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E-cargo: an opportunity for commercial transportation logistics?

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Academic Year 2021/2022

INTRODUCTION

People's consumption habits have always been influenced by the social and economic changes they face.
With the advent of the Internet, consumers have become more and more informed and conscious with respect to their purchases, and with this comes higher expectations and standards. Moreover, in recent years a phenomenon known as e-commerce has developed, through which consumers can make their purchases directly online and receive the product at home or at a collection point. This has obviously had a great impact on the value chain but especially on the distribution chain, forcing logistics operators to review their structure and keep up with the changes.
At the same time, as already mentioned, thanks to the Internet, people are becoming more and more informed and the spreading of news is becoming easier and faster. Hence the start of a constant increase in attention regarding climate change and how it is affected by several factors and actions undertaken by a consumerist-driven society on daily basis.
The purpose of this thesis is to understand whether the use of an all-electric aircraft can effectively meet the growing demand for "express cargo" and the need to reduce the CO_2 emissions of the logistics system in the long run.
This research is therefore divided into 4 chapters:

1) The first chapter will analyze the logistics sector and the impact that the development of e-Commerce and the outbreak of the Covid-19 pandemic have had on it.
2) The second chapter will then follow with a forecast of the air cargo market in the next two decades and a comparison of air and road transportation costs.
3) Next, the third chapter will present the environmental impact of the logistics and transportation sector, European and global sustainability regulations, and eco-friendly air transport options.
4) Finally, in the fourth and final chapter, there will be an in-depth look at the measures taken by the three largest express cargo operators in Europe (UPS, FedEx, and DHL) and a specific on the partnership between Eviation and DHL and BETA and UPS and the resulting electric airplanes.

CHAPTER 1
THE LOGISTICS SECTOR

1.1 – An introduction on the functioning of the logistics sector

"*Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information flow from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements*." (Council of Logistics Management, 1986)

The term "logistics" was initially used in the military field, to indicate "the collection of all the activities aiming at the organization and coordination of the displacement of man, materials and means".

Logistics is now a common function in all commercial and industrial enterprises but the awareness of its importance from an economic and organizational point of view only started spreading between the '80s and the '90s. Indeed, up to the 1960s there wasn't a unique function for the various distribution aspects. Before that, distribution activities were managed by the transport sector or by the manufacturers who had their own vehicles. The concept of physical distribution was originally developed, and then imported, from the U.S. between 1960 and 1970, and from here derived the awareness that distribution could also play a key role in managing activities.

The term has nowadays assumed different connotations with respect to the concept to which it is associated: materials logistics, transport, production, industrial, distribution, etc.

In particular, with regard to the business logistics, this is one of the main components of the managerial and organizational processes of a business together with marketing and financing activities.

The logistic system of business, also called Industrial Supply Chain, is considered as a set of resources, infrastructures, equipment, and operational policies that allow the flow of goods and information, from the acquisition of raw materials to the final consumers, passing through the production and distribution of products. For this reason, we speak of supply and warehouse logistics, production logistics, transport logistics and so on.

According to the traditional view, logistics consists of all the transport and storage activities that enable the distribution of the product to the sales network. The objective is to ensure the distribution of the right product, in the right place, at the right time. Following this approach, therefore, the production function plays a central role, as it decides what, where and how much to produce in order to optimize the use of resources and minimize total costs, regardless of the actual market demand. Logistics is therefore responsible for efficiently carrying out transport, optimizing routes and minimizing the so-called "dead times".

The main task of logistics is nowadays to bring the production closer to the sale, creating the basis for a functional co-working between the two functions, in order to assure the delivery of the products in the times and in the demanded amounts (effectiveness), containing as much as possible the costs of the supplies, the transports and the informative management of the production flows (efficiency).

The business logistic system must permit to realize the dynamic coordination between sales and production, guaranteeing an elevated service to the customer at low logistic costs. Such objective can be caught up through the management of the physical flows of materials in synchrony with the question of the market.

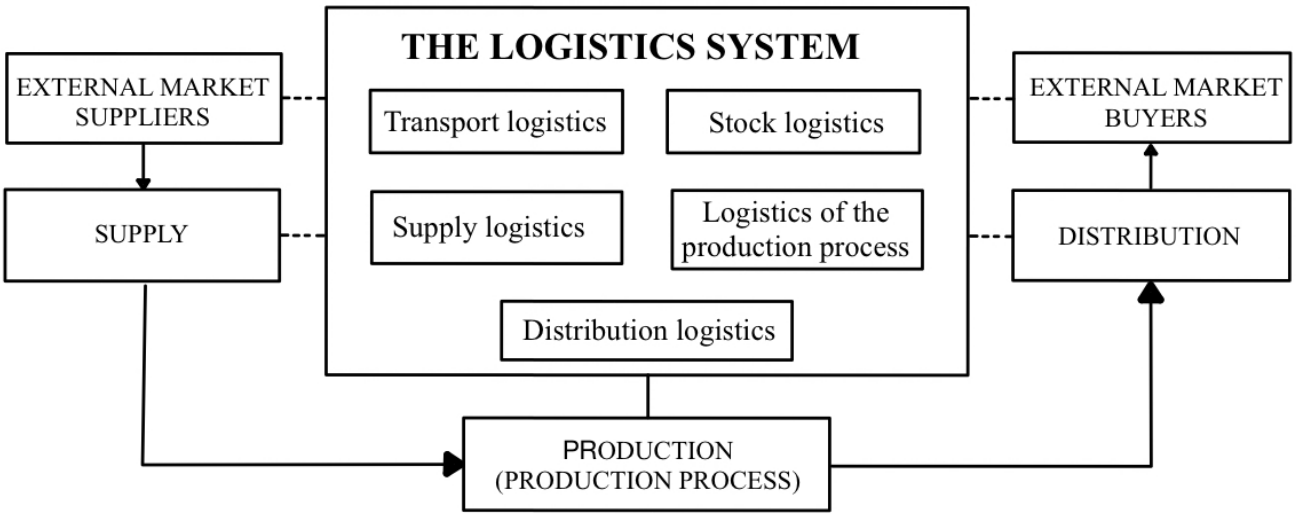

Figure 1: The logistics system (Balestri, 2012)

The current productive situation is characterized by a global economic system, with very high levels of competition, so it is becoming increasingly necessary to offer new and different products. A company that is trying to impose itself on the market must develop a preferential relationship with the customer, offering him a quality product and a continuous service, which makes him aware of the advantages of having chosen that product and that company.

The determining factors for the achievement of success in the perspective of this total quality are:

- the efficiency of the supply of raw materials and goods necessary for the transformation process;
- the possibility of having a logistical and commercial organization that allows the placement of the finished product or goods on the market, at the times and places required.

The task of company logistics is to connect rationally and efficiently the phases of acquisition of production factors, the development of the technical-economic transformation process and the distribution of the finished product.

The natural evolution of the logistic system leads to the affirmation of the integrated logistic system, with the aim of searching for the best combination between the sectors of supplying, storage and execution of orders received from customers.

The essential steps on which the organization and efficiency of the logistics system are based are the following:

- the stage prior to warehouse management, in which the requirements of goods and raw materials, as well as their procurement, are defined, must be developed in a specialized and qualified manner, choosing quality material, with reduced costs and reliable suppliers;

- internal data communication and transmission procedures must be timely and updated. That is, the warehouse must be coordinated with the production in order to evade the orders in the times required by the commercial service, allowing the company to achieve an advantage in the market.

The coordination of the productive phases has carried to the development of the concept of the supply chain. According to this, the enterprise is considered as a single ring of a logistic chain, that is identified as a net of connected organizational entities, interdependent but operating in a coordinated way. The main objective of the chain is to manage, control and improve the flow of materials and information. The chain starts from the suppliers and, after going through the supply, transformation and distribution phases within the company, reaches the final customers.

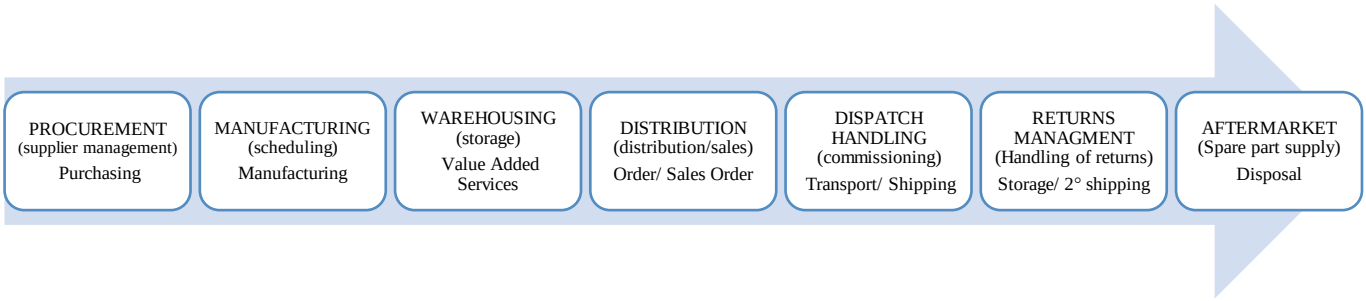

Figure 2: The supply chain (Self elaboration)

The supply chain has fostered the enlargement of the traditional concept of business logistics and can now be defined as "an extended enterprise", in which the business processes are properly integrated, from the end-user to the suppliers of materials, products, services and information, in order to create an added value for the customer.

The enterprise that intends to adopt this modern managerial philosophy must increase the rapidity and the flexibility in the evasion of the orders of their customers, strengthening their own presence on the market by reaching out to customers, by intuiting their needs before they become apparent and through the adaptation to the requests of the market.

The objectives that can be achieved with integrated logistics are generally three:

1) greater operational flexibility with contained costs, thanks to the reduction of company space allocated to warehouses and the level of stocks along the entire logistics supply chain;
2) synchronization of the demands of the customer with the arrival of the materials from the suppliers;
3) meaningful added value (efficient and punctual service) connected to the attainment of a competitive advantage over the competition thanks to a better service offered to the customer.

The activities that constitute the integrated logistic system are divided into two types: a system of physical structures and a management systems. Under the physical structures, there are all the facilities, materials and transport means that allow the actual flows of materials and finite products. The management system includes all the managerial activities (such as sales forecasting, customer service, management of stocks, transport, budget, etc) concerning the organization of the single logistics activities and the subsequent coordination between them.

One of the main consequences of supply chain development is that modern companies often outsource logistics services, agreeing with external suppliers to carry out certain phases of the company's logistics process.

However, the process of selling the products manufactured or the goods marketed apparently could represent the final phase of the company's operations on the market, in which the first contact with clients takes place, but in reality, it is not. That is why the sale of the product must be combined with services that allow for full customer satisfaction.

The logistics service is commonly defined as the set of logistics "benefits" combined with the sale of goods and services. Increasingly demanding customers do not simply request a product and consider their relationship with the company to be over at the time of delivery, but they express their needs by requesting a set of services that accompany the product even after sale.

The orientation to customer satisfaction induces the enterprise not to underestimate a series of elements related to the delivery of the good which are: timeliness and punctuality, reliability, and flexibility.

The logistics service is therefore configured as the ability of the company to adapt its logistical delivery methods to the needs of the customer, identifying these needs and trying to anticipate the demands.

From this point of view, the standardization of the clauses of delivery and evasion of the orders represents operative modalities that are not anymore compatible with the satisfaction of the customer in terms of personalization of the applied conditions.

The logistic extends to all the levels of the organization of a business, having to assure a high quality of the several phases of development of the productive process. The attention to the times of delivery is, indeed, an element that guarantees a competitive advantage in comparison to the competitor; people are obviously more attracted, in a condition of equal characteristics and price of a product, to choose the one that is delivered earlier.

The success of a business on the market today is also measured by the quality of the services offered post-sale, by the attitude to maintain the relationship with the customer "alive" during time, by their awareness of seeing satisfied their needs without the necessity to manifest them.

In order to reach this objective, companies invest a lot in the logistic service and place themselves in a collaborative relationship with their customers, trying to make them more involved in the company's choices.

The amount of the costs tied to the performance of the logistic service is defined as total logistic cost and its main components are correlated to the maintenance of the supplies in warehouse, to the processing of the orders and to the transport. These cost components are directly connected to the provision of the logistics service and are concretely sustained from an economic point of view; however, there are also stockout costs, which represent the invisible component of the cost of the logistics service, but which often have a predominant importance.

