value of this research. However, one could argue that the limitation in numbers can be restraining for the generalization possibilities of this paper.

In order to comply with the quality expectations, only the formal interviews have been cited in this paper and transcribed in the appendixes. However, a lot of small discussions with other experts have been conducted and have helped the elaboration of the interview guide as well as to build the theorical background of the industry. For example, a complete interview with a representative from the Belgian transport and mobility ministry has been performed, but not retained in this research as the discussion was not adding value to the content itself, while helping to confirm the theory and background of the paper.

### *b. Coronavirus disruption*

The Coronavirus crisis has exploded in the middle of this research. Although this has opened some discussion points such as the baseline change, it also gave a convenient way out to airlines when discussing the carbon reduction topics. This way out can be judged as too easy by some parties such as NGO's, or legitimate for other parties in the industry. Still, this has definitely impacted this research.

Furthermore, one could expect that the industry experts would be more accessible in those times due to the slow-down of activities. It was not the case. Indeed, in most of the companies, a share of the employees was temporarily fired, and another share was overloaded with the trouble caused by the crisis. Logically, the employees that were set aside were not enthusiastic about helping the company that just laid them off, while the other share had no time to spend on extra activities such as research. This situation caused an additional difficulty to reach the relevant people.

### *c. Narrow focus on Carbon Reduction*

This paper studies the impact of CORSIA on carbon emissions, and it is restricted to this area. In reality, the aviation sector is not limited to that, but it includes a lot of safety concerns as well as noise problems. On the positive side, it supports economies by connecting the world and by providing jobs. Therefore, another limit of this paper is its focus on the carbon emissions rather than on every other Sustainable development goal (SDG) that the aviation might influence.

This can be illustrated with an example out of the coronavirus crisis. Indeed, the companies are having to lay off thousands of employees and this is causing a real damage in the society. It proves the positive impact that airlines currently bring to the society, and it puts in perspective the priorities between climate and social.

## C. Further Research

### *a. Generalization to passenger segment*

This research was launched to focus on the air cargo segment for two main reasons. Thanks to the researcher's situation, the air cargo segment was more accessible in terms of professional network. Furthermore, focusing on one segment allowed for a better precision in the outcomes of the research.

Although some differences might be addressed if this study was focused towards the passenger segment, the main outcomes are likely to be similar as the CORSIA program is affecting both segments the same way. The main differences between the sector relies in financial capacities of large airlines as well as the mediatization of that segment which is far more important compared to the cargo side. This mediatization drives countries to be more active on this segment, as showed by the difference between the amount of existing passenger taxes and existing freight ton taxes.

### *b. Generalization to industry decarbonization ambition*

The discussion section has suggested that the lack of ambition of CORSIA is reflecting a lack of ambition is the industry overall. However, it could be interesting and relevant to research the extent to which this affirmation is correct.

Also, there could be a work of quantification for the domestic taxes. One downside of domestic taxes that has been highlighted is it lack of a precise objective compared to a program such as CORSIA. In this regard, researchers could study the impact of such domestic taxes on the industry, in order to inform countries on their possible tools and their impacts.

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# VI. Appendix

## A. Interviews

### *a. Interview guides*

**Interview Nicolas Meunier (Carbone 4) :**

*Introduction :*

Qui es-tu ? Ton expérience ?

*Future de l'industrie air Cargo ?*

Selon les constructeurs, les opérateurs et les grosses boites de consultance, l'industrie du transport aérien de marchandise devrait continuer de grandir de l'ordre des 4% dans la prochaine décennie. Penses-tu que cela est plausible ?

Si c'est plausible, est-ce pour autant désirable ?

Si ce n'est pas plausible, quel futur prédis-tu pour l'industrie ?

*Effet de CORSIA ?*

La mise en effet de CORSIA dans les prochaines années va demander du reporting et du carbone offsetting de la part des compagnies aériennes. Mais est-ce que cela va entrainer une réelle réduction en émissions dans l'industrie du transport aérien ? Et dans le CARGO ? Quel est ton avis ?

Dans l'industrie CARGO, il y a un mix dans la flotte entre avions pax convertis et avion neuf « freighter ». Penses-tu que cet équilibre puisse être bouleversé par CORSIA ?

De manière plus large, penses-tu que le marché des avions est structuré d'une manière optimale en termes de réduction d'émissions ? Ou est-ce que ce marché a tendance à freiner les réductions d'émissions ? Une piste pourrait être d'investir plus dans la productivité du recyclage des avions, pour « circulariser » ce marché ?

Concernant les SAF, la plupart des entreprises sont super optimistes quant à leur potentiel, alors que certains articles plus scientifiques ne le sont pas tellement (principalement dû aux méthodes

de production). Que penses-tu du potentiel de ces fuels alternatifs ? Est-ce que CORSIA pourrait accélérer le développement de ces carburants ?

Que penses-tu des marchés de Carbone offsetting ? Comment vois-tu l'évolution de ces marchés et leurs implications pour les compagnies ? Penses-tu qu'une « taxe carbone » aurait été plus efficace ?

*Autres contacts dans l'industrie ?*

Dans le transport aérien de marchandise ?

Dans le fuel et fuel alternatif ?

Chez les constructeurs ? Airbus ?

**Interview Michel Adam (IATA):**

*Control of IATA on ICAO:*

What was the role of the IATA in the creation of the CORSIA program by the ICAO?

*Efficiency of CORSIA?*

What is the main goal of CORSIA?

How do you see this program impacting the companies? Is this program going to help companies to reach the 2050 goal?

How do you see this impact evaluate in the long term? After 2030?

What was the reaction of the IATA when CORSIA was launched?

How do IATA see the cooperation between EU ETS and CORSIA?

*Contacts ICAO?*

**Interview Nicolas Desimpel (ASL) :**

*Effet de CORSIA ?*

Faites-vous partie de la phase pilote de 2021 à 2023 ?

Qu'est-ce que représente CORSIA pour vous ? Pensez-vous que CORSIA va avoir un réel impact sur la réduction des émissions dans l'industrie ? Plutôt qu'une porte de sortie pour éviter d'investir dans des nouvelles technologies ?

En termes de coût, avez-vous une estimation de la barrière à atteindre avant que CORSIA ait un impact incitatif ? (+preuve ?)

Que prévoyez par rapport à la coexistence de ETS et CORSIA ? Anticipez-vous une augmentation de ce prix du Carbone sur le marché ?

Vers ou cette incitation vous pousserait-elle ? Accélération de la flotte ? Utilisations de SAF ?

**Interview Gilles Dufrane (Carbon Market Watch) :**

*Introduction :*

Qui es-tu ? Ton expérience ?

*CORSIA :*

Quelle est votre vision par rapports aux objectifs de CORSIA sur le court et moyen terme ? Est-ce que CORSIA pourrait avoir un effet incitatif dans ce court/moyen terme ?

J'ai lu que vous aviez un rôle dans la sélection des programmes d'offsetts éligible ? Quels sont vos critères ? Comment voyez-vous le marché des carbones offsetting évoluer ? Que pensez-vous de ces marchés en général comme outil a la décarbonisation ?

Post-Corona : Comment pensez-vous que l'ICAO doit adapter son programme ? Changer la base de 2020 à 2019 ? Conserver 2020 malgré la situation en sachant que le trafic ne va probablement pas reprendre ses niveaux de 2019 de toute manière ?

*Contrôle et intérêt :*

Selon mes connaissances actuelles, j'ai pu comprendre que l'IATA joue un rôle majeur dans la mise en place de CORSIA. Que pensez-vous du conflit d'intérêt entre le 'environnemental' et l'aspect croissance des activités recherché par l'IATA ?

**Interview Aaron Robinson (United Airlines) :**

*Introduction:*

Who are you and what are your responsibilities within United?

*CORSIA:*

What is your global opinion about this program?

What is your opinion about offsetting programs? How will United approach their offsetting requirements?

What do you think about the CORSIA baseline modification?

How do you see ETS and CORSIA live together?

Do you believe such a scheme could in the mid-term accelerate the shift towards alternative fuels and other green solutions?

### *b. Interview IATA : Michel Adam.*

Senior Manager chez IATA, responsable programme CORSIA.

*Ma première question concerne le contrôle de L'IATA sur l'ICAO, lorsque l'ICAO a lancé son programme, quel a été le rôle de l'IATA ?*

Pour reprendre un peu les différentes étapes, il y a d'abord un travail au niveau plus politique qui était d'avoir un accord au sein de l'ICAO, au niveau de l'assemblée de l'ICAO. C'est typiquement l'assemblée qui a adopté les objectifs climatiques de l'ICAO, le but c'était de s'assurer qu'il y ait finalement un accord à ce niveau-là d'abord sur l'introduction d'une mesure basée sur le marché. Nous, au niveau de l'assemblée on n'a pas un rôle… L'IATA a un rôle d'observateur, en général à l'ICAO. Ça va plus être un travail de discussions avec les différents états afin d'assurer qu'ils soutiennent l'idée, et que leurs positions ne soient pas trop différentes des perspectives d'industrie. Notre rôle vu que l'industrie avait adopté des objectifs climatiques avant l'ICAO, était plus un rôle de moteur pour s'assurer que les états parviennent à un accord. Et que dans cet accord, certain des paramètres qui ont été assemblés au niveau de l'assemblée soit des paramètres qui fonctionnent pour l'industrie, les discussions que nous avons eu de notre côté étaient beaucoup sur la différence entre le composant individuel et sectoriel dans le calcul des obligations de compensations. Nous notre préoccupation c'était de s'assurer qu'il y ait un

« level playing field », sans distorsions de marché entre les différentes régions et ainsi de suite. Au niveau de l'assemblée, c'était le rôle de l'IATA. Et ensuite, au niveau plus technique on a un rôle qui est un peu plus important au niveau du CAPE. Ou là on a une fonction d'observateur. Je repars un petit peu en arrière. Ce qui arrive normalement pour l'élaboration de normes internationales, c'est que l'assemblée va prendre un accord de principe au niveau politique qui demande au conseil de l'OACI d'adopter des normes internationales, de réglementer la question en particulier. Donc par exemple, l'assemblée a décidé de mettre en place une mesure basée sur le marché, CORSIA, en demandant au conseil d'élaborer des normes internationales pour sa mise en place. Donc le conseil est l'organe de l'ICAO qui a cette fonction on va dire de règlementaire. Les membres de ce conseil sont essentiellement des représentants politiques, qui ne sont pas experts techniques, il y a donc besoin d'un comité technique dans le CAPE pour les questions environnementales. Et au sein du CAPE, on a un rôle plus important, les membres restent uniquement des états, des représentants politiques, mais l'IATA est aussi représenté par un groupe d'expert, d'autres acteurs sont aussi représentés tel que des ONG. C'est vraiment au sein de ce groupe d'experts que les détails techniques sont élaborés. Donc toutes l'annexe 16 qui contient les règles a été élaboré à ce niveau-là, c'est vrai que là on a peut-être un rôle qui est plus actif pour s'assurer que ces règles fonctionnent dans la pratique.

*En résumé, c'est l'ICAO avec les membres d'états qui ont décidé de faire une mesure market-based ; et après le conseil, là où l'IATA est plus présente, a décidé des détails techniques d'implémentation ?*

Voilà, oui.

*La suite, quelle est vraiment le but de CORSIA dans les 10-15 prochaines années ?*

La discussion a pris une tournure un peu inattendue avec la crise, on pourrait avoir une situation, ça dépend beaucoup de la rapidité de la reprise du trafic, finalement ou les émissions du secteur pourraient rester en dessous des émissions de base. Cela a un peu mis en accent finalement le rôle de CORSIA qui est presque un rôle secondaire. La vision peut-être un peu différente si vous parlez à l'industrie, aux états, ou aux ONG, vous n'aurez pas forcément la même réponse. Les états et l'industrie quand CORSIA a été adopté sont vraiment partis du principe que CORSIA jouait un rôle de complément. C'est à dire que si l'aviation est capable de stabiliser ses émissions au niveau de 2020, en tout cas c'était l'idée avant, CORSIA finalement aurait pas eu besoin d'être là. CORSIA a besoin d'être là à partir du principe ou l'on estime que les

émissions vont croitre encore après 2020. Il faut donc pouvoir s'assurer qu'il y ait une compensation de la croissance. Mais l'idée est vraiment que l'aviation devrait réduire ses émissions par le biais de la technologie et mesures d'exploitations. Et c'est que si cet objectif ne peut pas être atteint avec ces mesures que CORSIA arrive, pour régler la différence.

*Vous ne pensez pas que CORSIA puisse jouer un rôle incitateur vers ces nouvelles technologies, et mesures semblables ?*

Alors, ça c'est évidemment l'autre vision de CORSIA, qui est évidemment plus la vision qui sera mise en avant par les ONG. Ou le but de CORSIA est plus un mécanisme d'internalisation des couts, pour créer un mécanisme d'incitation qui mets un cout sur le Carbone et donc pousse aux améliorations. Il y a du vrai dedans, et là ou moi, comme vision personnelle, l'aspect qui est un peu différent dans le secteur, bon là la situation est un peu chamboulée, mais le cout du kérosène a toujours créé finalement une incitation forte pour réduire la consommation de kérosène, et cela a un impact direct sur les émissions. Donc il y a toujours eu cette incitation très forte. Et si on compare les couts CORSIA au cout du kérosène, j'avais fait un calcul l'année dernière donc je pense qu'il ne tient plus la route, mais avec le prix du kérosène à ce moment-là, émettre une tonne de CO2 c'était équivalent à bruler 300$ de kérosène. Donc émettre une tonne de CO2 coutait 300$ de kérosène aux compagnies aériennes donc comparé aux quelques dollars que coute la compensation de CO2 par le biais de CORSIA, ça ne représente pas grand-chose. CORSIA va ajouter un élément dans les considérations, mais ce ne sera pas l'élément prépondérant. Mais effectivement, en tant que mesure basée sur le marché, elle a un rôle d'incitation.

*Est-ce que la possibilité que les états commencent à taxer le kérosène, c'est quelque chose que vous entrevoyez, ou pas du tout ?*

De nouveau, la situation a un peu été chamboulé ce dernier mois. Si on se remets il y a quelques mois, on voyait qu'il y avait beaucoup d'états, essentiellement en Europe, qui effectivement allaient dans l'optique qu'une imposition du kérosène est nécessaire. On était finalement dans une discussion de gestion de la demande, on a eu beaucoup d'états qui ont voulu introduire des taxes sur les billets afin d'éviter la croissance du secteur. Sur un plan d'efficacité purement environnementale, alors pour moi les taxes sur les passagers je peine a voir l'utilité. Je quitte un peu mon rôle de l'IATA pour regarder ça d'un angle un petit plus objectif. On a vu que les taxes sur les passagers en général elles n'ont pas beaucoup d'effet, elles peuvent réduire la

demande significativement si elles sont fixées à un niveau suffisamment élevé, mais la plupart des taxes qui ont été introduites par les états n'ont quasiment pas d'effets, quand on voit la France a augmenté leur taxe de solidarité, les Pays-Bas voulaient introduire une taxe également. Mais ce sont des montants qui sont trop bas que pour avoir un effet incitatif. Le montant doit dissuader les gens de voyager, la situation qu'on avait en suisse, ou avant la crise on avait une discussion pour introduire une taxe sur les passagers, mais en Suisse pour qu'elle soit légale la taxe doit être suffisamment haute pour avoir un effet mesurable sur le trafic. C'est à dire qu'en Suisse on ne parlait pas d'une taxe de 7€ comme aux pays bas ou en France, mais le montant minimum était de 30€ jusqu'à 120€. Ce sont des montants qui sont complètement différents mais là effectivement on aura un impact sur le trafic. Le problème sur un plan environnemental, c'est que si on regarde la perspective d'une compagnie aérienne, qu'elle utilise un B-787 ou un B-767 pour transporter ses 250 passagers, le cout de la taxe sera identique. C'est le nombre de passager qui compte dans la détermination du montant. Que l'avion pollue plus ou moins, cela ne change rien. L'avantage d'une taxe sur le kérosène, c'est que là il y a un intérêt de réduire la consommation kérosène et donc les émissions. Donc la taxe kérosène est plus efficace sur un plan environnemental. Maintenant le problème des taxes, c'est que c'est impossible de fixer un objectif environnemental, de réduction du CO2, en fixant une taxe, on fixe un montant en espérant que cela ait un impact de plus ou moins 10%, mais contrairement à un mécanisme comme EU ETS ou CORSIA, il n'y a pas d'objectif quantitatif qui est fixé. EU ETS, les émissions de l'aviation doivent être plafonnées a 95% des émissions historiques de la moyenne entre 2004 2005 et 2006. Il y a une ligne qui est tracée. CORSIA on était parti sur la moyenne 2019-2020, la ligne est tracée. Si on prend une taxe sur le kérosène, on fixe un montant mais on n'a pas de garantie que finalement l'objectif soit atteint. Sur un plan environnemental les mécanismes un peu plus intelligents type cap and trade et offsetting permettent finalement de mieux mesurer l'impact environnemental.

*Quel va être le rôle de CORSIA par rapport à l'objectif de diminution de 50% des émissions en 2050 par rapport à 2005 ?*

Tout à fait, à un moment la pente doit diminuer, s'incliner vers le bas. Il est difficile d'envisager quelles technologies seront disponibles, l'idée reste de mette la priorité sur les technologies pour réduire les émissions, mais tout le monde sera d'accord que la technologie seule ne sera pas suffisante. La perspective de l'industrie (là il y aura probablement une divergence de perspective avec d'autres acteurs), de notre côté l'objectif c'est d'atteindre cette réduction sans couper les activités du secteur, la ou les ONG diraient qu'il est possible d'y arriver qu'en

diminuant les activités, la question est de déterminer avec quoi on va réussir à réduire les émissions du secteur en 2050 jusqu'à arriver à 325millions de tonnes. Probablement qu'une grosse partie de la tache reposera sur les carburants alternatifs, mais effectivement la compensation CO2 type CORSIA gardera un rôle dans le long terme. La technologie ne sera pas suffisante à mon avis, donc CORSIA continuera à jouer un rôle de compensation.

*CORSIA dans le long-terme, est ce que le cout de compensation de Carbone est supposé monter ? Potentiel d'augmentation ?*

Deux choses, la première c'est que CORSIA officiellement est censé s'arrêter en 2035. Ça c'était ce qui a été décidé par l'assemblée, maintenant probablement qu'il y aura une prolongation ou quelque chose de similaire, l'accord politique nécessitait de mettre un terme. Même si on regarde juste à l'échéance de 2035, sur les 15prochaines années, et c'est aussi un peu le concept derrière ce système, c'est qu'on aura effectivement sur toutes les unités qui vont être utilisées par les compagnies aériennes pour remplir leurs obligations, ce sera des unités qui pourront aussi être achetées par d'autres secteurs. Les compagnies aériennes seront en concurrence avec les états, avec le secteur maritime, avec les entreprises qui eux aussi ont des obligations ou des engagements pour réduire leurs émissions. Et beaucoup vont se diriger vers les offsets pour ça. On aura donc inévitablement une raréfaction de ces offsets qui va entrainer une augmentation des couts des unités, et le système doit être tel, et c'est tout l'intérêt du mécanisme, c'est qu'un jour, le cout des unités de compensation sera tel que pour un acteur économique, il deviendra plus intéressant de réduire ses propres émissions. Le secteur aérien en est maintenant à un stade où c'est moins cher de payer un offset que d'investir dans des carburants alternatifs pour réduire ses émissions, ou d'installer des wing-lets sur tous ses avions ou de prendre d'autres mesures. A partir du moment où le cout des offsets va augmenter, l'équation économique va être modifiée et on va arriver un jour ou finalement ce sera plus intéressant d'investir dans les carburants alternatifs car ce sera moins cher que de payer de l'offset, ou ce sera moins cher d'accélérer le renouvellement de la flotte plutôt que de payer des offsets. On aura probablement à un moment, un retournement ou pour le secteur économiquement ce sera plus intéressant d'accélérer les mesures internes plutôt que d'utiliser les réductions externes. On est maintenant au début, le cout de CORSIA ne sera pas suffisant pour créer ce mécanisme d'incitation, mais dans le futur probablement que la situation va s'inverser.

*Quel est le potentiel des marchés de compensation ? En termes d'évolution de prix ?*

Nous aussi on a de la peine d'avoir des sources qui donnent un ordre de grandeur, on a utilisé (et l'ICAO a utilisé) dans toutes ses études d'impact des projections de l'agence de l'énergie internationale, qui prévoyait un cout du carbone a 8$ en 2020 augmentant jusqu'à 20$ en 2035. Et l'estimation supérieur est de 20$ en 2020 et 40$ en 2035. Les couts étaient les projections pour les mécanismes obligatoires style EU ETS, mais pas forcément du marché volontaire comme les offsets qui sont très utilisés. Maintenant on voit que sur les mécanismes obligatoires on n'est pas loin de 20$, c'est le cas d'EU ETS, pour les compensations volontaires on est en dessous de 8$. De nouveau cela dépendra beaucoup de quel crédit et quelle compensation on utilise, certaines vont être en dessous d'1$ ou d'autres seront à 15 ou 20$. Il y a une grande marge finalement entre les différents projets. L'ICAO a restreint le choix pour s'assurer qu'il y ait un minimum de qualité environnementale associé aux compensations utilisées par le secteur, mais de nouveau à ce stade-là, on n'a toujours pas de clarté sur le coup que ce sera même en 2021. Et probablement que ce sera très différent entre compagnies aériennes, ceux qui auront des meilleures stratégies d'achats auront des meilleurs prix, certaines vont viser les crédits les moins cher et voir CORSIA comme un mécanisme purement réglementaire ou il faut minimiser les couts. D'autres compagnies vont avoir une autre perspective sur CORSIA et les obligations de compensation en se disant, si en même temps je peux investir dans des projets qui sont dans mon pays, même plus cher ça a une valeur ajoutée par rapport à mes investissements, ma clientèle. Ils seront prêts à investir plus d'argents selon ces aspects. C'est très difficile de prévoir ou sera le prix du carbone dans 15ans.