Going more in-depth about the transportation processes, the performance of any productive activity must be able to count on an efficient transport system and always requires, also at specialized levels, the help of transport functions.

Goods placed on the market are more competitive when they are available at the right time, in the right place and in the right quantity. The optimization of the various factors that concur to the availability of a good on a particular market today requires a difficult examination of a series of elements belonging to the same chain, in which transport represents the links that contribute to making continuous a phenomenon formed by different activities.

The management of transport is therefore integrated in a set of operations necessary for the transfer of materials, semi-finished products, products and goods.

The transport activities allow the constant connection between the sources of supply, the plants where the production process takes place, the centralized and decentralized warehouses, the points of sale and the outlet markets. Transport is therefore indispensable for the development of every economic and productive activity since it constitutes the conjunction point between the several commercial operators.

The obstacle represented by the distances that separates the various operators can be overcome through an efficient and effective system of connections and transport that guarantees continuous and rapid supplies to industries, trade and consumers. That is why it is usually preferred to talk about a transport system to highlight the key concept of integration between the various automotive, rail, maritime and air transport networks. An integrated transport system, in which there are interchanges between the various networks and between the various means of transport in fact ensures the essential requirements of efficiency and speed.

Careful management of transports constitutes one of the focal points in the logistic management of the productive process and it also has a significant impact both on company costs and on the logistics service.

More specifically, regarding the incidence on the entity of the business costs, the cost of the transports has a weight higher than 30% (Balestri, 2012) with respect to the total logistic cost of an industrial business; consequently, a bad management of the system of the transports has a negative repercussion on the entire cost of the logistics and on the incidence of this last one on the business revenues.

With reference to the importance of the management of the transports in the business logistic service, it is necessary to say that the timeliness of a delivery depends both on the immediate availability of a product in the warehouse and on the rapidity with which the product is transferred from the warehouse to the customer.

The binomial containing costs-efficient and effective logistic service is reachable only through a series of decisions that every enterprise should take having as its final objective its global efficiency.

The essential ones are:

1) Managing internally or outsourcing the transport service.

   With the first solution, to a huge investment in transport means and a high degree of capital immobilization corresponds an immediate availability of means. With the outsourcing of the service of transport the enterprise, acquires flexibility in the management of the service, with sensitive savings of costs and no employment of capital, to which corresponds however the risk of not having the availability of the carriers in the appropriate moment. Naturally, this latter aspect is influenced by the contractual weight of the company with respect to those who manage the transport service;

2) Defining the frequency and average size of shipments, through an assessment of the cost of maintaining stocks in the warehouse for a more or less long time;
3) Assessing which means and modality of transport are more opportune, comparing the relative costs with the performances in terms of speed and capacity of cargo.

There is no a priori optimal solution to the business decisions examined; in the majority of cases, there is a mix of options to which the company resorts depending on the type of transport to be carried out.

As stated before, a transport system, especially if integrated, is based on different modes of transport, each of which has specific characteristics, which can advantage and disadvantage in terms of time, costs, risks and quality of service. From the comparative cost/benefit assessment comes the optimal combination that the company uses, all appropriately weighted in relation to the level of service that is intended to be offered to the customer.

The main means of transport that will be analyzed are:

1) Road transport
2) Rail transport
3) Maritime transport
4) Air transport
5) Intermodal transport

(1) Road transport is the most widely used and in continuous development.

It consists in loading goods onto vehicles travelling along with the road network. Unlike other types of transport, it allows a direct connection between the sender (the company that sends the goods) and the receiver (the company that receives the goods).

The costs of road transport are higher than the ones of sea and rail transport but are lower than air transport. However, the load capacity of some vehicles is reduced and, with the increase of the payload the speed of delivery decreases. One positive feature of this type of transport is the flexibility, given by the widespread capillarity of the road network that allows the connection of the various points of origin with the respective destinations.

→ Advantages: direct connection between sender and recipient, high speed in deliveries and high flexibility in connections

→ Disadvantages: high operating costs and low load capacity

(2) Rail transport is still underdeveloped and noncompetitive, and so for now it covers a modest share compared to the total traffic. It consists in loading goods onto wagons that travel along with the rail network. The main aspects that characterize rail transport are low costs, high load capacity and generally long travel time. In general, the type of goods transported is of low value and in large quantities.

Rail transport is particularly advantageous when the sender and the recipient company have direct tracks with the railway line, which allow the goods to leave directly from the origin and arrive directly at the recipient, without the need to use means of transport to reach the nearest railway stations.

→Advantages: low operating costs and high load capacity

→Disadvantages: long travel times

(3) Maritime transport or sea transport consists on loading goods onto ships as they travel their sea route from one port to another. It is characterized by its economy compared to other types of transport, thanks to the large quantities of goods that a ship can carry. However, it is a type of transport that requires long travel times due to the slowness of the means of transport used. The ideal type of goods transported by sea is of low value and in large quantities.

→Advantages: low operating costs and maximum load capacity

→Disadvantages: long travel times and low flexibility

(4) Air freight consists of loading goods onto aircraft that travel the relevant routes from one airport to another. The aircraft can be either totally dedicated to cargo transport and therefore follow a specific route, or it can be a scheduled flight loaded both with passengers and cargo and therefore follow a non-commercial route. This type of transport, although characterized by the extreme speed of shipments, still has a limited use due to the high cost per unit of load. In particular, it is taken into consideration for the solution of particular situations such as urgent shipments, perishable goods, high value and small size products.

The choice of air transport over other transport routes depends essentially on the value of the goods, the distance to be covered and the speed of delivery. It is important to focus on the speed of delivery that can be achieved by air freight, since, even though air transport is more expensive than other transport systems it must be properly assessed in terms of various aspects. These are the reduced lead time for capital invested in inventory, the lower inventory management costs, the quicker turnover of stocks, the prompt response to market requirements and all the consequent indirect advantages. From that it derives that the cost of the transport cannot be the only indicator on which to carry out the arbitrage of convenience with the comparison costs/benefits.

→ Advantages: short connection times and coverage of large distances

→ Disadvantages: high operating costs per load unit

To go more in-depth, it is important to consider that air cargo is a key component of many international logistical networks as an essential resource for managing and controlling the flow of goods, energy, information and other resources, such as products, services and people. It is difficult or almost impossible to realize any international trade, global export, import process, or international repositioning of raw materials, without a wise management of the opportunities offered by air transport. In this regard, the operational responsibility of logistics becomes the geographical repositioning of raw materials, work-in-progress and finished goods at the lowest possible cost. In particular, as already stated, air freight is characterized by its speed and very low risk of damage, making it particularly suitable for fragile, valuable or urgent goods to be delivered.

Air freight processes are based on a characteristic recursive structure in which the same actors are involved within the logistical activities to be implemented for the transfer of goods from one place to another.

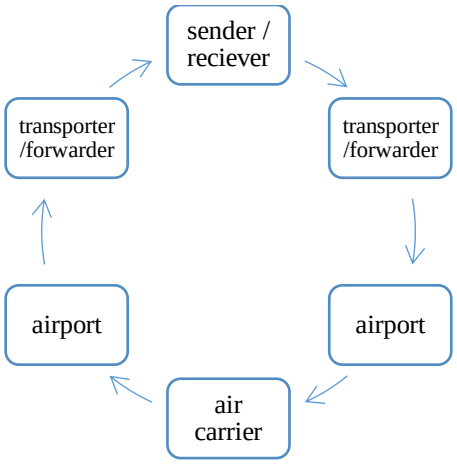

Figure 3: Air freight processes ((Faioli, Fantoni, & Mancini, 2018))

Within this context, the critical issues associated with logistics systems involving intermediate carriers that transport goods from the point of departure to the airport and vice versa (in particular trucks and trains), as well as the logistics structures with which they interact, and in particular logistics hubs (also known as interports), are integrated.

Operational activities closely linked to airport logistics and flight phases differ depending on the context in which they are carried out; specifically, a distinction can be made between activities carried out on the ground and those carried out inside the aircraft.

Ground activities (Airport Handling) focus on administrative management and control of the regularity of transport documentation, as well as the loading and unloading of incoming and outgoing freight. The main activities are therefore the acceptance of goods, the securing of warehouses, palletizing and the management of customs documentation.

The activities that involve the aircraft instead are the security check and the movements, in entrance and exit, from the aircraft to the warehouses.

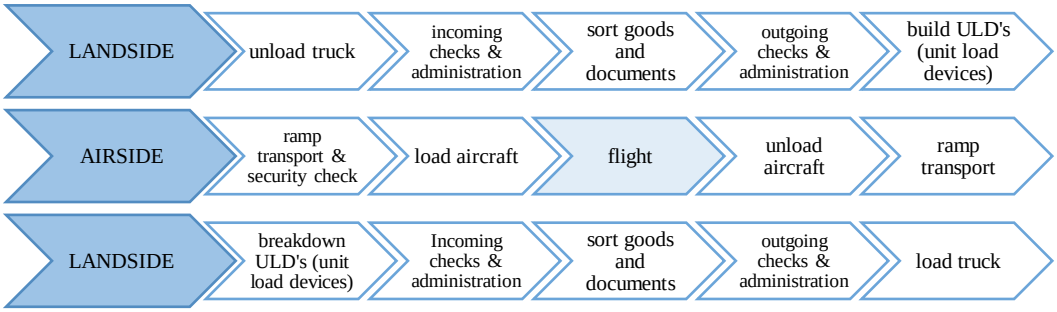

Figure 4: The key activities of airport logistics and flight related phases (Faioli, Fantoni, & Mancini, 2018)

The analysis of the critical elements of each type of transport shows how difficult it is to choose a priori the use of freeway transport rather than rail, or sea transport rather than air, or vice versa. Indeed, it often happens that a company uses various types of transport in a complementary way within the same shipment.

(5) This is referred to as intermodal transport, where intermodality is to be understood above all as the integration of transport, no longer seen as a sum of separate transport activities, but as a single service from the place of origin to the place of destination, in a global perspective of transfer of goods.

The intermodal transport is generally carried out through one of these combinations: trucks or semi-trailers loaded on ships or loaded on special rail wagons, in order to avoid the movement of goods from one means to another, or containers transported on ships, railroad cars or trucks.

The loading of one means of transport onto another belonging to a different system represents a typical case of combined transport. In order to concretely implement intermodal transport and create an integrated transport system, a number of freight centers have been created to act as junctions between several transport systems.

Therefore, by the analysis of costs and benefits of the different types of transports it emerged that the best way to move products, whether they are to be assembled or finished, depends on a series of different variables.

- Costs: The most expensive mean is air transport, while the cheapest one is rail and sea transport.
- Load capacity: The means that guarantee more capacity are maritime and railway, while the one with less capacity is road transport.
- Travel times: The fastest mean is air transport, while the slowest are sea and rail.
- Connections: The most flexible mean is the automobile and the least flexible are the sea and air.

1.2 – The impact of e-commerce on the logistics sector

E-commerce is the set of commercial transactions involving goods or services sold through electronic means. Depending on the mode of sale and the type of products we can identify two types of electronic commerce

- indirect electronic commerce (offline), which is the form of commerce more similar to the traditional one; in this case material goods are viewable on an online catalogue in which product characteristics, price, delivery and payment methods are illustrated. After the order, the good is shipped or delivered to the buyer with the traditional channels (postal shipment, courier, etc); the payment can be made or directly at the moment of the order (credit card or other electronic payment systems) or at the delivery.

- direct electronic commerce (online), in which instead the sale of intangible goods is provided exclusively through the Internet or through an electronic network, and so the performances are essentially automated. In these cases, the purchaser views on the online catalogue the good or service to be purchased, proceeds to the order, executes the payment with electronic systems, and can either download the good or receive the service.

From the point of view of the parties involved in electronic commerce, there can be distinguished various models for each of which different principles and applicable legal regimes can be identified.

(1) The "business to business" (B2B) model: it is established between professional businesses and for the most part concerns commercial transactions.

(2) The "business to consumer" (B2C): it is the most common and well-known model. It consists in the purchase on a website of goods and services by the final consumer. This type of relationship on the one hand has allowed companies to reach directly and in the shortest possible time the largest number of consumers,

while on the other hand it has opened for consumers the possibility of having access to a wide range of products without the burden of going to physical shops.