*Quid de la coexistence entre EU ETS et CORSIA ?*

Nous on a une vision qui reste que l'aviation internationale doit être règlementée uniquement par le biais de CORSIA, ce que les états font pour l'aviation domestique est un autre problème. Notre position et notre interprétation de la résolution de l'assemblée a toujours été que les états membres de l'ICAO ont adoptés CORSIA comme l'unique mécanisme visant à réglementer les émissions de CO2 de l'aviation internationale, l'aviation domestique est sujette à l'accord de Paris et là c'est la discrétion des états de faire ce qu'ils veulent plus ou moins. Donc ça c'est la position officielle. On se rend compte que les institutions Européennes ont une vision un peu différente et ça dépends un peu de à qui on s'adresse. Le plus problématique est la situation qu'on a maintenant où les émissions couvertes par plusieurs règlementations. C'est à dire que si une compagnie aérienne émet 100 tonnes de CO2, ces 100 tonnes seront sujettes à CORSIA et à EU ETS, et je pense que c'est cette duplication qui est la plus problématique. Sur un plan légal, ce qui est très problématique c'est que même en restreignant EU ETS aux vols intra

européen, on reste avec une règlementation qui s'applique à des exploitants non-européen dans le cadre d'exploitations intra européenne. Là il y a un conflit de juridiction. La commission est censée arriver avec un rapport cette année, ce sera intéressant de voir quelle solution ils sont prêts à offrir, je pense que les débats vont être animés. Notre point de vue, et je sais que c'est le point de vue de pas mal d'états non-européen, CORSIA c'est l'aviation internationale et ensuite les états ont le champ libre pour leurs politiques nationales. Après, à ceci s'ajoute la discussion à savoir si les vols intra-européens sont des vols nationaux ou pas, on entend des acteurs européens qui tentent d'argumenter que ces vols intra sont des vols nationaux, mais sur un plan juridique c'est un peu difficile de soutenir cette approche.

*La clé de l'accord résidera dans le prix du carbone alors ?*

Effectivement, il faut voir aussi, et ça c'est un peu ma perspective cynique sur le monde, une des grosses différences entre EU ETS et CORSIA, c'est où va l'argent. CORSIA est un mécanisme dans lequel les compagnies vont payer directement, enfin il y aura des intermédiaires, mais où l'argent va dans des projets de compensation. EU ETS, c'est un mécanisme qui est plus administratif ou les unités qui sont utilisées par les différents acteurs pour se conformer ne sont finalement que des bons émis par des états mais ne correspondent pas forcement a une réduction d'une tonne de carbone. Par contre, ils génèrent des revenus pour les états, cet aspect-là aussi qu'il faut toujours garder en tête. Personnellement, je reste du point de vue qu'un mécanisme comme le EU ETS s'il est bien mis en place, c'est un mécanisme sur un plan environnemental qui est efficace, dans le domaine de l'aviation le problème est plutôt une question de juridiction et voir à qui on peut imposer le mécanisme. Il faut donc garder en tête qu'outre la considération environnementale pour l'Europe il y a une considération financière car EU ETS génère beaucoup de revenu pour les états, ils n'ont forcément pas envie d'abandonner ces revenus.

### *c. Interview Carbon4 : Nicolas Meunier.*

Consultant chez Carbon4, passif dans l'aéronautique : 4ans chez Air-France KLM dans le trafic passager.

*Il y a 3 grands piliers sur lesquels se basent les grands joueurs de l'industrie pour soutenir leur argument de croissance du marché. L'e-commerce la globalisation et l'importance des produits à haute valeur ajoutée. Est-ce quelque chose de plausible ?*

Globalement, si on suit les tendances historiques, le cargo ça ne va pas très bien, les 4% par an c'est plutôt pour le passager. Le cargo a tendance à stagner, et les chiffres de l'IATA ne sont pas non plus encourageants. Il n'y a donc pas de raison que cela change la tendance. D'un point de vue environnemental, ce qui est important dans l'industrie, c'est plutôt vu comme du green marketing pour se débarrasser de toute contrainte. Ce n'est pas de nature à perturber le marché du Cargo. A cela près que certaine compagnies cliente souhaitent changer certaines pratiques aussi pour des enjeux d'images. Ce qui devrait affecter la demande globale de manière minoritaire mais non négligeable.

*Et l'impact de la croissance du e-commerce ? Et l'impact du Coronavirus ?*

Ça ne représente pas une grande part selon moi de l'air fret. En général, on achète des produits qui sont à distance non aériennes qui peuvent être livrés par camion. Là où il va y avoir des livraisons par voie aériennes c'est plutôt sur le B2B, les gros industriels, qui eux pourraient solidifier leurs liens entre centres de distributions. Le coronavirus pourrait avoir un effet de relocalisation majeure, notamment sur les produits pharmaceutiques quand on voit que 80% des principes actifs sont produits en Inde ou en Chine, c'est assez gênant pour les US ou pour l'UE en pleine crise. Le développent du e-commerce ne devrait pas être bouleversant pour l'industrie, ce qui serait le cas d'une potentielle relocalisation de produits tels que le pharmaceutique. Étant donné que le CARGO transporte des produits a grande valeur ajoutée, c'est peut-être aussi les premières choses qui vont être relocalisées. « Si jamais pendant 3mois mon pays est bloqué et je n'ai plus accès à des machines à lavées, ce n'est pas bien grave, par contre pour des médicaments, je n'ai plus la barrière aérienne comme à présent. »

*Qu'est-ce que CORSIA ?*

Historiquement il y a eu le protocole de Kyoto, les COPS (« conference of parties », ou tous les pays se réunissent et décident ensemble des trajectoires et sur les accords pour limiter les gaz à effet de serre et l'impact sur climat au niveau mondial. Chacun contribue en fonction des NDC, national determined contribution, qui sont en place depuis les accords de Paris en 2015.) Il y a 2 secteurs qui échappent à ces NDC nationaux car en fait ils n'arrivent pas à être reliés à un pays en particulier, ce sont le transport aérien international et le transport maritime international, donc ça faisait 20 ans qu'ils passaient à chaque fois entre les mailles du filet parce que on ne savait pas trop comment les gérer, ce qui a commencé à agacer certaines personnes. Plutôt que de se voir imposer une réglementation extérieur par l'UE, les US ou encore l'ONU

que chacun déterminerait individuellement, l'OACI (=ICAO) a dit qu'ils allaient faire leur plan pour l'aviation internationale. Ils ont donc créé CORSIA en 2016. C'est un programme qui va de 2020 à 2035, ou l'idée c'est de compenser la croissance supplémentaire à partir de 2020 et par rapport à 2020, sous la forme de compensation carbone. Et donc, c'est quelque chose de petit voire inexistant par rapport à l'ensemble des enjeux de l'environnent et par rapport à l'ensemble des engagements de l'industrie. Le secteur aérien a défini l'objectif de diviser par 2 ses émissions en 2050 par rapport à 2005 et ce n'est pas dans CORSIA. C'est un engagement de forme oral qui n'a pas été écrit ni formalisé par l'ICAO, mais cet engagement-là est beaucoup plus fort que CORSIA, car dans CORSIA on ne parle même pas de réduction d'impact, on parle de compensation.

*Quid de cet accord de principe ?*

C'est un accord oral dans le sens où il n'a jamais été formalisé et ni ratifié par l'ICAO, mais tu peux le trouver dans n'importe quelle communication de compagnies, ou dans les factsheets de l'IATA. C'est quelque chose d'assez clair qu'ils n'ont pas intérêt dénoncer maintenant. Cet accord a été passé en 2009. Ils ont pris 3 engagements, qui ont été résumés par l'ATAG, qui est un groupe de lobby de l'IATA :

- Efficacité énergétique améliorée de 1,5% par an entre 2009 et 2020
- CORSIA
- Division par 2 des émissions en 2050 par rapport à 2005.

L'objectif 1 est réalisé sans problème, ce qu'ils savaient déjà en passant cet accord, avec l'arrivée des nouveaux avions. Il n'y avait pas de prise de risque car avec le « business-as-usual » ils le faisaient. Le deuxième c'est CORSIA, pas de prise de risque car ce n'est que de la compensation carbone, les compagnies ne doivent rien faire si ce n'est payer un peu plus. Et le troisième est une énorme prise de risque, par contre il n'y a pas du tout de trajectoire pour y arriver, et avec les taux de croissance actuels c'est même impossible. A Carbon4 on a démontré que c'était impossible. Mais comme c'est lointain, ils ont tendance à dire « on verra plus tard ».

*Pourquoi créer CORSIA, si cela ne va quand même rien changer ?*

Car ils ont la pression d'être un secteur qui passe entre les mailles du filet. Donc CORSIA leur permet d'avoir une mesure non-coercitive qui leur permet de maintenir leur activité sous la forme business as usual sans être imposé de normes environnementales plus contraignantes. Ils

gardent en fait le contrôle sur l'aspect environnemental. A titre d'exemple, l'UE a mis en place les quotas ETS, c'est un système d'échange de quotas pour les industries de l'énergie très carbonés, qui comprends les vols au sein de l'UE aussi. Ceux-là sont soumis aux quotas UE ETS, mais maintenant que CORSIA est mis en place, l'ICAO veut éviter que ces compagnies soient assujetties à une double réglementation. L'union européenne refuse pour l'instant car CORSIA est tellement peu ambitieux qu'ils préfèrent encore appliquer EU ETS plutôt que le programme de l'ICAO. Au départ, EU ETS devait s'appliquer à tous les vols internationaux, sauf que la Chine et les US ont fait pression pour l'empêcher. L'UE s'est donc restreint à l'espace Européen. Le mot final n'a pas encore été donné de la part de l'UE quant au futur de l'EU ETS pour l'aviation.

*Que faudrait-il faire pour rendre CORSIA plus ambitieux ?*

Il faudrait s'appliquer à changer le mode d'activité, les émissions du transport aérien. Pour atteindre un monde dé-carbonisé en 2050, il faut que tous les secteurs se dé-carbonisent, absolument tous ! En France, il y a la stratégie nationale bas carbone, et dedans on trouve que tous les secteurs doivent se « décarboner », chaque secteur a des objectifs extrêmement ambitieux. L'aviation, au travers de CORSIA elle dit : « moi je continue en ne faisant rien mais par contre je compense avec des crédits carbone dans un autre secteur », ce n'est pas possible car tous les secteurs doivent se décarboner ! Tout le monde doit faire sa part pour pouvoir vraiment avoir un plan ambitieux. Il y a 3 leviers possibles pour l'aviation, pour une diminution réelle des émissions :

- L'activité
- L'efficacité énergétique
- Le vecteur énergétique

L'activité c'est le taux de croissance, l'efficacité énergétique c'est essayer de consommer moins de kérosène par tonne kilomètre transportée, et le vecteur c'est changer le kérosène fossile. A court et moyen terme c'est développer des carburants qui sont durables, mais pas n'importe lesquels car les carburants à base d'huile de palme par exemple, sont sur leurs cycles totales encore plus émissifs en carbone que le kérosène fossile. Mais il y a des solutions durables qui peuvent permettre de réduire les émissions carbones.