(3) The model "consumer to consumer" (C2C): The website that uses this model helps consumers to directly sell their goods. It's a diffused form mainly thanks to online auctions, sites where buyer and seller meet to deal with any type of product. In these cases, the site only manages the environment where the parties interact, doing most of the work, from the publication of the product until the shipment, to their "customers". The website usually makes a mark-up on the cost to the consumer.

(4) Finally, there are the "peer to peer" (P2P) relationships.

In the last years, and specifically in Italy by the end of August 2017, a new model of marketplace was spread, the peer-to-peer model. Facebook, which was for ten years outside of the world of e-Commerce, decided to activate a new feature that would allow users to post ads for free, within its social network, in a section called precisely "Marketplace". Unlike other competitors, Zuckerberg's company does not require a commission on sales, as it does not offer any kind of guarantee or assistance in buying and selling; it simply puts sellers in touch with buyers through its platform. They will then agree on how and when to ship, how to pay and how to resolve any disputes.

In the era of the digital economy, e-Commerce is experiencing an incredible explosion, which has disruptive effects on the logistics chain ranging from the organization of transport to warehouse management, to city deliveries; in practice, e-Commerce is affecting the entire supply chain. For example, it is changing the nature of logistic centers, interports and warehouses; these structures must quickly adapt to a different type of clients, that operate on the web and that, therefore, need different spaces and services than the one of traditional operators.

The growth of e-Commerce, moreover, has even more exposed and further aggravated the issues of logistics in urban centers, experienced even by cities with technologically advanced structures, because of the extreme fragmentation of deliveries due mainly to the different steps in the procurement of services.

Internet is by now an unstoppable revolution and staying away from it is no longer an available option for any type of business, not even a small store. This does not necessarily mean selling online, at least not immediately, but it does mean being present on the web.

Internet and digital, if correctly used, represent tools of a competitive advantage and cost reduction able to improve the physical store, strengthening its key elements and extending its competitive characteristics.

E-commerce opens the door to new opportunities; physical stores can serve a limited number of clients, in established times and in circumscribed physical spaces. The traditional selling channel represents a small business as it can only serve a few people (customers in the proximity of the store) and for a short time. On the other hand, the biggest and most important advantage of e-commerce is that it allows the business to address the needs of national and international markets, overcoming geographical boundaries. On the web it is possible to reach an unlimited number of customers, without time and place restrictions. In practice, the online store has a huge business potential because it can sell to many people and for a long time. Even small

businesses can access the global market to sell and buy products and services, increasing sales and profit.
The web has revolutionized the way of perceiving the purchase, giving to consumers great bargaining power and also more awareness thanks to global competition. It has also allowed sellers to lower their costs and set a price lower than the one in physical stores. Today, people need to do things quickly and easily and the web has been able to give them this opportunity.
Going further, it is important to notice that e-commerce and physical stores are not in competition but must work in an integrated way to support each other. More and more consumers inquire on the internet before buying and an incredible number of them express their evaluations on the internet after buying. For every online purchase there are at least three more that are formed online but then materialize in the physical world. Consumer behaviors that integrate the online and offline buying process are increasingly common and can be divided into three types:

1) Many consumers search for information online (reviews, product descriptions, data sheets, etc.) and then go to the physical store to have the item in their hands immediately after the purchase. It is the phenomenon indicated by the acronym ROPO (Research Online Purchase Offline). Intercepting the ROPO, and so making sure that during their online research, potential customers are directed to the store and perceive at best the validity of the offer must be one of the objectives of the online strategy of a physical store.
2) There is also the opposite phenomenon: customers who try products in the store, perhaps taking advantage of staff's expertise to get a better idea of the features, and then leave without buying anything because they will buy it online. The phenomenon is becoming known as showrooming, as if the store were merely an exhibitor for online sellers, or even TOPO (Try Offline, Purchase Online).
3) Another behaviour that is spreading lately, a perfect example of integration, involves buying online and picking up the product in-store, perhaps because the good has a considerable value and you do not trust the transport done by a third party or because, as in the case of clothing, the customer before finally withdrawing wants to try the item.

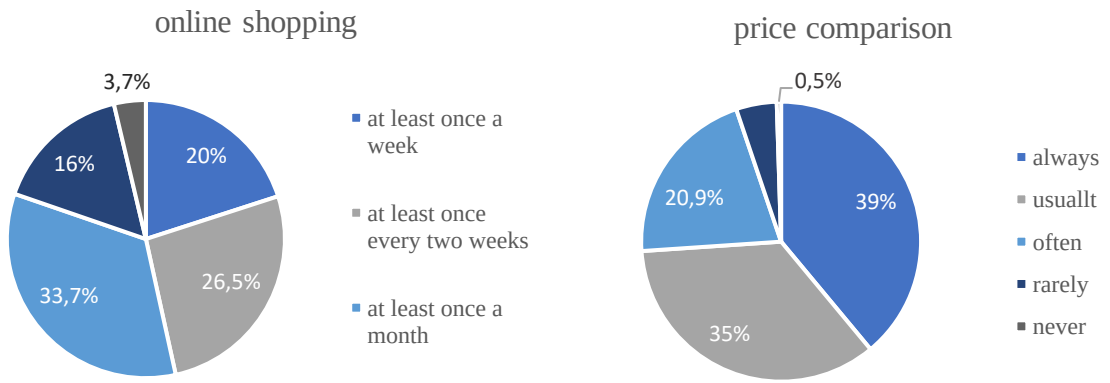

Figure 5: Frequency in percentage of online shopping and use of price comparison, February 2020 (Idealo Magazine)

Starting from the years 10s of the 2000, e-commerce has recorded a nearly exponential growth of its revenues;

that results from the fact that consumers have become more and more attracted to this new distribution channel that satisfies their needs of timing and comfort.

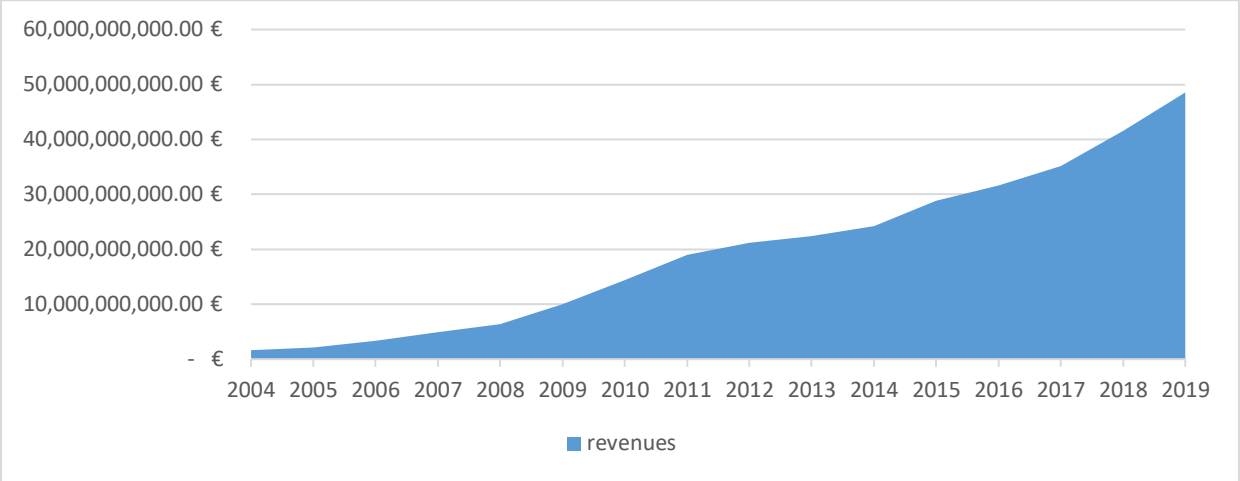

Figure 6: Revenues of the e-commerce from Italy (Casaleggio Associati, 2021)

There can be detected around ten moves that have determined the growth of the phenomenon:

1) Consumer reviews

   Today, people have no reservations about booking a vacation, hotel, or home they've never been to because they can first look at sites like TripAdvisor and read reviews from real users who have already gone through the same consumer experience. Feedback has made customers more knowledgeable and informed.

2) Responsive sites

   Responsive design allows customers to create a single user interface that adapts to the size of whatever device they are using, giving them a tailored experience.

3) Mobile

   Correlated to number two, the ability to browse on the move has completely changed the way people browse and buy online, being able to search and view a product virtually anytime, anywhere. However, while mobile presents new challenges, it can also be a valuable ally for retailers in intercepting new customers by increasing in-store traffic.

4) PayPal

   Online transactions have always been the soft spot of e-Commerce since consumers initially mistrusted the payment methods available online. For this reason, systems like PayPal were born, thanks to which it is now possible to store all the data of the payment methods in a safe way, speeding up the transaction. No data will be communicated to the seller. However, PayPal is for now only the second most used means of payment, right after credit cards.

5) User experience

   The world of online retail is increasingly competitive, users are informed and knowledgeable. A site that provides an optimal experience is essential to compete in the market. It is not just a matter of a beautiful site, with attractive graphics and innovatively presented content, but about usability; e-Commerce sites

must know users and know what they want, interact with customers in a discreet but present way, direct navigation according to their needs and accompany them throughout the buying process in an efficient way.

6) Deliveries and returns

   Until a few years ago, the delivery of a product in 24 hours was a new and exciting option, as well as expensive; today, it is almost taken for granted. In tomorrow's e-commerce, probably same-day delivery will become the standard option, with the ability to choose the most convenient time slot relative to one's schedule. Also, even when a product doesn't go well, expectations are highly settled; in many markets, such as fashion, customers expect to be able to return the product with no extra cost and in a short time. The assurance of these dynamics has contributed to the success and spread of online commerce.

7) Click and collect

   When consumers use e-commerce, they can buy any product from anywhere in the world, but the problem arises when their schedule does not match the working time of the courier. So, if you can't be home to wait for your package, you can always go to the store to pick up your purchases. A method of pickup that has encouraged physical stores and pushed the big chains to ally themselves with the courier collection points. It seems like a trivial solution, but it can significantly increase sales, attracting customers who otherwise would not have purchased.

8) Search filters in browsing

   The navigation through the variety of products offered on websites, made it essential to simplify and speed up browsing and searching for items. Users can search for exactly what they want, entering their own preference parameters (which can then be used for re-marketing operations) and shortening search times, which usually tend to inhibit purchases by rising the abandonment rate. The biggest innovation has been “faceted navigation”, which is the ability to apply filters to search engines. Until a few years ago not many e-Commerce sites used this technology in a meaningful way, while today it is difficult to find a site that lacks it.

9) Social media

   They actually play a dual role: a channel for companies to reach their customers and talk to them, and a tool for customers to incentivize retailers to offer better services. Social media platforms are fundamental to promote products and websites in a targeted way and to build a two-way relationship with customers.

10) Big data

    Managing relationships with the public based on the information they have is a key step to e-commerce success. More sophisticated tools, such as SAP Hybris Marketing, allow companies to tailor communications based on their customers, increasing the likelihood of completing the sale.

In addition to that, it is also fundamental to understand that e-commerce is no more a phenomenon reserved to young customers, who are anyways the biggest users of the Internet.

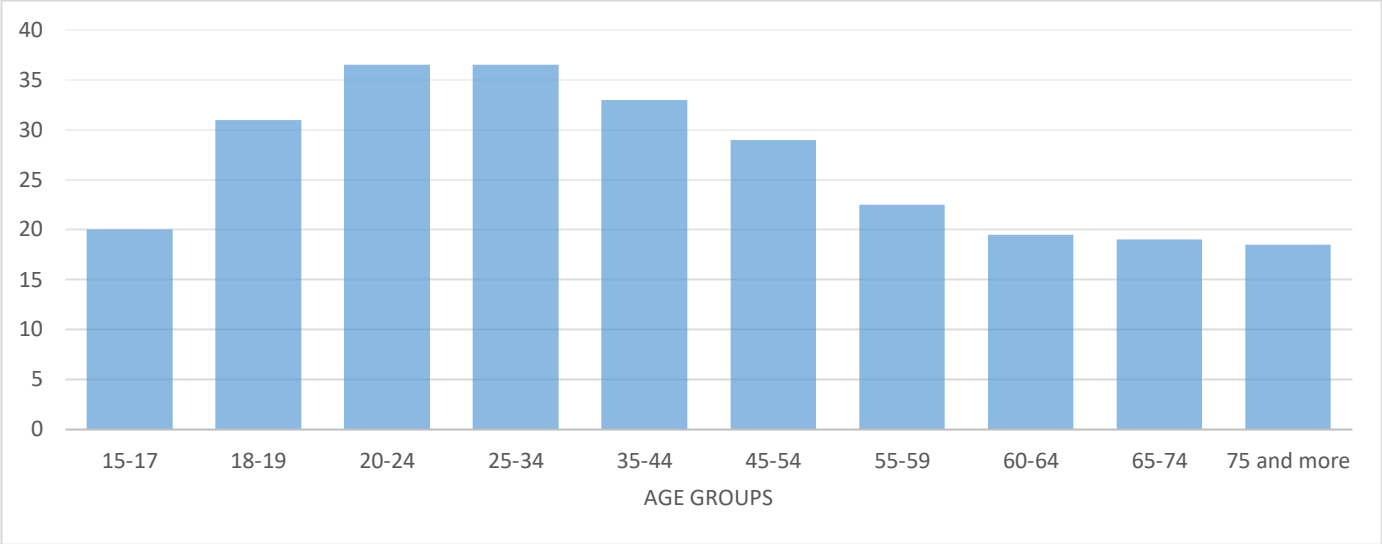

Figure 7: Online purchases in % divided by age groups (ISTAT, s.d.; International trade organization, s.d.)

Indeed, looking at Istat data for Italy, it can be seen that online purchases come from different age groups, since it is necessary to earn a certain income to spend in order to be a heavy spender, even online. This reflects in the fact that the biggest buyers are the medium-high income consumers, which have a great weight both in terms of overall volumes and, above all, in terms of influence on others.

SECTOR	**2005**	**2016**	**GROWTH RATE**
Tourism	1123	8561	7x
IT	310	2932	10x
Clothes	85	1898	22x
Insurance	339	1225	4x
Books, Music, Film	85	687	8x
Furniture	n.a.	652	n.a.
Grocery	56	575	10x
Others	734	3119	3x
Total	2822	19649	7x

Figure 8: Sales in the e-commerce sector in Italy millions of € (Politecnico di Milano and ISTAT)

In terms of product categories, tourism takes the greatest share, favoured by the consolidated habit of paying deposits for bookings, or paying in advance for the amount of the trip; the same works also for online sales of tickets for transport, which accounts for over 70% of total sales in the sector. An important role is also played by IT and electronics, favoured by the means used to navigate, and by insurance and financial services in general. Publishing is favoured by the digitalization of books, songs, videos, etc.

In general terms, it can be stated that no product category can consider itself safe from online competition. Given the important numbers and trends that distinguish it, e-Commerce represents an interesting opportunity for different sectors but is only timidly grasped by the retail world, which often lives it only as a threat.

Today e-commerce represents one of the businesses with greater prospects of successful competition for those

companies that intend to profitably exploit the combination of business and technology. E-commerce represents, indeed, from the point of view of time, the last competitive opportunity made available to companies by IT; which, however, has already contributed significantly to the growth of companies both in terms of efficiency and in terms of their approach to the market.

Therefore, nowadays logistics is not only involved into warehousing and transports, but it became an element of competition with the other enterprises, and can be, if adequately exploited, a strategic strength for the success of the companies. This is realized both thanks to a reduction in the costs and in function of an increase of the added value of the final product, obtained by improvements of the service offered to the customer.

As a consequence, it is obvious the logistics enters into the area of the services offered to the customer and it has been seen that market demand for a product increases when that product also satisfies the requirements of punctuality and reliability of delivery, reduction of the lead time of purchase etc.

Logistics and e-commerce are indeed intimately tied: most likely that the second one is destined to better the field of the logistics, while the first one is often the true weak point of the online commerce. On the other hand, logistics is the critical factor of success on which not only e-commerce giants are challenging themselves, but also retailers who, alongside physical stores, develop an e-commerce activity.

Shorter delivery times, customized deliveries and services that are still being developed such as "predictive shipping" and delivery by drones are the path on which the relationship with the consumer and the success of sales are measured (fast delivery time is one of the major requests of online buyers). Logistics and retail are the sectors most affected by online commerce, and in particular, logistics can outgrowth from the development of this sector. Indeed, even if e-commerce is global, it should always be managed locally to meet the needs of fast and effective delivery to customers. It's the shipping that makes the difference: the delivery time together with the indication and respect of a precise time for the arrival of the courier are the element that most guide the final opinion of the customer.

The process of direct delivery service is divided into three main phases:

1. Receipt of the order and generation of a delivery guarantee or promise of receipt
2. Picking and assembly the order
3. Order delivery

From the analysis of the market, it emerged that there are a series of factors that influences the way in which each logistic company execute the delivery:

1) Sizing of the fleet
2) Routing
3) Pricing
4) Delivery Cost
5) Level of service and customer expectation
6) CO_2 emissions
7) Innovation and benefits

8) Order fulfilment
9) Customer density
10) Failed deliveries and delays

The main business models adopted by enterprises can be divided into three categories:

1) Online pure player: these are specialized online sales operators that sell exclusively through their own eCommerce site. They are equipped with a physical network infrastructure (warehouses, sorting hubs and transit points may also belong to other logistics operators but are without points of sale);
2) Click & Mortar: in addition to selling through a network of physical points of sale, they also offer the possibility to buy online and receive the goods at home or at a pick-up point. Characteristic of this category are the traditional merchants (called "Brick & Mortar") that have converted to multi-channel sales (e.g., Esselunga, which operates in northern and central Italy);
3) Intermediaries: these are online aggregators of products sold by other merchants. The term associated with intermediaries is "Drop Shipping": they do not hold stock and are not owners of the goods that are displayed and sold on the proprietary website. Upon receipt of the order, these operators take care of finding the products from the physical stores among which the buyer can choose, of the order consolidation and of the final distribution activities (in Italy Cortilia).

This last model is still a novelty in the eCommerce sector, especially in Europe, while it was the first to be born in the US ten years ago. New operators have also begun to spread in Europe and Italy after the success of Amazon Fresh in the US and, more recently, in the UK. Excluding intermediaries, only a small number of online and multichannel merchants are vertically integrated into the final distribution activities: this was a decision with a strong strategic impact on the company's organization in terms of dedicated personnel, investments in structures and logistic means and specific skills. It is mostly a choice made by the large-scale distribution brands, such as Tesco in the UK and Esselunga in Italy, which deal directly with last-mile delivery since the capabilities of couriers may not be compatible with the specific transport needs of certain products.

Moreover, for logistics companies it is important to identify what are the main features that customers expect when buying online products. The most important ones are as follows:

1) Punctuality
2) Independence
3) Timeliness
4) Economic convenience
5) Transaction cost
6) Personalization and control
7) Information completeness

The e-Commerce industry has undoubtedly revolutionized the way in which people make their purchases and has completely transformed the B2C industry, a market where the necessity to meet the needs of individual customers becomes a must. With the growth of e-Commerce, consumer preferences are the focus of the parcel

delivery market. Large players, as well as start-ups, have identified last-mile delivery service as the discriminating factor to compete in the market.

In general, the revolution of connectivity and telecommunications has created opportunities and the need for a strong reorganization and therefore a path towards sustainability of the entire transport and logistics system.

1.3 – Revenues of the e-commerce before and after the Covid-19 pandemic

The health emergency that we have found ourselves in during recent times has upset not only our lives and habits, but also various economic sectors, including inevitably logistics and transports.

The pandemic has revealed the critical aspects of a system based primarily on globalization, but it has also shown the entire world how crucial logistics are: while the world stopped and looked at what was happening, trucks, planes, ships and trains continued to circulate to allow each of us to continue to enjoy those comforts now taken for granted.

If it is true that the crisis has upset the present, it is equally true that also the future will change, not only because it has determined new economic and geopolitical balances, but also because it has questioned both the efficiency of our health systems and the general organization of our lives, production, consumption, transfers of people and goods. It was in fact a real crisis for three main reasons:

1) it affected horizontally all sectors,

2) it affected vertically the entire supply chain,

3) it affected final consumer demand.

Moreover, it can be defined as a structural crisis because it changed models, both in the production and in the marketing and physical distribution of goods. On a more general level, there was a double negative shock: on the demand side, with the postponement of consumer spending decisions, the closure of numerous commercial activities (in sectors such as catering, accommodation, transport, cultural activities and entertainment) and the cancellation of tourist flows; on the supply side, with the blocking of numerous production activities, both by law and to allow for the sanitization of the workplaces of companies still in operation. The Covid-19 crisis has made it clear how interconnected we are to one another, both in terms of social and labour issues.

From a retail perspective, it is clear that the pandemic has benefited e-commerce and, to a lesser extent, also neighbourhood stores. However, there is still a strong concern for smaller stores that had to face the prolonged closure and were not able to reopen once the emergency was limited. Looking at e-commerce data today, it can only be confirmed the trend that was predicted: new e-shoppers grew by more than 1.3 million in Italy *(Council Freight Leaders, 2017)* only in the lockdown period and, home and instant delivery services have undergone massive growth throughout the first periods of the emergency. Sectors such as food, household goods and personal care have experienced an unprecedented boom in e-commerce. The emergency has once again underscored the healthy state of e-commerce. Indeed, looking into a more concrete data about the sectors that have been influenced by this peak in the online sales, it can be seen that, accordingly to what stated before, they all had a medium growth of around 19%, divided by industries as

follows:

Industry	Pre Covid-19	Post Covid-19	Growth rate
Furniture and Appliances	327	383	17%
Food and Personal Care	381	482	26%
Electronics and Media	505	601	19%
Toys, Hobby and DIY	525	636	21%
Fashion	658	752	14%
TOTAL	2397	2855	19%

(All the data are calculated in billions of USD)

Figure 9: Impact of Covid-19 on ecommerce (International trade organization)

The health emergency has put the supply chain under pressure due to several factors: the security regulations to be adopted, the difficulties at the borders, the closure of production centers, even those located in other countries affected by the virus and, finally, the peak demand for certain products to be managed logistically in a short time.

If, during the first phase of the health emergency, some logistics chains had to stop or at least slow down, others were hit by a sudden increase in demand, like those linked to the food or pharmaceutical sectors.

Therefore, if even before the spread of Covid much of the stress of the supply chain was going to be poured on the final link, the one related to the last mile, the health crisis has certainly worsened this aspect.

With the closure of commercial activities and the limitations of travel, indeed, e-commerce, has experienced an unprecedented boom that the chain was perhaps not yet ready to face. More and more consumers have begun to make purchases online and, above all, to request always shorter times for the delivery of goods; it is the phenomenon of instant delivery that inevitably generates stress on the entire supply chain. The Covid has therefore accelerated a phenomenon already in strong expansion like that one of the home deliveries with all the repercussions on the supply chain that it brings with itself.

On the other hand, however, the pandemic has also highlighted the crucial role that logistics plays in our lives even if most consumers are not completely aware of it: the pandemic brought out the centrality of this sector without which we would not be able to enjoy all the comforts and conveniences we have today.

If before the concept of logistic chain was reserved to the insiders, today the understanding of what intervenes between the production of a good and its availability on the market is much more diffused.

The possibility of grabbing any type of good in a short time and according to our needs only depends on the proper functioning of the entire supply chain. Despite all the difficulties, therefore, it is thanks to the correct and efficient functioning of the entire chain that the sector has resisted the crisis, ensuring supplies of various types of goods even in the midst of a lockdown period.

It is by now out of doubt that, although the development of e-commerce already had its annual rate of growth quite advanced, the latter has undergone a boost thanks to the pandemic. Looking at the data concerning the

development of e-commerce shares in total retail sales in a series of countries before and after the pandemic calculated in January 2021, we can see that during the peak of the pandemic, specifically in March and April 2020, when the majority of nations around the world established lockdown measures, e-commerce share in addition to retail sales saw extents that were not seen before. Within UK, where an already developed e-commerce system existed, nevertheless its share saw an increase up to 31.3% before stabilizing. Moreover, up to the beginning of 2021 UK, US and Canada were the leading countries where e-commerce had the highest share with respect to the total retail.