Jusqu'à aujourd'hui, les entreprises ont raisonné de manière purement économique. Le secteur aéronautique est un des secteurs qui se développe les plus au niveau de l'efficacité énergétique,

beaucoup de R&D, etc. Par exemple, on pourrait renouveler encore plus rapidement les flottes d'avions, et arrêter d'utiliser certaines sortes d'avions qui économiquement ne sont pas encore tout à fait amortis, c'est possible mais là on sort du rentable économiquement, c'est l'étape d'au-dessus. Remplacer ses avions plus rapidement permet d'économiser encore plus de fuel même si économiquement ce n'est pas rentable.

*Est-ce que CORSIA pourrait diminuer cette barrière économique ?*

Non, c'est beaucoup trop faible. Aujourd'hui CORSIA ne sait pas encore exactement sur quel crédit carbone elle va s'appuyer, l'ICAO est actuellement en train d'étudier ça. Fin Mars, elle a sélectionné 11 programmes. Dans ces programmes-là, les crédits carbones sont des Euros par tonne de carbone évité et ça démarre à 2 – 3€ la tonne, alors que les crédits EU ETS c'est environ 25€ la tonne ce qui est déjà beaucoup plus important. Et si jamais on voulait faire un renouvèlement accéléré de la flotte, Carbon4 a calculé qu'il faudrait arriver à 200-300€ la tonne de carbone. Il y a une course aux compagnies qui se font neutre en carbone, qui a commencé avec Air France, qui a déclaré que tous ses vols domestiques seraient neutres en 2020, british Airways de même, et EasyJet a carrément dis « depuis novembre, on est neutre en carbone ». Ils font ça avec de la compensation. Ils vont beaucoup plus loin que CORSIA et dépensent 30 millions par an pour « se racheter une âme ».

*Est-ce que le prix de ces carbones off setting risque d'augmenter au vu de la forte croissance en demande ?*

Oui il risque d'augmenter un petit peu, mais pas de manière significative. Je sais que le marché a été sous pression, justement avec les récentes déclarations des compagnies à la fin de l'année dernière mais cela n'a pas fait exploser les prix. Étant donné que pour l'instant c'est principalement un enjeu d'image, dans le cas d'EasyJet par exemple, ils ont tout intérêt a se déclarer neutre en carbone si ça ne leur coute que 30million d'€ par an, si c'était plus cher ils ne consommeraient probablement pas autant de ces crédits… Toutes ces conventions carbones dans l'absolu c'est bien, je ne nie pas que c'est quelque chose de louable en soit, je dis juste que ce n'est pas du tout suffisant, et que ça ne doit pas permettre de pouvoir se dédouaner de faire des efforts conséquents sur la dé-carbonisation du secteur en absolu.

*Pourquoi ne pas simplement faire une taxe carbone plutôt qu'un programme d'off setting ?*

Pour les mêmes raisons qui ont poussé la création de CORSIA, le contrôle. CORSIA c'est les compagnies aériennes et l'ICAO qui le dirigent, contrôlent ce qu'elles doivent faire et comment. Après elles peuvent justifier auprès des états en disant « vous voyez on fait quelque chose ». Le degré d'ambition est fixé par l'ICAO, dans le cas d'une taxe carbone, ce degré d'ambition est fixé par l'état et peut être modifié à tout moment par celui-ci. Il y a la taxe sur le kérosène qui devient de plus en plus insistante, il y a 9 pays au sein de l'UE qui veulent la mettre en place. Elle pourrait être mise en place d'ici quelques années et elle pourrait impacter le trafic cargo. La taxe sur le kérosène est mieux qu'une taxe carbone car elle valorise les efforts qui sont faits au sein de l'efficacité énergétique. Si jamais un avion très léger ou très neuf vole pour 500 passagers, sa taxe kérosène sera plus faible qu'un plus vieil ou plus lourd avion qui fait le même vol. Alors qu'en terme d'écotaxe, c'est le nombre de passager qui va compter donc ce serait la même pour 2 avions.

*Quel est la probabilité qu'une telle taxe voit le jour de manière globale ?*

Ça ne va pas être simple à mettre en place mais c'est un peu le sens de l'histoire. En février 2019, les Pays-Bas ont mis le sujet sur la table au sein d'une réunion, en Mai, ils étaient 5 pays, en parallèle il y a un rapport sur la mise en place d'une taxe sur le kérosène qui a fuité dans le journal français Le Monde. Fin 2019, 9 pays demandaient cette taxe, mais d'ici à ce que l'on obtienne un accord des 27 pays, et que la taxe soit suffisamment puissante, il va encore se passer du temps. Mais c'est le sens de l'histoire donc il faut s'y préparer.

*Qui de l'accélération du cycle des avions ? Est-ce que le recyclage en est un frein ?*

Un avion c'est utilisé en moyenne 10 à 12 heures par jour pour un moyen-courrier, et 15 a 18h par jour pour un long-courrier, un avion ça vole tout le temps ! L'emprunte carbone donc lié à la fabrication c'est proche de 0,01% par rapport à son cycle total. Raccourcir le cycle des avions n'est pas gênant du tout d'un point de vue climatique. Et le fait que ces avions passent plus rapidement vers les pays en voie de développement, c'est mieux aussi. Car l'accélération dans les pays développer se répercutera dans les pays les moins développés aussi. Il y a une filière de recyclage à créer effectivement, qui a déjà commencé dont à Tarbes (France) ou Airbus a déjà commencé à recycler des avions. Là où cela devient compliqué, c'est dans la composition des avions. Avant les avions étaient faits de métaux et d'alliages relativement simples, maintenant que les avions sont en composites, le recyclage est rendu beaucoup plus difficile. De là, il y a un sujet important qui est l'écoconception des avions, tout en maintenant des

performances élevées. Un cimetière des avions est aussi un problème, mais en ordre de grandeur, le nombre d'avions mis à la décharge annuellement comparé au nombre de voitures mises à la décharge chaque année, c'est ridicule.

*Quel est le potentiel des SAF ?*

Les fuels alternatifs coutent 2 à 6 fois plus cher que le kérosène fossile. On se retrouve face à un enjeu d'image. Toutes les compagnies tiennent absolument à faire des vols de démonstration avec des bio fuels. (Tel que Air-France KLM qui fait San Francisco-Paris avec des bio fuels) Toutes les grosses compagnies ont quelques vols en biocarburants mais pas plus car cela coute trop cher. Alors que les biocarburants pourraient être une solution énorme pour l'aviation car il n'y a pas d'électrification possible avant 2050. Le potentiel est énorme mais il faut faire attention car tous les carburants alternatifs ne se valent pas. Par exemple, les carburants à base d'huile de palme sont construits à partir de déforestation etc donc quand on prend en compte tous les effets, on s'aperçoit que l'huile de palme émets 2 à 3 fois plus que le kérosène fossile. Il faut donc faire attention à choisir les bonnes matières premières avec les bons procédés chimiques, on peut réduire l'impact de près de 80%, en acceptant de payer le prix pour.

*Est-ce possible d'avoir une échelle globale dans les biocarburants ?*

Oui bien sûr, il faut développer la filière. Ces carburants intéressent aussi la filière automobile, le cosmétique… il y a donc largement la place pour développer un bio carburant responsable. Encore une fois, le secteur de l'aéronautique ce n'est pas un secteur immense. Il y a 20 000 avions qui volent dans le monde. Les besoins en carburant par rapport au secteur automobile sont donc bien moindres. Le dernier point, si on limite la croissance, c'est beaucoup plus facile d'atteindre une pénétration de marché importante que dans le cas contraire.

*Comment une compagnie peut-elle agir par rapport aux bio-fuels ?*

Un bon exemple c'est KLM qui a fondé avec l'aéroport de Schiphol, Skynergie. Une entreprise qui produit du bio-carburant. Il y a des solutions, tels que de s'arranger à taxer le kérosène mais exempter le bio-carburant, ce qui rendrait ce dernier comparativement plus économique.

### *d. Interview ASL : Nicolas Desimpel.*

Flight Operations Department Manager. Responsible for Offsetting programs & reporting at ASL.

(Introduction not recorded)

*Avez-vous déjà commencé à vous adapter à CORSIA ?*

Oui, on a déjà commencé avec CORSIA. En fait, on est soumis dans un premier temps à l'autorité wallonne de l'air et du climat en tant que ASL air Belgique basé à Liège. La WAC est basée à Namur et régule tout ce qui est environnement et émissions en Wallonie. Toutes les compagnies aériennes qui ont leur base sur le sol wallon doivent faire un rapport annuellement à la WAC qui est le même genre de rapport que toutes les compagnies volontaires pour CORSIA doivent remplir. C'est eux qui vont devoir approuver le rapport final avant de l'envoyer, je crois, à l'ICAO.

*Il y aura donc toujours cet intermédiaire "Wallonie" entre vous et l'ICAO ?*

Exactement, que ce soit pour l'ETS ou CORSIA, on doit passer par la WAC. Ils ont mis en place un système informatique qui s'appelle les swaps. Nous ce qu'il se passe c'est que on fait le travail en interne (moi) de récupération des data, traitement des data, tous les calculs etc qui prennent encore pas mal de temps malheureusement car assez manuel. Il existe des logiciels sur le marché pour aller plus vite, mais bon ça n'est pas encore arrive chez ASL. Après ça, il y a le vérificateur qui arrive, il passe plusieurs jours sur site puis à distance il vérifie les data, c'est quand même assez précis comme vérification ça dure pas mal de temps. Une fois que les rapports sont approuvés par le vérificateur, on reçoit une lettre « d'acceptation » ce qui nous permet d'encoder CORSIA dans les systèmes informatiques de la WAC qui eux approuvent le rapport final.

*Et qui définis le montant des charges CORSIA alors ?*

A partir du moment que la vérification est faite par l'auditeur, on sait ce qu'on va devoir payer.

*Vous-avez déjà des stratégies/partenariats en place pour les off setting ?*

En fait, non, car jusqu'à récemment tout ce qui était critère d'éligibilité de programmes d'off setting n'étaient pas encore bien définis il me semble.

*Je confirme que les programmes n'ont pas encore été définis entièrement, ils sont en cours de sélection en ce moment même.*

Du coup ce qu'il se passe, au niveau de ASL, je suis bombardé de mail et d'appels de gens qui viennent de projet d'off setting, qui poussent pour vendre des trucs. Leur argument est qu'il vaut mieux acheter maintenant car si vous attendez que les critères d'éligibilité soient connus, les prix vont augmenter. Et eux se basent sur : notre projet devrait être éligible car il se base sur ces critères-là là et là… Nous on est pas du tout dans cette optique-là, on préfère attendre les recommandations de l'IATA, qui est quand même un organe de référence là-dedans qui fait bien son boulot. Nous on a déjà soumis notre rapport pour 2019 il y a 1 mois et demi.

*Il y a justement des discussions quant à la base du cap de CORSIA, qui est 2020 mais en raison du Corona virus pourrait changer vers 2019. Qu'en penses-tu ?*

L'IATA a justement fait un séminaire il y a quelques jours, présenté par Michel Adam. A la base la Baseline de CORSIA est censée être une moyenne de 2019-2020. Mais forcément vu que le passager de 2020 est un peu mort, par chance le cargo est épargné. L'IATA s'est rendu compte que si on voulait garder cette base on redescendrait à des niveaux semblables à ceux de 2014. Toute l'augmentation qu'il y a eu entre de 2014 et 2020 serait un peu oubliée.

*Y a-t-il déjà eu des estimations interne chez ASL d'une limite à partir de laquelle le prix du carbone induirait un réel changement au sein de la compagnie ?*

Non on ne l'a pas fait. La raison pour laquelle on ne l'a pas fait, c'est qu'on vole principalement pour Fedex, c'est notre client principal. En fait, Fedex chez nous prend en compte tous ces frais carbones. Tout ce qui fuel est payé directement par Fedex et donc tout ce qui y est lié aussi. Jusqu'à l'heure actuelle, Fedex s'en fou complètement de ce qu'on paye, peu importe le prix, ils payent. Leur optique n'est pas du tout en mode « fuel efficiency ». Vu que CORSIA et ETS sont directement liés à la consommation de fuel qui est directement payé par Fedex, il n'y a pas vraiment d'incitation pour nous de réduire notre consommation. Et puis pour répondre à ta question précisément, on ne nous a pas demandé d'analyser l'impact de CORSIA sur notre contrat. Je sais qu'il y a des compagnies plus proactives que nous a ce niveau-là, dans ces séminaires de l'IATA, il y a toujours les mêmes personnes et dans les grosses compagnies il y a vraiment des experts environnement qui sont spécialisés là-dedans, ce qui n'est pas mon cas car on est une petite compagnie. Je suis la seule personne qui s'occupe de ça chez ASL, je fais des rapports etc puis je m'arrange avec un gars des finances pour ce qui est trading mais sinon c'est tout. Il n'y a pas de moyen mis en place pour aller chercher plus d'informations.

*Par rapport à Fedex, c'est intéressant de mentionner qu'en faisant des recherches, ASL n'apparaît nulle part dans les rapports annuels de Fedex. Leurs rapports montrent une belle image de Fedex en termes d'efficacité énergétique avec de nouveaux avions etc, alors qu'après évidement le leasing ne rentre pas dedans.*

Franchement nous je te dis on a aucune contrainte à ce niveau-là. Un exemple clair de leur politique « anti-efficiency ». Tu sais que quand un avion part d'une destination X vers une destination Y, il a besoin d'un certain fuel a bord par rapport à la masse à bord. Alors que nous, on ne prend pas ce fuel minimum, mais on prend le fuel nécessaire comme si on transportait la masse maximale de l'avion, alors que souvent il n'est pas chargé à son maximum. On brule donc beaucoup trop de fuel, et ça c'est une demande de Fedex. Comme ça, s'il y a des variations de fret en dernière minute, ou si un dernier camion devrait arriver, l'avion serait en tous les cas prêts à partir. Ce qui veut dire que sur une année ça a un impact incroyable sur la consommation de fuel. C'est une demande de Fedex, et Fedex paye pour donc nous on applique car financièrement on n'a pas grand-chose à dire. Je ne trouve pas ça top mais je ne suis pas le boss d'ASL, c'est comme ça. Je pense que en tant que boss d'ASL, j'essayerais de trouver un juste milieu entre flexibilité en consommation.

*Au niveau d'avions, vous utilisez que des conversions ?*

Oui, parce que déjà au niveau B-737, il n'y a pas de nouveaux freighters ça n'existe pas. Sur le long courrier, il y a des avions qui peuvent sortir neuf de l'usine, mais ce n'est pas dans nos budgets d'acheter des avions neufs pour le moment, et ce n'est simplement pas dans nos plans.

*Je comprends que si vous n'avez aucun cout lié aux émissions carbone, c'est normal que ça ne fasse pas beaucoup de sens d'acheter des neufs.*

Après on investit quand même dans des nouveaux avions même s'ils ne sont pas entièrement neufs. Par exemple, on est en train d'introduire des B-737-800, qui sont déjà beaucoup plus fuel efficient et qui ont d'autres niveaux de capacité que les 400.

*Est-ce que vous avez déjà pensé pro-activement à la possibilité que Fedex impose des minima en terme d'efficiency ?*

Oui, c'est un peu une réfection que j'ai eue il y a un an plus ou moins. Ma vision des choses est que Fedex c'est bien, mais le contrat peut soit changer de philosophie, soit s'arrêter tout simplement. Il y a donc environ un mois, le conseil d'administration a décidé de lancer un projet

de fuel efficiency. Il sera lancé sous peu chez ASL (pas encore officiel au sein de la boite donc à ne pas raconter trop rapidement). Il consiste en plusieurs choses, du monitoring qui intègre toutes data comme les données de vols pour après analyse pouvoir recommander des bonnes pratiques au pilotes pour économiser le fuel. C'est un programme assez complexe qui doit être implémenté, là on regarde avec quelle compagnie on travaillera sur cette implémentation de software. La réfection est donc là, surtout qu'on vole pour Fedex avec les B-737, mais avec les autres avions (les 47 et 57), on vole principalement à notre propre compte, chaque euro d'économisé là est donc gagné pour la compagnie. Si on peut éduquer les pilotes, techniciens et dispatcher à avoir une vision plus efficiente des opérations, ce serait clairement de l'argent dans notre poche.

*A Liège, est ce qu'il y a déjà la possibilité d'utiliser des carburants alternatifs ?*

Cette une bonne question, je ne sais pas trop il faudrait que je demande en interne. En ce moment on est en train de faire un projet avec l'aéroport de liège et la fuel farm donc si ça t'intéresse je peux te mettre en relation avec eux.

[disgression]

*De manière plus générale, en perspective, que penses-tu de l'objectif de CORSIA, de son potentiel côté incitatif ou de son côté « porte de sortie » pour les compagnies ?*

Je pense que cela va dépendre fortement de l'impact financier que le programme a sur les compagnies, si on prend l'exemple de ETS, le prix a rapidement augmenté de 5€ a 25€ en 3ans plus ou moins. Malgré ça, je ne vois pas un impact hyper important. Si je prends notre enveloppe des fuels sur une année, et si on prend l'enveloppe dédié aux émissions chaque année, ce n'est rien du tout, c'est peut-être 1% du prix total. Forcément c'est de l'argent, je pense que l'année passée on a payé 6 ou 7 millions pour les ETS, une partie est reçue gratuitement de la région wallonne mais au bout ça ferait quelques millions qu'on pourrait épargner sur une année. Bon, on n'arriverait pas à tout épargner à 100%, donc si on fait un petit effort on pourrait réduire un peu, peut-être 10% ce qui ferait 500k ou 600k par an d'épargne… Et qu'est-ce que ça représente 600k sur une année ? Donc voilà l'impact de CORSIA sur les compagnies aériennes ne va pas être hyper fort. Maintenant peut être que les fonds débloqués par ETS et CORSIA pourront amener à supporter des projets qui ont réellement besoin d'argent et ou les 600k sont parfaitement suffisant. Car leur échelle n'est pas la même que celle des compagnies aériennes. C'est clair que pour nous, si les compagnies vont moins voler à cause de ETS et CORSIA, je

ne pense pas. Maintenant tu as des taxes, comme la taxe carbone qui a été lancée en France par exemple, là tu vois qu'elle a vraiment un impact financier et qu'elle impacte donc le prix des billets.

*Quid des taxes sur le kérosène ?*

Ah oui ça, ça ferait vraiment mal mais CORSIA et loin d'avoir ce genre d'effets.

*Comment vois-tu la coexistence de CORSIA avec ETS ?*

Et ben CORSIA couvre plus de pays que ETS, donc je ne sais pas ce que ça va représenter au total par rapport à ETS. ETS ne couvre que les vols intra européen, CORSIA couvre les vols entre beaucoup plus de pays. Je ne sais pas ce qui sera plus cher, je n'ai pas encore fait les calculs. Il faudrait faire une comparaison de nos émissions qui sont sujettes à ETS, et les comparer aux émissions internationales et au prix de CORSIA. En tant qu'opérateur, on ne fait que suivre les recommandations de l'IATA en fait. Donc on ne réfléchit pas beaucoup plus loin que ça, on ne cherche pas tellement à faire des estimations de coût ou quoi. En termes de chiffre, l'ETS en 2019, on a émis 256 000tonnes de CO2 et CORSIA en 2019 on a émis 750 000tonnes de CO2. C'est 3x plus donc il faut que le prix de CORSIA soit plus haut qu'un tiers du cout ETS pour que cela nous revienne à plus cher que ETS… Donc je ne sais pas trop le prix de CORSIA, mais j'imagine que la différence comparée à la situation actuelle ne sera pas énorme. En plus, sur CORSIA on est taxé que sur la différence par rapport à la Baseline, en partie de manière sectorielle et en partie de manière individuelle. Au final, la situation est super floue en termes de coût et on attend que l'IATA communique sur les détails.

### *e. Interview Carbon Market Watch : Gilles Dufrasne.*

Policy Officer chez Carbon Market Watch (ONG), responsable des négociations internationales au niveau des nations unies, accords de Paris.