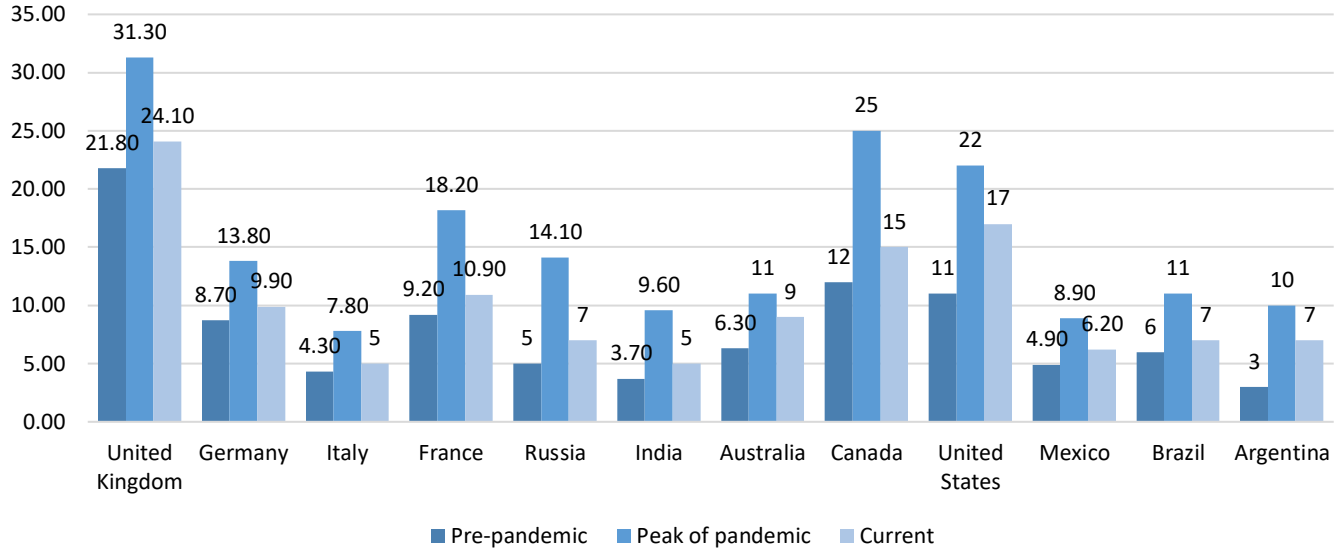

Figure 10:Development of e-commerce shares in total retail sales in selected countries before and after the coronavirus (COVID-19) pandemic as of January 2021 (Statista)

CHAPTER 2
THE CARGO FLEET

2.1 - The composition of the cargo fleet

Air commerce was firstly regulated by the Paris Convention of 1919 and by the Warsaw Convention of 1925 in order to facilitate its growth; however, in reality, nations firstly used air cargo to develop extensive airmail networks.

Then, starting from the 1950s the demand for air freight services started to grow mainly due to longer range, higher capacity, and more fuel-efficient aircraft such as the Boeing 707. These new characteristics of the planes reduced the cost of air transportation helping the airlines that were emerging at the time to maximize their revenues.

Since the 1970s, growth in air cargo traffic has been steady and has only been affected by three global events:

1) the War of the Two Gulfs in 1990/1991,
2) the attack on the twin towers in 2001,
3) the 2008/2009 crisis.

Subsequently, during the first period of Covid-19, due to the limitations on passenger movements, and therefore the decrease in belly-cargo, there was a drop in traffic. Starting from 2021, by contrast, due to the increased demand to transport high value and small size materials (mainly vaccines, drugs and medical supplies) there has been a higher than average increase in air traffic.

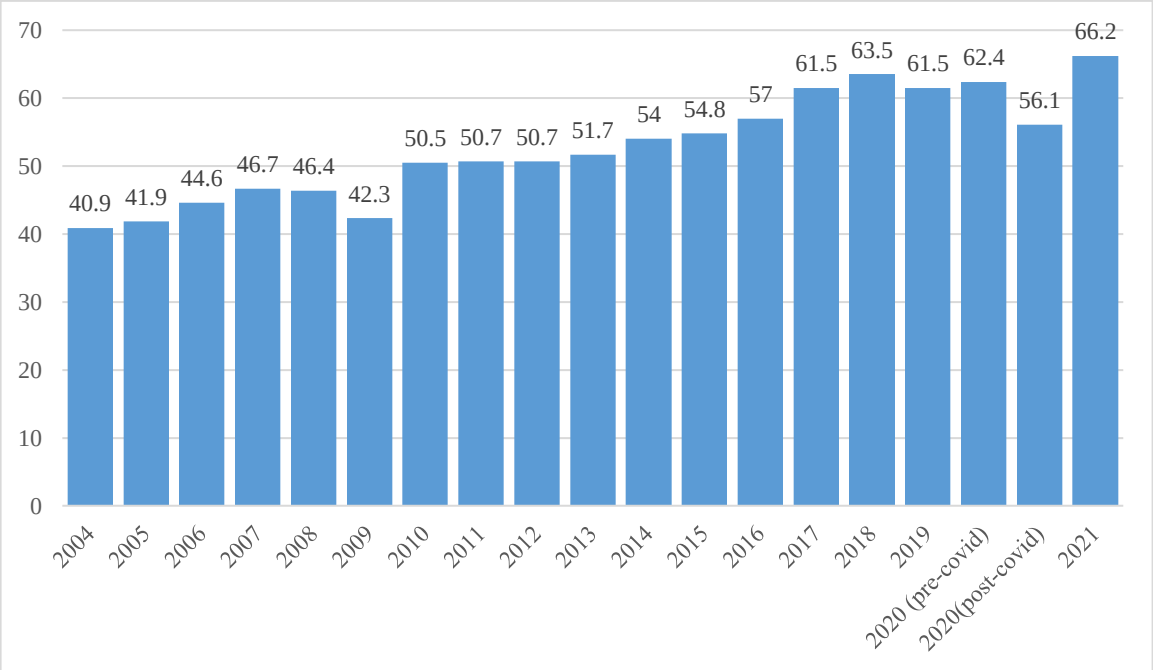

Figure 11: Worldwide air freight traffic 2004-2019, Million metric tons (IATA)

Earnings from commercial air transportation have followed the same trends as traffic over the years, as shown in the following chart:

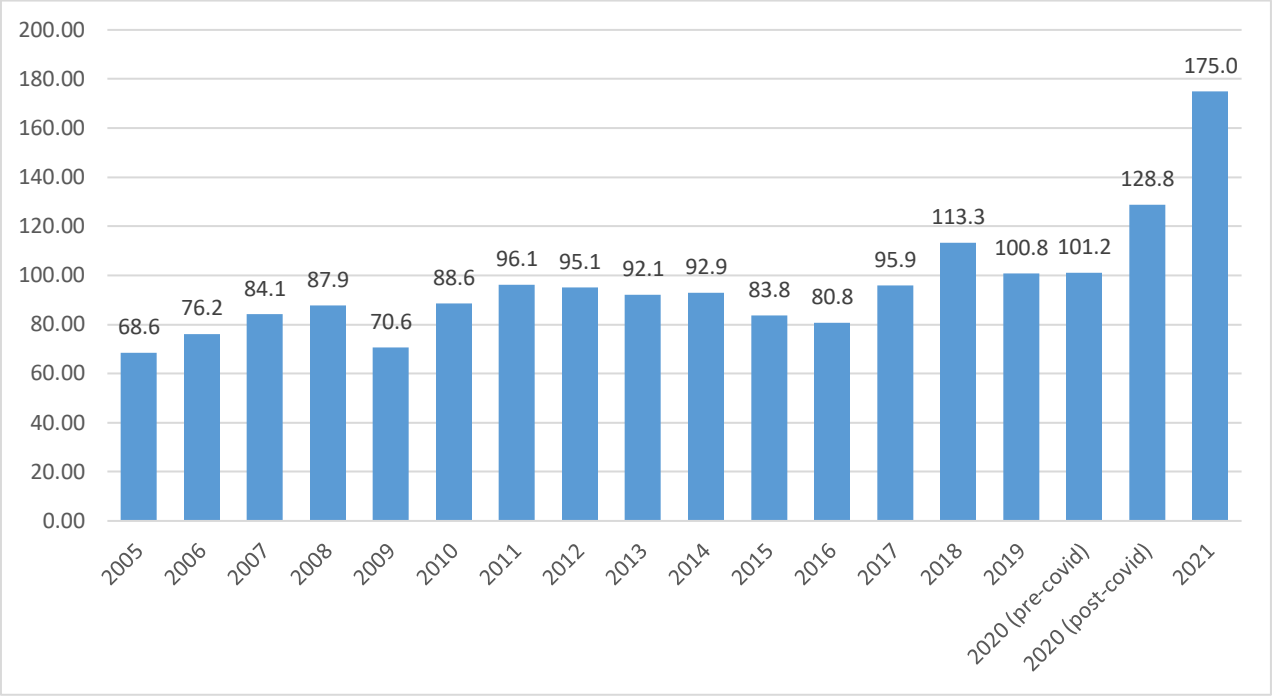

Figure 12: Worldwide revenue of cargo airlines in billion U.S. dollars (IATA)

As of today, the air cargo fleet earns approximately 175 billion in revenues per year and, according to estimates, this number will continue to increase.

Commercial air cargo traffic is divided into four main categories:

1) belly-cargo
2) dedicated freighters
3) a mix of both 1 and 2
4) express freighters

Belly-cargo is a type of transport characterized by the loading of goods on passenger flights in the lower part (belly) of the aircraft. On the contrary, cargo aircraft, or transport aircraft, are fixed-wing aircraft designed or converted for the transport of goods, rather than passengers. They are deprived of passenger facilities and generally offer larger doors for loading and unloading cargo. Aircraft designed for cargo transport have several features that distinguish them from passenger aircraft:

- Wide fuselage, to accommodate more cargo or bulky cargo,
- High wing, to allow the cargo area to be located closer to the ground,
- A considerable number of wheels, to allow landings on unprepared runways,
- High tail, to allow direct entry and exit of cargo into the aircraft by means of a tailgate,
- Specially designed for international transports.

The combination of belly-cargo and dedicated freights consists of using both dedicated main-deck freights and the belly capacity of passenger networks in order to have reliable air connections to and from home markets and hubs.

Express cargo operates main-deck freighter fleets of different sizes to "provide time-definite services as well as general air cargo capability" (Boeing).

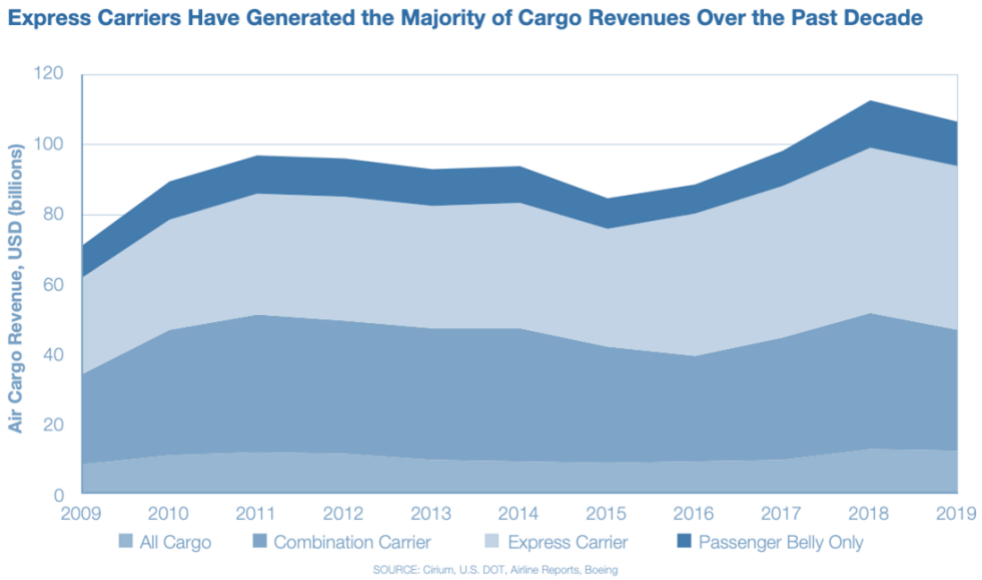

Figure 13: (Boeing)

Although almost 50% of global air cargo is carried as belly-cargo, dedicated freighters are an essential component of the operational flexibility and customized scheduling that logistics operators try to provide to their customers. Indeed, airlines that have main-deck freighters in their fleets earn up to 90% of the total air cargo industry revenues.