*Quelle est votre vision chez Carbon Market Watch par rapport aux objectifs de CORSIA, sur le court et moyen terme, et comment voyez-vous ce programme devenir incitatif dans le futur ?*

Pour nous CORSIA aujourd'hui c'est de plus en plus une blague, je pense que la façon dont le système a été mis en place au départ n'était déjà pas très ambitieuse, il y a déjà un problème avec le système lui-même donc. L'objectif qu'il fixe est simplement de la compensation de croissance des émissions. On peut se questionner sur la question de compensation mais même

sans ça, c'est juste la croissance des émissions donc on parle de peut-être 10% des émissions du secteur aérien au niveau mondial. Et encore, on parle des vols internationaux donc ce qui reprends que 60% des émissions du secteur aérien, 40% étant domestique quand on pense aux grands pays tels que les US, la chine etc. Tout ceux-là sont éliminés, ensuite on prend juste la croissance au-delà de 2020. L'objectif en lui-même est donc un peu ridicule. Et puis l'idée de compenser, de ne pas mettre une mesure claire sur les émissions ça entraine directement le risque de savoir si les redits de compensation qui vont être achetés, dans quelle mesure cela sera vraiment des réductions d'émissions ? Est-ce que c'est des crédits additionnels ? Ou simplement payer un projet qui allait de toute façon avoir lieu ? A partir du moment où l'on part sur un système de compensation, il y a beaucoup de question pour savoir si cela va réellement fonctionner. Et d'après ce qui est en train de se mettre en place, le type de crédit éligibles, etc. c'est de plus en plus clair que le système va avoir aucun impact. Rien que pour les mesures adoptées par le TAB qui détermine quels programmes sont éligibles, quels types de crédits carbones peuvent être utilisés, on a déjà une offre qui est 3 a 5fois supérieur à la demande pour la phase pilote. Donc il y a beaucoup plus d'offre que de demande donc ça veut dire que le prix va rester ce qu'il est aujourd'hui. Et aujourd'hui c'est bien en dessous de 5€/ton, donc est ce que ça va être incitatif pour entrainer la de carbonisation du secteur aérien, c'est très clair que non ! D'ailleurs je serais assez intéressé de savoir ce qu'a dit Michel Adam de l'IATA, j'avais vu un blog de l'IATA sur les bio fuels ou ils disaient notamment que de toute façon CORSIA ne serait pas un incitant pour acheter ces bio fuels car le prix est beaucoup trop faible. Compenser les émissions à court terme à la limite, pour nous c'est loin d'être assez, mais en tout cas un incitant ça n'en est certainement pas un.

*Ce que Michel pensait, dans le court terme ce n'est certainement pas un incitant, par contre, dans le plus long terme, il espère que cela puisse le devenir en se basant sur le fait que le prix du carbone, dans un marché tel que celui-là, pourrait augmenter. Après, si je me base sur ce que vous venez de me dire concernant l'offre et la demande sur le marché du Carbone, une augmentation du prix du Carbone ne me semble pas réaliste.*

Après, moi je parle de la demande pour la phase pilote des 3 premières années. La demande sera plus large pour les années suivantes c'est un système qui dure 15ans. Mais l'offre qui est déterminée aujourd'hui va encore augmenter parce que le système d'éligibilité des crédits fonctionne de la façon ou le TAB, qui détermine ces critères d'éligibilité, réévalue régulièrement ces critères. Des nouveaux programmes sont redéfinis comme étant éligibles donc l'offre va augmenter aussi au fur et à mesure. Dire qu'il n'y a pas d'études sur le prix

future ça ne me paraît pas très correct, clairement c'est un prix futur, donc personne n'a de certitudes, mais on a quand même une bonne idée de l'offre et de la demande potentielle future et historiquement on voit que les prix sur les marchés carbones sont assez faibles. D'autant plus aujourd'hui avec les demandes de rechanger le niveau de référence de CORSIA, pour amoindrir encore plus le système qui déjà est extrêmement faible.

*Par rapport à cela, avez-vous un rôle à jouer dans le TAB ? J'ai cru comprendre que les ONG avaient un rôle à jouer dans la mise au point de CORSIA ?*

Donc en fait non, on n'est pas dans le TAB. Dans le TAB c'est un groupe de 19 experts nationaux, il n'y a que des représentants nationaux qui parfois ont des liens assez étroits avec les marchés carbones ou le secteur aérien, mais c'est en tout cas des employés du gouvernement. Il n'y a donc pas du tout d'ONG ni de représentants de l'industrie. Ce à quoi faisait référence Michel ce sont des groupes techniques qui préparent les règles, on travaille dans des groupes techniques pour préparer les règles, proposer des critères d'éligibilité qu'on pense seraient de bons critères… ça s'est envoyé au conseil de l'ICAO et c'est ce conseil qui prend la décision finale. La décision est toujours prise par ce corps politique qui est représenté par 36 états membres. C'est clairement les états qui prennent les décisions. Entre parenthèses, avec un clair manque de transparence, personne n'a vraiment accès aux documents, on n'en sait même pas quel est l'agenda des réunions etc. c'est aussi quelque chose qui a été un peu discuté dans la presse. Dans ce groupe technique, en effet, les ONG en font partie, on est 5 ONG regroupées sur une seule entité qui s'appelle ICSA (international coalition for sustainable aviation), alors oui on est dans le groupe, donc on participe aux discussions, après on est aussi un peu instrumentalisé je trouve par l'ICAO ou l'IATA qui va dire que ça a été fait avec les ONG. Ce n'est pas complètement correcte parce qu'on est aussi un groupe de peut-être 100 personnes, si une personne d'une ONG dis quelque chose mais qu'à côté de ça il y a 30 personnes de l'industrie qui disent autre chose, il y a peu de chance qu'on arrive à changer les règles dans le sens que l'on voulait. Donc oui on a une certaine marge de manœuvre, on peut faire avancer les discussions mais on est loin de mettre en place un système qui reflète réellement ce que les ONG voudraient.

*Quel est votre avis concernant la révision de la Baseline de CORSIA vers 2019 plutôt que 2020 ?*

Pour moi c'est vraiment le secteur aérien qui utilise la crise du coronavirus pour amoindrir un système qui est déjà totalement inadapté, et après avoir soutenu CORSIA pendant des années, il demande maintenant une fois de plus de réduire le système. Je pense qu'ils jouent un double jeu quelque part. D'un côté, l'industrie aérienne (évidemment l'IATA représente plein de compagnies, et certaines sont plus ambitieuses que d'autres) mais l'IATA en tant que groupe de lobby, a toujours soutenu CORSIA extrêmement fort, et l'utilise comme excuse comme on a besoin de rien d'autre. Et donc de dire en Europe, pourquoi est-ce que vous voulez renforcer le système de marché européen ? On va avoir CORSIA ! Pourquoi est-ce que vous voulez renforcer les taxes sur le kérosène ? On va avoir CORSIA ! Donc on a un système qui est extrêmement faible qui est utilisé pour réduire la possibilité d'avoir d'autres politiques. En même temps, il y a un travail interne pour amoindrir CORSIA lui-même qui est clairement plus difficile à voir pour le public et pour le media parce que c'est des questions super techniques. Si l'IATA demande de changer le seuil de référence a 2019 plutôt que 2020 par exemple, on ne va pas faire la une du JT de la RTBF avec ça quoi. C'est vraiment une rhétorique un peu hypocrite pour moi de dire qu'on a ce système et qu'il est très bien et que le secteur aéronautique est ambitieux, parce que non il ne l'est pas et le système qu'on a ils essayent constamment de l'amoindrir et le changement de Baseline c'est juste un exemple de plus de ça.

*La probabilité que les activités repassent au-dessus du niveau de 2019 dans les prochaines périodes n'est pas très haut, du coup il y a de fortes chances que CORSIA ne servent même à rien durant la phase pilote.*

Au moins durant la phase pilote, on pense que les obligations de compensation vont rester négatives donc il y aura zéro obligation. C'est vraiment regrettable de voir que les états sont en passe de soutenir ce changement, en parallèle a la distribution de milliards d'euros en aide d'états. Oui le secteur aérien est dans une situation difficile avec la crise, mais ils ont quand même très bien su sortir leur épine du jeu en réussissant à avoir beaucoup d'aides d'états avec virtuellement aucune condition climatique à part ce qui a été annoncé hier en Autriche. Et en parallèle, réussir à amoindrir les politiques climatiques adoptées.

*Pour prendre une métaphore, à quel point c'est correct de dire : « je travaille, je gagne de l'argent, et ensuite je décide moi-même de combien je vais me taxer pour ensuite dire aux autres que je suis taxé donc il n'y a aucun problème. »*

C'est plus ou moins juste, après on ne peut pas dire que l'IATA décide concrètement des règles car ce n'est pas l'IATA qui prends les décisions officielles a l'ICAO. IATA a beaucoup de pouvoir pour influencer les pays qui prennent la décision. Donc quand on dit que c'est décidé à l'ICAO, ce qu'on veut dire c'est que c'est décidé par les états membres qui le composent. Tout comme quelque chose de décidé à l'union européenne, c'est un peu facile de dire que c'est l'Union Européenne qui a décidé car finalement ce sont des états membres… Pour l'ICAO c'est pareil, et l'influence que l'IATA a c'est principalement sur les états membres. Si tu regardes un peu la position qui est adoptée par certain pays sur le changement de Baseline, on voit que la coalition de l'Amérique latine sur l'aviation soutien ce changement, les US soutiennent ce changement, la commission européenne aussi, il y a tout un débat en cours au niveau de l'Europe, il n'y a que la suède qui s'oppose un peu à ce changement. Voilà clairement l'IATA et l'industrie aérienne ont un énorme pouvoir sur les gouvernements qui eux ensuite prennent les décisions.

*Est-ce que le problème serait le manque d'expertise des politiques dans le domaine ? On pas du tout ?*

Non je ne dirais pas qu'ils ne sont pas experts dans leur domaine, les gens qui travaillent les dessus connaissent très très bien leur matière, peut-être pas tous évidemment mais la plupart. Je crois qu'a un niveau national c'est que l'industrie reste très puissante dans les gouvernements notamment parce qu'elles représentent un intérêt pour la politique d'un pays. Dans le cadre du secteur aérien, il y a aussi une dynamique assez complexe entre les départements transport et les départements environnement dans chaque si on regarde un peu les discussions intra gouvernement qui détermine la position du pays, souvent on se retrouve avec le ministère du transport qui se trouve en faveur de la position très pro-industrie, et le ministère de l'environnement en faveur d'une position plus climatique. Et donc finalement, ce qui a un impact majeur dans la position finale adoptée c'est la relation de pouvoir entre ces 2 ministères, qui a la compétence de quoi et qui prend la décision. Une autre chose à prendre en compte c'est l'équilibre à prendre en compte entre adopter un niveau d'ambition en lien avec ce dont on a besoin et arriver à un accord avec 197 états au niveau des nations unies. Puisque c'est des politiques qui sont mises en place au niveau de l'ICAO. Par exemple, ce qu'on attend beaucoup de la commission européenne c'est « on va quand même changer ce niveau de seuil de référence, car si on ne le fait, beaucoup de pays pourraient ne plus participer à ce système ». C'est un argument qui va revenir souvent. C'est un peu moins dans le cadre des luttes de pouvoir

entre ONG, gouvernement et industrie, mais c'est très important dans le mécanisme de prise de décision.