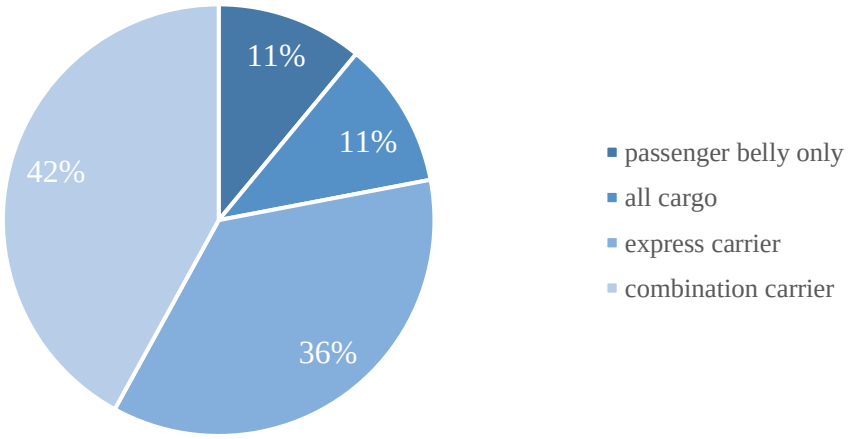

Figure 14: Air cargo revenues (Boeing)

The regional breakdown of air traffic is more concentrated in Europe, Asia-Pacific and North America, which respectively account for 20%, 34% and 24% of the total RTK (revenues per tonne-kilometers) which is equal to 264 billion.

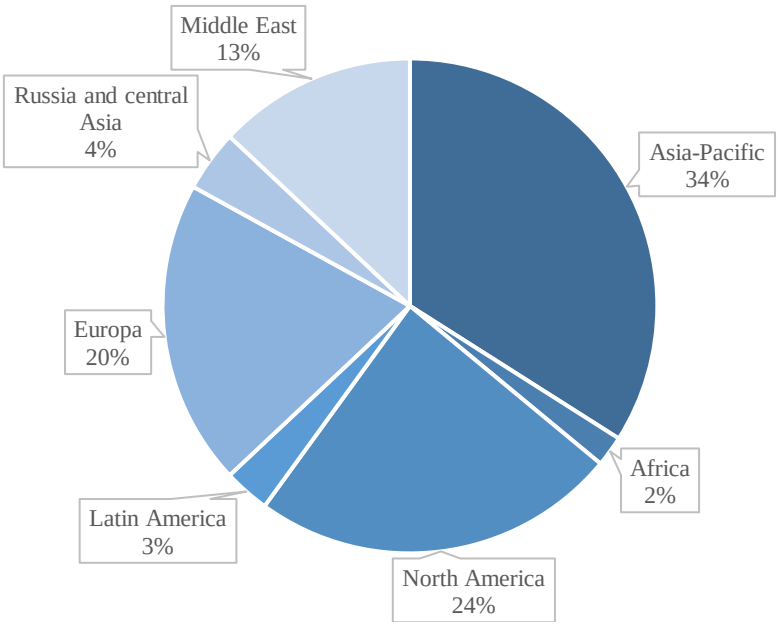

Figure 15: Market share by air domicile (Boeing)

As for the most important airlines, their respective revenues, and their main commercial routes, these are presented as follows:

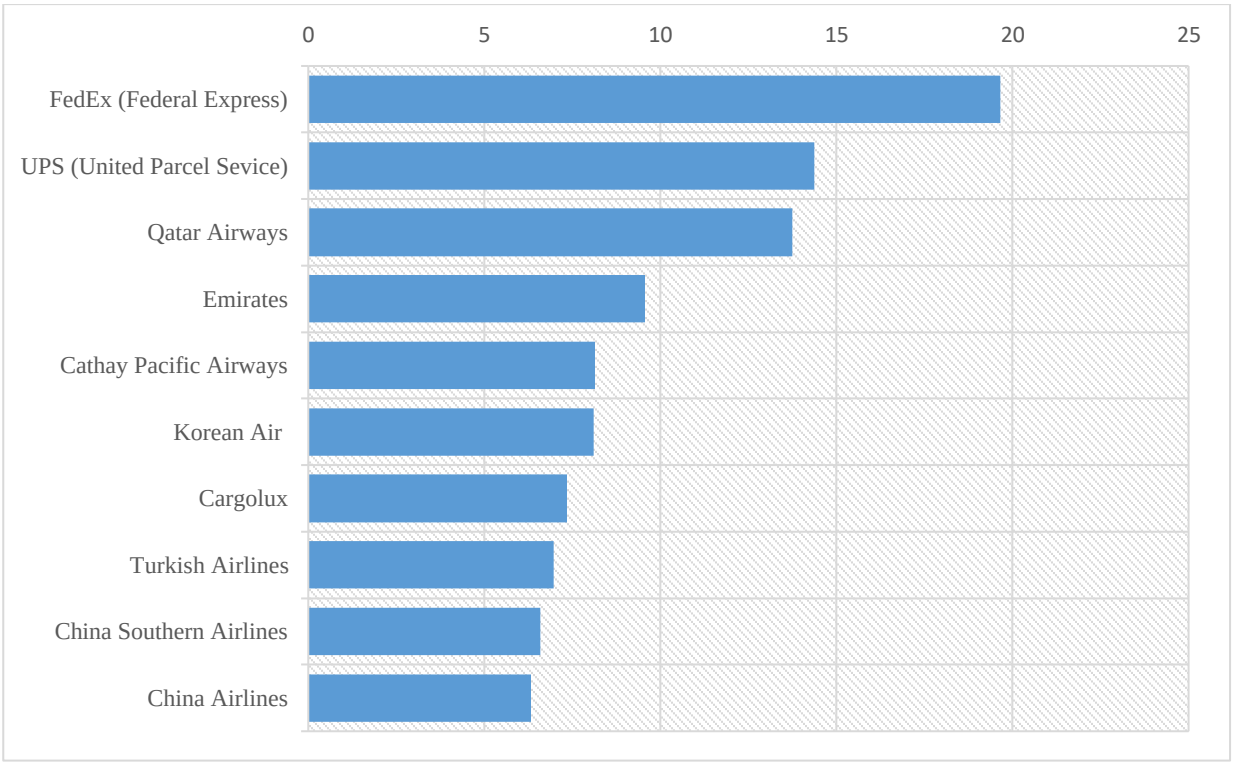

Figure 16: Top 10 Cargo, CTK millions (IATA)

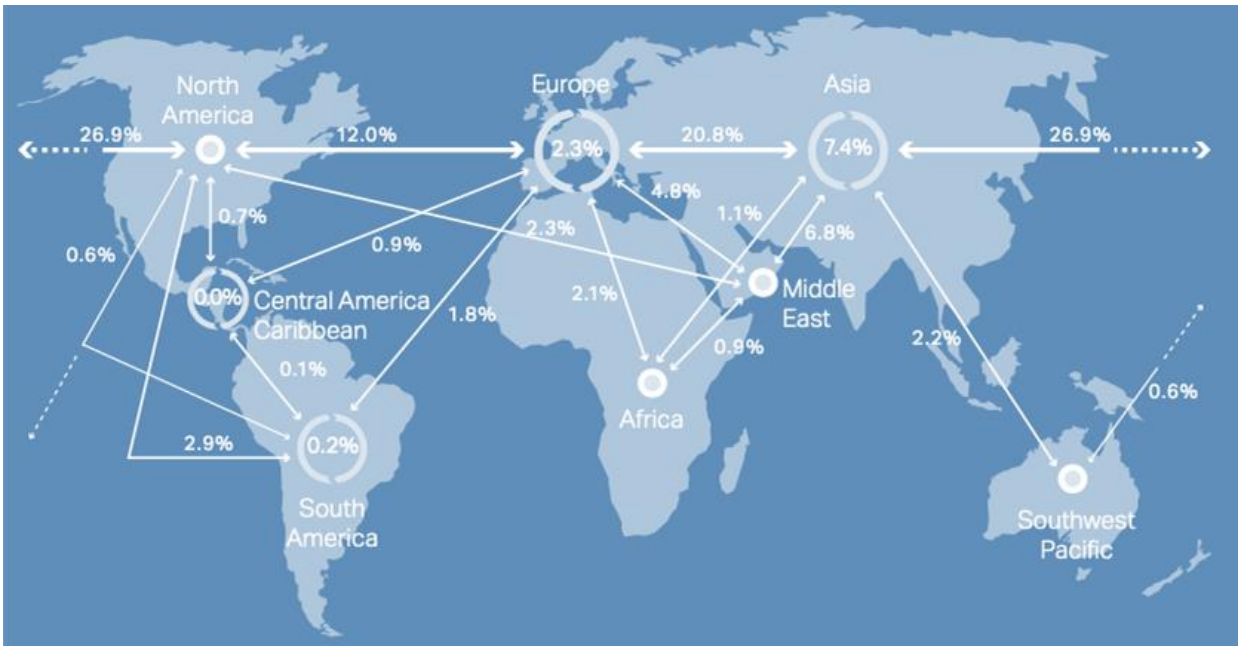

Figure 17: Top 10 Cargo, CTK millions (IATA)

2.2 - Forecasts of the growth of the cargo fleet for the next 20 years

As already seen above, before the Covid-19 crisis, about half of the world's air trade was handled by widebody passenger lower cargo holds; since the interruption of passenger traffic in March 2020, this capacity has drastically decreased causing a change in transport modalities. After the gradual reintroduction of passenger flights, the lower-belly capacity has stabilized at a level still lower than the pre-pandemic one as can be seen in the following graph relative to 2020 and the first half of 2021:

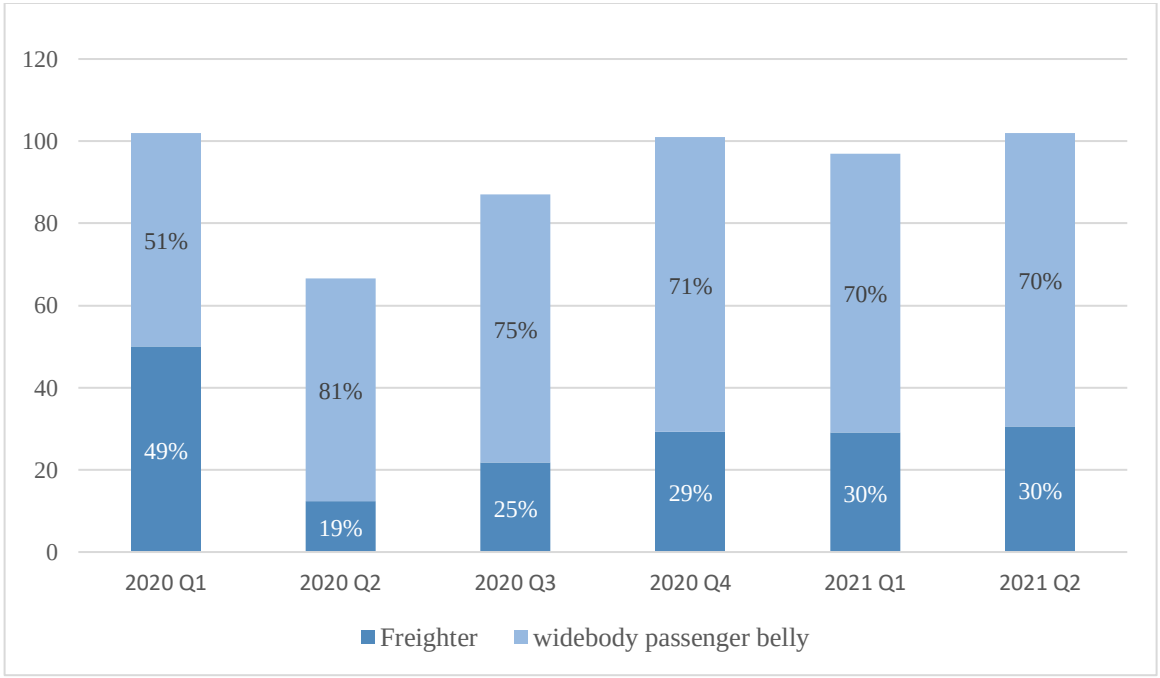

Figure 18: Global air cargo capacity (Boeing, 2021)

In order to cope with this totally anomalous situation, air logistics operators have adopted various strategies such as postponing retirement and/or restarting some of their dedicated freighters and, in particular, transporting cargo also in passenger cabins by introducing the so-called "preighter".

In general, even if air cargo traffic has increased between the second half of 2020 and the beginning of 2021, despite the support of preighter and the increase in the use of dedicated freighters and general load capacity, it is still lower than pre-pandemic levels by about 13% *(Boeing, 2021)*.