*Comment voyez-vous la combinaison entre EU ETS et CORSIA se passer ?*

La discussion c'est comment est-ce qu'on va mettre en place CORSIA, mais aussi et surtout comment est-ce qu'on va réformer le système européen du carbone, parce qu'aujourd'hui il n'est pas en lien avec les objectifs de l'Europe. Le système c'est un système d'échange de quotas d'émissions, donc il y a un quota qui est distribué aux compagnies, ce quota c'est la quantité maximale qui peuvent être émises chaque année, et chaque année ce nombre de quotas distribués diminue. Et donc aujourd'hui, la façon dont le système est mis en place entrainerait à ce qu'on arrive à zéro carbone en 2058, ce qui n'est plus en lien avec les objectifs de l'Europe. Du coup, les discussions commencent au sein de l'Europe pour revoir le système. Le secteur aérien est aussi couvert par ce système, il y aura donc des discussions. Une particularité de ce système pour le secteur aérien aussi c'est la distribution gratuite de ces quotas. Donc, l'idée de donner des quotas, c'est aussi de mettre un prix sur le carbone et de dire « ok si une compagnie veut émettre 1t de carbone elle doit acheter 1 quota » sauf que la plupart de ces quotas sont distribués gratuitement. L'industrie aérienne reçoit 80% de ses quotas gratuitement, mais comme elle émets plus que cette limite, finalement l'industrie doit en racheter. Dans les faits, au final elle reçoit 50% de ses émissions gratuitement. Parmi les priorités de la commission se trouve de mettre fin à ce système de distribution de quotas gratuit, ou en tout cas de le diminuer fortement. La commission européenne veut réduire fortement, certains pays veulent abandonner cela complètement notamment la Pologne. C'est un débat qui va avoir lieu en parallèle avec la mise en application de CORSIA.

*Est-ce possible selon toi d'exempter l'aviation de EU ETS pour la laisser suivre uniquement CORSIA ?*

Je ne pense pas ! C'est quelque chose que l'IATA demande et qui est poussé par l'industrie, le sens que la commission a l'aire de prendre est de dire non, on ne va pas remplacer EU ETS par CORSIA, je crois que si la Baseline est changée c'est encore plus difficile de justifier un remplacement de EU ETS par CORSIA pour l'industrie. C'est clair pour tout le monde que l'ambition de CORSIA est juste incomparable avec l'ambition de EU ETS alors que le mouvement de la commission va dans le sens d'un peu plus d'actions pour le secteur aérien ! Je vois très difficilement comment ils pourraient politiquement supprimer toute la politique

climatique et la remplacer par ce système qui ne vaut absolument rien. La commission doit encore communiquer sur la manière techniquement de mettre en place CORSIA, je ne sais pas exactement comment ils vont faire mais ça m'étonnerait vachement qu'ils remplacent le système en place.

*Est-ce que l'Europe fixe le prix du carbone dans le cadre des quotas EU ETS ?*

Alors non pas du tout ! L'Europe ne détermine pas le prix de marché de la tonne de carbone. Le quota c'est un marché carbone, la seule chose que l'Europe détermine c'est la quantité de quotas permis sur le système. Évidemment, la quantité de quotas à un impact sur le prix, mais par exemple ici au début de la crise du coronavirus on a vu une baisse de valeur du quota carbone parce qu'il y avait moins d'émissions et maintenant il est en train d'un peu récupérer avec la reprise, ça reste un marché quoi. Moi je dirais même qu'il est plus transparent qu'un marché volontaire de compensation mais bon.

*Il y-a-t-il un point que vous souhaiteriez approfondir ou ajouter ?*

Sur le thème des compensations, je ne sais pas si tu as regardé un petit peu les compensations volontaires que font les compagnies aériennes. Il y en a beaucoup qui se lancent dans ce genre d'activités. Un angle que je trouve intéressant dans la question des relations de pouvoir dont tu parlais, un des raisons pour laquelle elle s'engage dans ce genre d'activités volontaires c'est pour pouvoir dire « on a pas besoin d'être régulés par le gouvernement, pourquoi nous mettre des règles parce que de toute façon on fait déjà une compensation de manière volontaire », donc c'est un argument qui est utilisé pour éviter des règles, ce qui les arrange bien parce que choisir des crédits carbones comme ça c'est clairement la façon la moins cher pour elles d'avoir une quelconque action climatique entre guillemets. Apparemment le ministre des transports en Angleterre aurait donné une interview en disant que finalement les conditions climatiques aux compagnies aériennes parce que de toute façon elles le font déjà. Pour moi, c'est vraiment un exemple flagrant de la stratégie des compagnies aériennes qui fonctionne à merveille. Ensuite, un autre problème, une autre thématique c'est la qualité des produits et des crédits qui circulent sur ce genre de marchés.

### *f. Interview United Airlines : Aaron Robinson.*

Senior Manager chez United, environmental strategy and sustainability. Responsable programme CORSIA.

I am Aaron Robinson; I am senior manager at United Airlines on environmental strategy and I cover a number of topics within my area. The biggest focus of course for us is Decarbonization, CORSIA is certainly a mechanism that at mid-range has a target for decarbonization for United and for the industry. The biggest part of my work is focusing on sustainable fuels development, another decarbonization technology which is really what we need for that long-term goals.

*Do you think that the objective of the industry for 2050 is something achievable in the current situation?*

I think it still is, it is obviously a big objective and a difficult goal to reach. It also depends how you look at it right? When it was first conceived, kind of all options were on the table, including offsets most notably, in the last years we had a couple of airlines that said we are going carbon neutral immediately by buying offsets. There are certainly different perspectives out there, should that ok or not? Should there be a deeper goal? 50% at the time was a big reduction, now you have companies and even countries that are committing to a net zero so… There are different perspectives! Still, I think the overall goal is realistic, it will require a lot of work and effort to get there.

*You said you were specialized in alternative fuels? What is your role exactly for that at United?*

So, we are not experts in fuel production or development, we rather leave that to the experts. What we do and what I am responsible for is signing contracts and investing in companies to ultimately supply our company. And policy measures that support the growth in the industry.

*How do you see the penetration rate of the fuels evolve?*

There is not much in the system today though it's increasing every year. It is important to keep in mind two things. One, we are competing with the oil industry and petrol for over a century, that one has achieved a certain level of technology which results in low costs. Secondly, if you look at any kind of new industry or technology, productivity all starts out pretty slow and then you go out with a real rapid ascent through exponential growth. We are hoping that's what we will be able to achieve.

*Next to sustainable fuels, do you see other alternatives or technologies support the carbon reduction?*

Again, it depends how you measure the scope of our problem. Certainly, reducing fuel use is quite important as well, that is actually what I have been working on, certainly newer aircrafts are the biggest contributor to that. And that is not our specialty, that the manufacturer's domain. Beyond that, it may be that we will be using other technologies. You know 5 years ago no one was really thinking very much about carbon capture, these days there is much discussion on it. Hopefully in another five years we will have a lot of those options really appearing in mass and able to provide.

*Coming back to CORSIA, do you think that CORSIA could drive the companies towards the new technologies?*

I think it is important to remember what CORSIA was elaborated for. The idea of CORSIA was to build a mechanism that stabilizes the emissions at the 2019 2020 level by offsetting the growth. As it is a regulatory mechanism, it will be achieving its aim as it is a required for the airlines to participate. In terms of reduction, there is no reduction yet that is required by it.

*What do you think about the CORSIA baseline modification?*

So it is important to remember the reason for having this average baseline, when the European emission trading started to include aviation, the baseline year was 2010 and that was the year of the volcano eruption which has negative effects on the sector, so the airlines ended up paying something higher due to an artificially lower baseline. When CORSIA was developed, they wanted to avoid something like that happening again, that impacts the sector in an unreasonable way and avoid that kind of distortion. That how the idea of the 2019-2020 baseline occurred. And that has some distortions as well, obviously this year has a bigger impact, and as a result it has a even bigger unforeseen shock to the baseline, while the intend of this baseline was to avoid shocks… This is probably an unreasonable shock bigger than any anticipated. Based on that it is logical to adapt the baseline.

*The activity level is not foreseen to reach the 2019 level before a couple of years, then you wouldn't have CORSIA at all?*

Sure, but then CORSIA would have achieved it intend right? If the intends are to stabilize the levels and that emission levels aren't above 2019 level, then even without CORSIA the goal will be achieved.

*About ETS, they are working on a way to merge both systems. What is the point of view of United about that?*

The objective of CORSIA was to avoid having multiple overlapping frameworks covering emissions. What we didn't want to happen was ETS covers the entire Europe, Canada said if you flight over our space you need to pay emissions there, and then the UK have their passenger duty for environmental concerns. In that regard, we would have to pay for environment four times over. Which is, a bit unfair, my view is that ETS needs to be, once CORSIA is in effect, pulled back away from international. It can certainly continue for domestic, that make sense. Because that's a different set of flights, but for international it should be pulled back.

*Is there a similar scheme in the US? Similar to ETS?*

No there is not, there are definitely some individual states that have their own schemes, but they don't cover aviation in large part as it is under national state oversight not state level.

*So United would be covered only by CORSIA from 2021, right?*

Yes, that's correct! The domestic measures are introduced according to the action plan of the US in regard with the Paris agreement, but obviously, we are not current signatory of the agreement. But that is where the authority would come from.

*So domestic flights are included into the NDC of the US for Paris agreement?*

Correct, but obviously that's suspended but it would be covered under that. And then the government would decide if it makes sense to focus on aviation, to focus on other sectors, and then they would hopefully focus on what is right to achieve carbon reductions.

*If United were to use offsetting programs, how would you approach the case?*

The biggest concern is the legitimacy of the offset and then also the overall cost. The thing that we would do is minimizing the cost while still meeting the CORSIA eligibility criteria. In that sense, there is certainly an interest to invest in high quality offsets. Otherwise, it would have to be potentially connected to United's products, is it something that can help technology innovations to help aviation down the line, or is it located in a market where United flight to for example. We flight quite a bit to Brazil, and there is quite a bit offsets there so it would

make logical sense to invest there. There are also plenty of projects in India, but we don't fly there so it probably doesn't make too much sense to go there for offsetting programs.

*But there is no plan yet? Which means that you are not using them at the moment?*

No for the moment we are waiting and seeing. What the baseline will be. If the baseline ends up changing, then likely we won't need to do any action on that at the time. Going back to ETS, when it started in 2010 I had lots of providers of offsets reaching out to me saying 'hey can I talk with you about buying offsets from us?', I answered that I'd rather wait that I know for sure that I have to buy offsets. And a decade later, I still didn't have to buy them for that, I am glad I didn't spend the time on that, and I spend the time on other priorities to decarbonize in the meantime. There is certainly a number of things on which we can focus before that. I would also like to add that airlines are having to layoffs thousands of employees at the moment, it also doesn't necessarily make sense to spend time on that if there are employees in the coming years.

*Do you want to add anything?*

The only other topic I would think about is to encourage you to look at the overall cost of CORSIA, you know it is measured in the billions of Dollars, but compared to the overall industry cost structure… Some people need to be much more onerous to get the job done, others view it as… Building a political compromised is hard, it took a decade to reach an agreement for CORSIA, but it took 25 years for the Paris agreements.

### *g. Mail template*

Dear Miss, Mister,

My name is Alexis Le Clef, student in second Master of Business Engineering in Belgium (CEMS/LSM). I am currently writing a thesis about the development of the Air Cargo industry in relation with the carbon emission trading scheme (CORSIA) that they are facing from 2020, and how this scheme could lead them towards their 2050 ambition of halving emissions compared to 2005 levels.

In order to assess the impact of CORSIA on Air Cargo companies, it would be greatly valuable to have your opinion regarding the program and its effects on your company.

Concretely, I would like to discuss the following:

- What is the vision of your company in terms of Carbon footprint?
- What are the main strategies that have been set to mitigate carbon emissions?
- How does your company prepare for the introduction of CORSIA?
- Overall, what is your opinion about this scheme and its impact on the industry?

I would highly appreciate to schedule a ±30min videoconference call in order to talk about that subject. The outcomes of the interview can be kept confidential, those outcomes will be transcribed and send back to you for final approval to ensure clarity and to avoid any confusion. Furthermore, you can choose not to answer precise questions, your insights and opinion over the topic in general will still be extremely valuable.

Following on this discussion, I will share the outcome of my thesis. Those will be gathering the opinion of different relevant actors in the air transportation industry concerning the future the industry in terms of carbon reduction.

I look forward to hearing from you and hope you are doing fine in those troubling times.

Sincerely,

## B. Life cycle assessment

### *a. Material production*

$$E_1 = \frac{44}{12} \cdot Ma \cdot \sum_{i=1}^{nm} qm_i \cdot [ec_i^{v.m} \cdot (1 - reuse_i - rec\ o_{vi} - recym_i) + ec_i^{r.m} \cdot recym_i] \cdot \sum_{j=1}^{nen} ef_j \cdot pmp_{j,i}$$

Ma – Mass of the aircraft [kg]

Nm – Number of different materials used in production

$Qm_i$ – share of material i in total mass of the aircraft

$ec_i^{v.m}$ – energy consumption per kg during the production of material i from virgin material [kJ/kg]

$ec_i^{r.m}$ – energy consumption per kg during the production of material I from recycled material [kJ/kg]

$Reuse_i$ – reuse rate during production of material i

$Recov_i$ – recycling rate during production of material i

$Recym_i$ – recycling rate during production of material i

Nen – Number of different types of energy used during the production of material i

$Ef_i$ – emission factor for type of energy j [$kgCO_2/MJ$]

$Pmp_{j,i}$ – share of type of energy j in the production of material i

### *b. Manufacturing of the pieces*

$$E_2 = Ma \cdot \sum_{i=1}^{nm} qm_i \cdot (1 - reuse_i) \cdot \sum_{h=1}^{ntp} ptp_{i,h} \cdot em_{i,h} + E_{2,oth}$$

Ma – Mass of the aircraft [kg]

$Qm_i$ – share of material i in total mass of the aircraft

$Reuse_i$ – reuse rate during production of material i

Ntp – number of different process in the manufacturing of aircraft pieces

$Em_{i,h}$ – emissions during the manufacturing of piece i by the process h [$kgCO_2$/kg of material]

$Ptp_{i,h}$ – share of process h in the manufacturing of piece i

$E_{2,\ oth}$ – emission resulting from non-mass related processes such as painting, lighting, heating, etc. [$kgCO_2$]

### *c. Assembly*

$$\mathrm{E_3} = \frac{44}{12} \cdot \mathrm{Ma} \cdot ec_{as} \sum_{\mathrm{j=1}}^{\mathrm{nen}} \mathrm{ef_j} \cdot \mathrm{pas_j}$$

Ma – Mass of the aircraft [kg]

$ec_{as}$ – energy consumption during assembly [kJ/kg]

$Ef_i$ – emission factor for type of energy j [$kgCO_2/MJ$]

$Pas_j$ – share of energy j in the assembling

### *d. Use*

The total emissions of an aircraft during its lifetime, without accounting for degradation, is expressed:

$$E_{4,1} = efc \cdot T \cdot F_c$$

Efc – CO2 emission factor [tCO2/tFuel] ICAO standard: 3.16 $\cdot \frac{tCO2}{tFuel}$

T – total utilization time of an aircraft [Years]

$F_c$ – fuel consumption [tFuel/years] $F_c = ff\ [{}^{tFuel}/_{hours}] \cdot T_c[{}^{hours}/_{year}]$

The total amount of $CO_2$ emissions caused by the aircraft degradation phenomena is expressed:

$$E_{4,2} = \{\sum_{i=1}^{ns}[(Sd_{i-1} - \Delta Sd_{i-1} + \frac{ksd_i}{2}) \cdot Tsr_i] \cdot F_c\} \cdot efc$$

$Sd_{i-1}$ – structure degradation

$\Delta Sd_{i-1}$ – structure repair potential

$Ksd_i$ – rate at which the structure is degrading

$Tsr_i$ – time between the structure repairs

$F_c$ – fuel consumption [tFuel/years] $F_c = ff\ [{}^{tFuel}/_{hours}] \cdot T_c[{}^{hours}/_{year}]$

Efc – CO2 emission factor [tCO2/tFuel] ICAO standard: 3.16 $\cdot \frac{tCO2}{tFuel}$

The total amount of $CO_2$ emissions caused by the engine degradation phenomena is expressed:

$$E_{4,3} = \{\sum_{i=1}^{ne}[(Bv - \frac{Rv_{i-1}}{2}) \cdot Ter_i] \cdot F_c\} \cdot efc$$

Bv – upper degradation limits that initiates the repair process (set by manufaturer)

Rv – value of the reparation at the time I (not consistent over time)

$Ter_i$ – time between the engine repairs [Years]

$F_c$ – fuel consumption [tFuel/years] $F_c = ff\ [{}^{tFuel}/_{hours}] \cdot T_c[{}^{hours}/_{year}]$

Efc – CO2 emission factor [tCO2/tFuel] ICAO standard: 3.16 $\cdot \frac{tCO2}{tFuel}$

The total amount of $CO_2$ emissions can still be estimated by the following expression for the maintenance operations:

$$E_5 = FLCaf\ \cdot rep \cdot (E_1 + E_2 + E_3)$$

FLCaf – number of flights cycles an aircraft performs during its lifetime (cycle=takeoff till landing)

Rep – coefficient of reparations

$E_1$, $E_2$, $E_3$ – emissions of the steps of manufacturing for the required pieces for the reparation

### *e. Disposal*

$$E_6 = \frac{44}{12} \cdot Ma \cdot ec_{di} \sum_{j=1}^{nen} ef_j \cdot pdi_j$$

Ma – Mass of the aircraft [kg]

$Ec_{di}$ – energy consumption during disposal [J/kg]

$Ef_i$ – emission factor for type of energy j [$kgCO_2$/MJ]

$Pdi_j$ – share of energy j in the disposal

| Recyclable aircraft material | $CO_2$ generated by virgin material production (kg $CO_2$/kg material) | $CO_2$ generated by recycled material production (kg $CO_2$/kg material) | $CO_2$ saved by recycling (kg $CO_2$/kg material) | References |
|---|---|---|---|---|
| Aluminum | Primary production: 3.83 | Production from recycled: 0.29 | 3.54 | BIR (2008) |
| Batteries | PbA: 15 | 0.604[a] | 14.4 | Ishihara et al. (1999) |
| | NiCd: 3.1–3.2 | 1.32–1.8[a] | 1.59 | Rydh and Sanden (2005) |
| | NiMH: 14.8[1] | 1.18[2–a] | 13.62 | Sullivan and Gaines (2010)[1] and Ishihara et al. (2010)[2] |
| | NaS: 11.6–13.2 | 8.64–9.78[a] | 3.19 | Rydh and Sanden (2005) |
| | Li-ion: | | | Rydh and Sanden (2005)[1] |
| | NCA-G: 18.1[1] | 1.5–2.22[1–a] | ≈16[1] | Ishihara et al. (1999)[2] |
| | NCA-G: 18.2[2] | 0.29[2–a] | ≈17.9[2] | |
| Blast media group | Steel primary (BF/BOF route): 2.3[1] Steel primary (BF route): 1.54[2] | Production from recycled: 0.68[2] | Steel: 1.62 | Norgate et al. (2007)[1] Universe Project (2012)[2] |
| Cardboard | 1.22 | −3.45 | 4.67 | Overcash (2013) |
| Caustic spent aqueous solutions | NaOH: 0.074 | – | – | Franklin Associates (2011) |
| Coated wire | Pyrometallurgy from ore concentrate: 1.25 | 0.44 | Pyrometallurgy: 0.81 | European Copper Institute (2012) |
| | Hydrometallurgy from oxide ores: 1.57 | | Hydrometallurgy: 1.13 | |
| Composites | 12 | 2 | 10 | Rydh and Sun (2005) |
| Construction/demolition debris | Concrete: 0.159[1] | Concrete: 0.009[2] | Concrete: 0.15 | Greenspec (2012)[1] |
| | Aggregate: 0.0048[1] | | | EPA.GOV (2012)[2] |
| Electronics | – | – | – | – |
| Ferrous metal such as steel | See entry for blast media | | | |
| Florescent lamps | Production phase: 0.88 | – | – | OSRAM (2012) |
| Food waste and trash | ≈0.504 | 0.00625 | 0.5 | Levis (2008) |
| Gloves | Latex: 1.254 | – | – | Esmaeili (2013) |
| Kevlar | N/A | N/A | N/A | N/A |
| Nonferrous metal (not aluminum) (titanium, copper) | Pyrometallurgy from ore concentrate: 1.25 | Production from scrap: 0.44 | Pyrometallurgy: 0.81 | BIR (2008) |
| | Hydrometallurgy from oxide ores: 1.57 | | Hydrometallurgy: 1.13 | |
| Oil | – | – | – | – |
| Paints (outdated) | Water-borne paint: 3.4 Solvent-borne paint: 5.00 | – | – | Greenspec (2012) |
| Paint-contaminated solids | See entries for cardboard and paint-contaminated solids | – | – | – |
| Paper | See entry for cardboard | – | – | – |
| Plastic bottles | PE: 1.69 | PE: 0.50 | PE: 1.19 | Universe Project (2012) |
| | PET: 4.10 | PET: 0.47 | PET: 3.63 | |
| Plastics from all industrial operations | See entry for plastic bottles | | | |
| Solvents | – | – | – | – |
| Tin | Primary production of tin: 2.18[b] | Production from recycled: 0.024[c] | 2.156 | BIR (2008) |
| Tires | 3.39 | Retread: 2.36 | 1.03 | Remanufacturing.org (2013) |
| Toner cartridges | 2.37 | Close to zero | ≈2.37 | Ahmadi et al. (2003) |
| Tyvek suits | High density polyethylene: 2.5 | – | – | Momani (2009) |
| Wood | Waste wood: 0.78 | Chip board: 0.01 | Chip board: 0.77 | Universe Project (2012) |

*Figure 16: Amount of generated and potentially saved CO2 emissions from replacing virgin with recycled materials. (Asmatulu et al., 2013)*

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