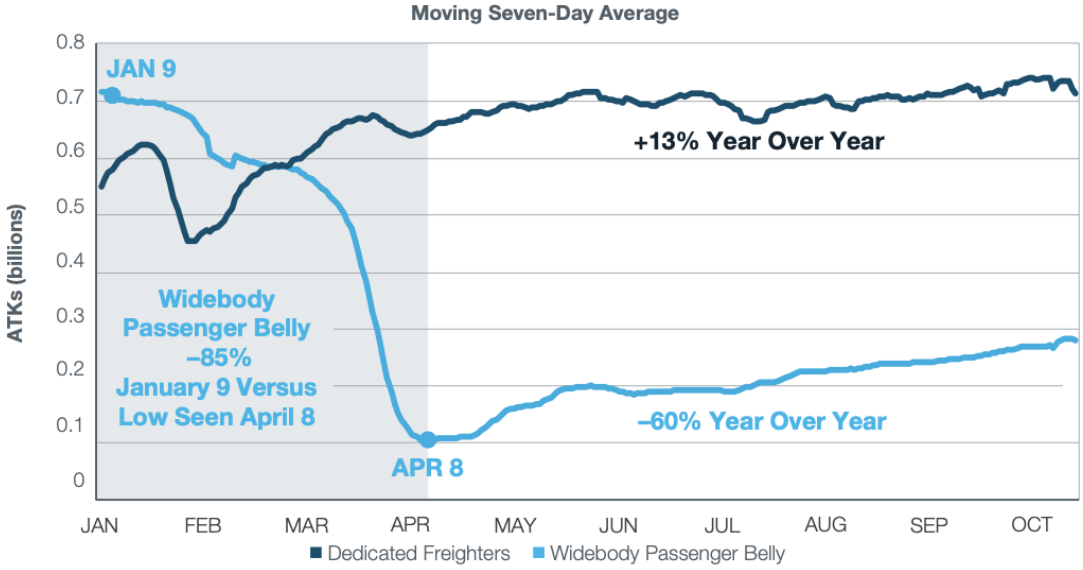

Figure 19: Reduction of passenger service (Boeing)

The combination of both the fall in air cargo capacity and the urgent demand for medical supplies due to Covid-19, as it has already been seen, led to a spike in the revenues from air cargo commerce in the second quarter of 2020. Moreover, freighter operators have experienced an increase in demand for their services also due to the new consumption habits generated by the various restriction measures. As a matter of fact, in this period, air cargo operators are the only ones who are able to meet the logistic needs for speed, reliability and security.

For this reason, thanks to the increase in air cargo yields and the reduction in long-haul international networks, optimal conditions have been created for many operators to use their widebody fleets for only-cargo operations.

Figure 20: interior of aircraft (Source: Google image)

Indeed, during the pandemic peak worldwide, approximately 90% of widebody passenger flights were used for cargo-only operations, and it has also been estimated that by the end of September 2020, nearly 200 airlines were using 2500 scheduled passenger aircraft for cargo-only operations.

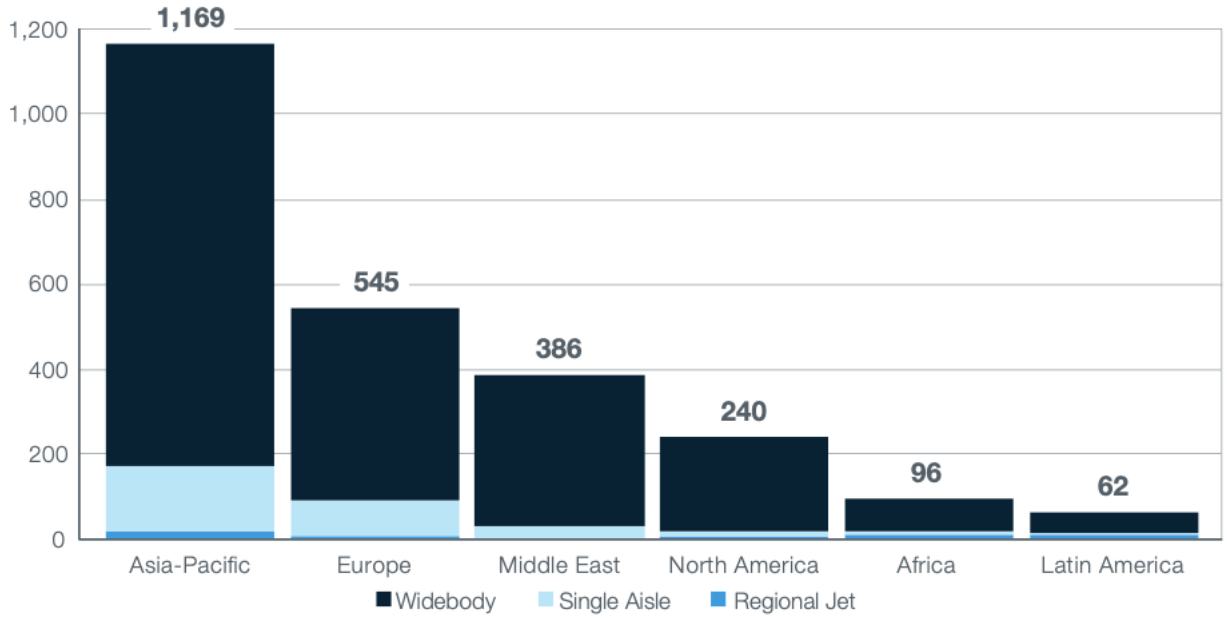

Figure 21: Passenger airplanes deployed as cargo-only flights (IATA)

In September, cargo aircraft traffic decreased by 12%, but this did not cause a reduction in earnings. However, by 2020 nearly a quarter of cargo capacity had been lost, nevertheless, there was an increase in costs with earnings up 40% and cargo industry profits up 16%.

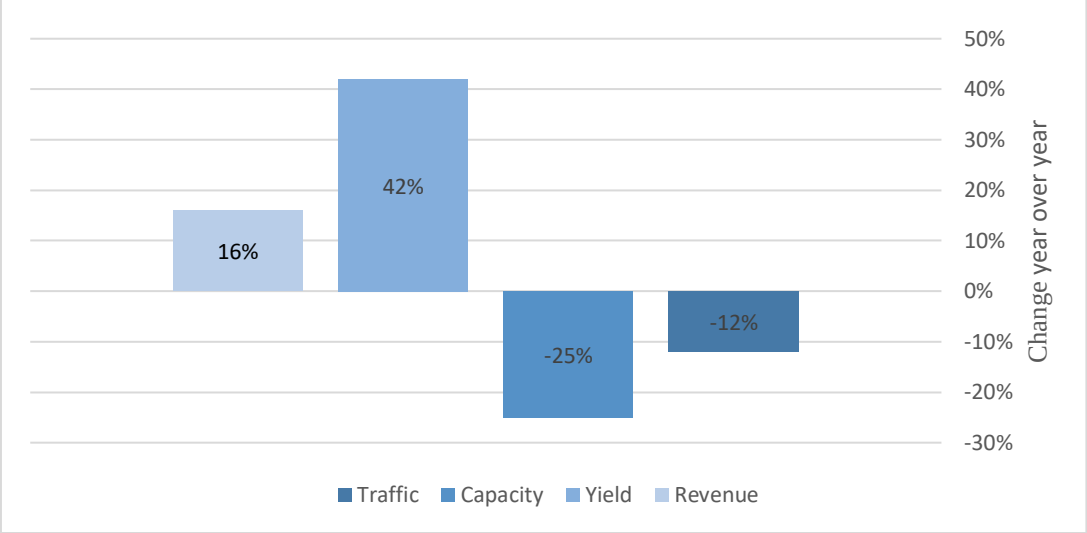

Figure 22: Constrained cargo capacity is driving higher Yields and Revenue (Boeing)

Moreover, in addition to the growth in the e-commerce and express cargo due mainly to Covid-19, as already discussed in the previous chapter, another element to be considered with respect to the increase in demand for air cargo transportation is the path of globalization and its effects on the supply chain. Air transport is, as a

matter of fact, very sensitive to the global increase in industrial production and to the structure of the manufacturing supply chain. It is sufficient to say that nowadays to produce a tennis ball, materials are transported in 14 countries for about 50,000 *miles* (*IATA*). Moreover, already before the health crisis, there has been a shift of manufacturing activity from China to other even more low-cost countries, generally Asia-Pacific areas, as even in China the cost of labour is slowly increasing. This phenomenon obviously depends on production technology but will take many years to have significant effects. At the moment, therefore, imports from China to the USA are nine times higher than those of other Asian countries (*IATA*) and this highlights China's dominant position in manufacturing and as a supplier of goods and services. The development of other means of freight transport can influence the growth of air cargo. For example, almost 90% of the world's global market goods are transported by sea; however, in the last decade there have been difficulties. Indeed, the introduction of gigantic ships capable of carrying more than 15000 containers, has created an excess of supply, resulting in reduced profits, especially during periods of a slowdown in world trade.

Although normally maritime traffic does not compete with air traffic, given the considerable difference in goods handled, however, the visible difficulties of maritime transport due to stagnant growth may positively influence the growth of air cargo.

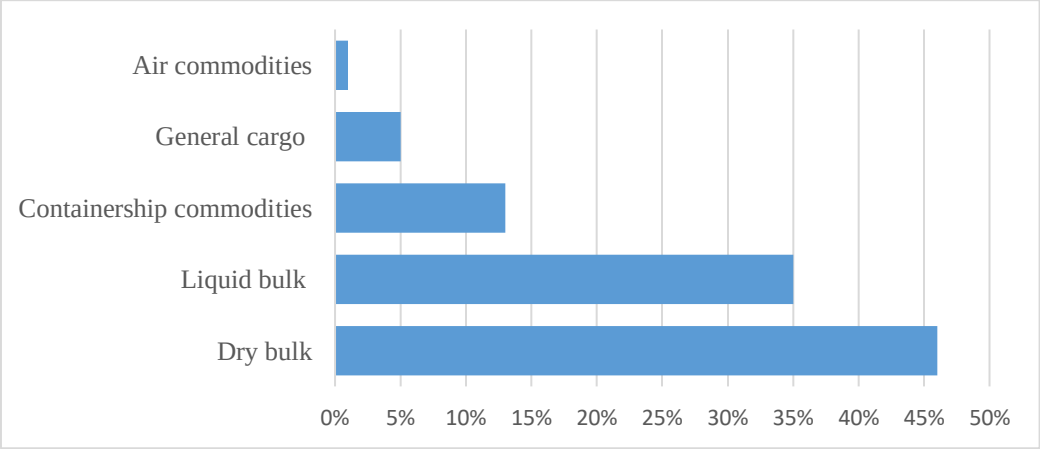

Figure 23: Commodity group classification (IHS Markit GTA)

In addition to all the factors already analyzed, another determinant that influences the growth in the size of cargo fleets has been highlighted by COVID-19, namely the lower reliability of airlines and passenger aircraft, which have been put in obvious difficulty by the pandemic. Even before 2019, more than 50% of global cargo traffic was attributable to transport-only aircraft as opposed to passenger aircraft, but this percentage will tend to rise further in the coming years. The reasons are clear:

1) passenger routes are not necessarily the most attractive for cargo,

2) scheduled passenger flights often do not meet the time requirements of exporters,

3) exporters prefer "palletized" freight which is not always available in the cargo compartments of passenger aircraft,

4) hazardous or perishable materials cannot be transported on such aircraft,

5) weight restrictions and/or regulations often prevent full loads causing unacceptable delays.

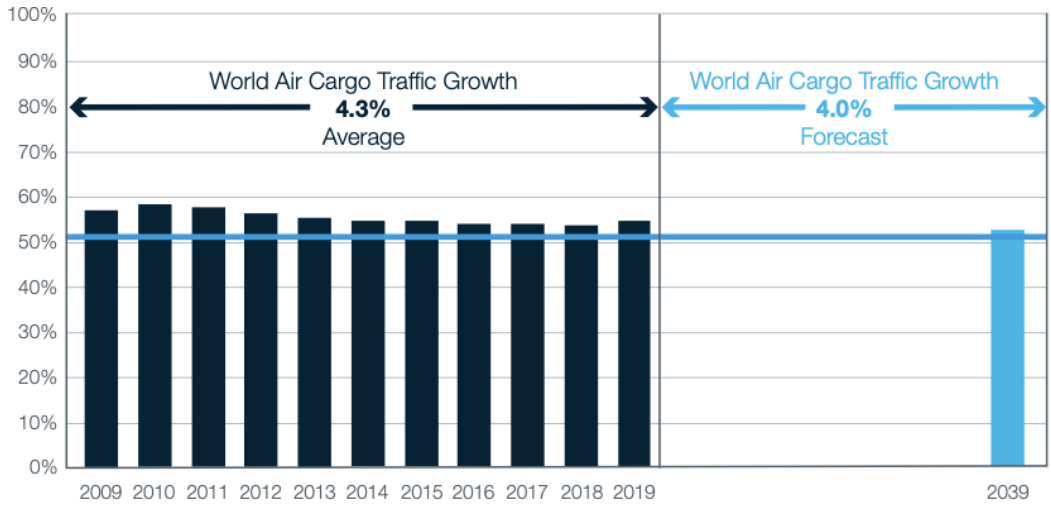

Figure 24: World RTKs carried on freighters (Boeing)

The global air freight market in terms of revenue-tonne-kilometer (RTK, tons of freight transported for a fee multiplied by the transport distance in km) has been estimated by most analysts to grow at 4.1% per year. By contrast, airmail alone will grow slightly more moderately at an average of 1.7% until 2039. Based on these forecasts, global cargo traffic is expected to double over the next 20 years from the current 270.2 billion RTKs in 2019 to at least 578 billion in 2039.

Regionally, the Asia-Pacific area will continue to drive and dominate, with domestic traffic in China and Asia-Oceania expanding at 5 % annually, same as the Chinese domestic market, due in part to the fast-growing economies and middle classes in those areas. East Asia-North America and East Asia-Europe traffic will also have higher growth rates than the global average.

Region	**History 2009–2019**	**2019**	**Forecast 2020–2039**
World	4.3%	–3.0%	4.0%
East Asia–North America	3.1%	–7.5%	4.3%
Europe–East Asia	4.2%	–3.2%	4.4%
Intra–East Asia and Oceania	5.2%	–5.4%	4.9%
Europe–North America	3.4%	–4.7%	2.3%
North America	3.3%	3.2%	2.6%
Domestic China	4.9%	3.5%	5.8%
Latin America–Europe	3.9%	–1.2%	4.1%
Latin America–North America	2.1%	–3.6%	2.6%
Africa–Europe	2.8%	4.0%	3.3%
South Asia–Europe	4.1%	3.7%	4.3%

Middle East–Europe	4.8%	10.6%	2.4%
Intra-Europe	4.8%	6.0%	2.3%

Figure 25: Air cargo growth by region (Boeing)

The world market has slowed down its growth only because of the economic crisis of 2008-2009, for the rest in the last 30 years, it has been very stable and resilient to local crises, terrorism, economic and pandemic problems with an average of 4.1% per year.

World cargo traffic is the sum of freight and mail traffic, and the relationship between these elements and world GDP is obviously very strong; so, on the basis of all the elements listed before the average projection is about 4% per year in the next 20 years measured in RTK is quite reliable.

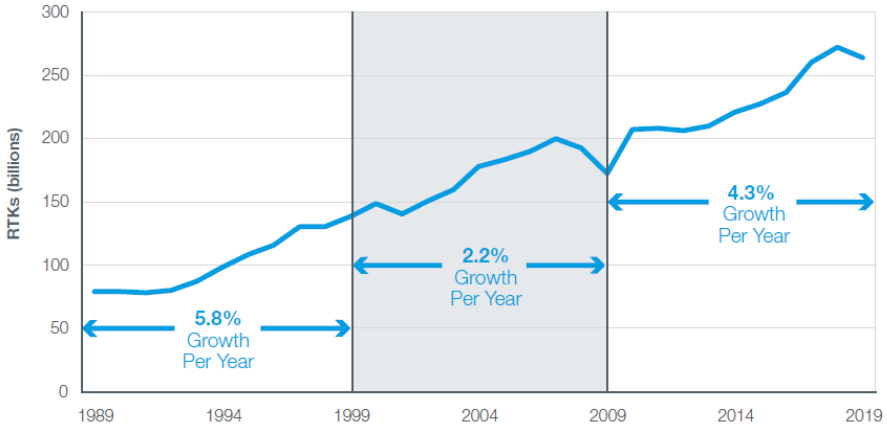

Figure 26: World air cargo traffic history and forecast of growth (Boeing)

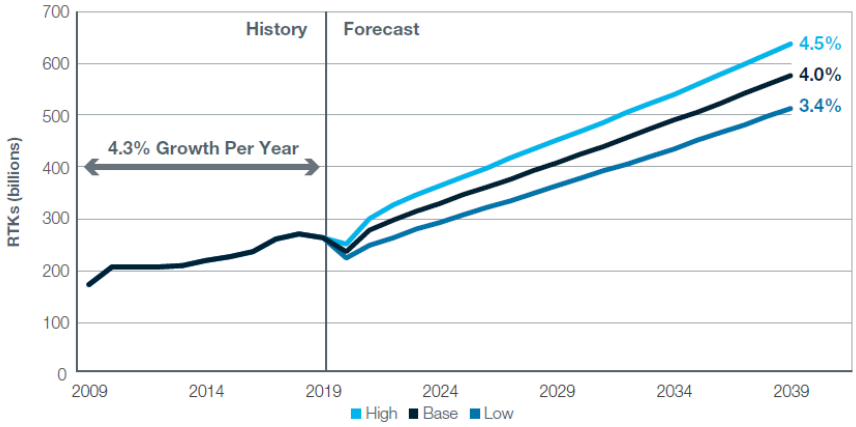

Figure 27: World air cargo traffic history and forecast of growth (Boeing)

As already mentioned, therefore, the commercial air fleet will grow by around 60% over the next twenty years, which means that it will increase from 2010 to 3260 units. To date, of the 2010 units, 750 are standard body, i.e., less than 45 tons, 650 are medium body, between 40 and 80 tons and 610 are large, i.e., over 80 tons. According to IATA estimates, of the 3260 vehicles in 2039, standard bodies will grow by 72% and medium bodies by 50%.

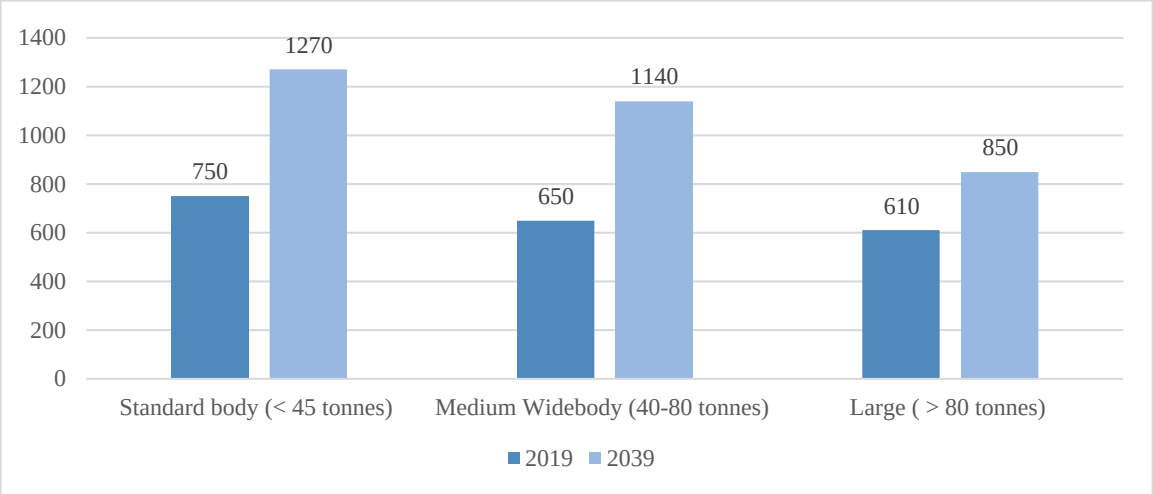

Figure 28: Freight fleet 2019- 2039 (Boeing)

To be clearer, this is the official classification by weight of the most used aircraft:

- Standard body (<45 tonnes): Boeing 727, Boeing 737, Boeing 757, Boeing MD-80, Boeing DC-9, Airbus A320 Series
- Medium Widebody (40-80 tonnes): Boeing 767, Boeing DC-10, Airbus A300/A310, Airbus A330, Ilyushin Il-76TD
- Large (> 80 tonnes): Boeing 747, Boeing 777, Boeing MD-11, Antonov An-124, Ilyushin Il-9

In summary, of the actual number estimated for the growth of the commercial air fleet over the next twenty years, about 30% (1250 units) will be due to actual growth stimulated by all the factors previously mentioned while the remainder will either be replaced (1180 units) or retired due to obsolescence (830 units).

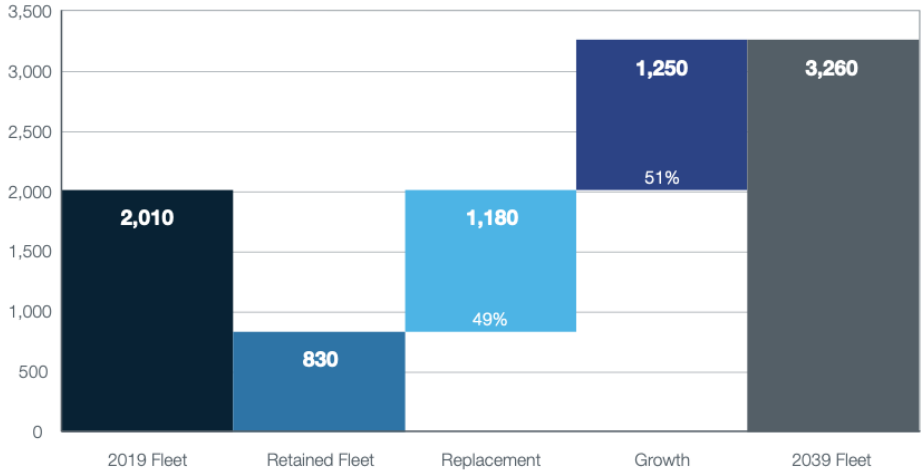

Figure 29: Growth, replacement and retained fleet forecast (Boeing)

Finally, it is important to consider that fuel consumption has always played a fundamental role in the operating costs of air-trade operators, who are therefore focused on constantly improving the consumption and efficiency of their vehicles.

The period of stasis in air trade due to the lower demand caused by the pandemic has forced many operators to ground part of their fleet, making it actually cheaper to replace these vehicles than to reactivate them. It is therefore very likely that all these vehicles will be updated with new technologies that will take into account

the current need for efficiency and sustainability.

To date, in fact, studies are being conducted mainly on:

1) airline operations,

2) new airplane technologies,

3) development of sustainable aviation fuels.

A brief clarification on all-cargo aircraft (freighters) compared to cargo compartments of passenger aircraft (passenger lower hold)

As mentioned above there are two options for cargo transport: dedicated specially designed aircraft and cargo compartments under the floor of passenger aircraft (lower holds or passenger belly). Each of the two options offers advantages and disadvantages and currently the first option covers a little more than 50% of traffic (*IATA*).

Cargo aircraft are particularly suitable for transporting high-value goods due to high standards of safety, stability, direct routes, reliability and finally large capacity in both volume and weight for dangerous goods. These advantages allow cargo operators to offer high value-added services and generate almost 90% of the total cargo industry profits (*IATA*). With the introduction of new generation widebody passenger aircraft that have larger cargo compartments, many passenger airlines are offering enhanced cargo services to increase profits. However, despite the increase in cargo capacity and the improved services offered, there are some issues that limit future development such as the limited height of the cargo compartment. In addition, safety standards and different regulations lead to restrictions on the cargo that can be transported, as well as the fact that cargo routes are generally small in number and highly concentrated, which often causes the need for additional transshipment of cargo from passenger airports to exclusively commercial hubs. On the contrary, the global passenger network is much more extensive and widespread but often with destinations of little commercial cargo interest. These large differences between the two modalities of distribution explain the significant difference in load factors between cargo and passenger aircraft, which are 75% compared to 30% *(IATA)*. This analysis explains the strong growth that will be seen in the coming years in the number of purely cargo aircraft, especially in the express segment, which will have to carry well over half of the world's cargo in the next 20 years.

2.3 - Comparison between the costs of air and road transports

The objective of this section will be to compare data about the costs of air and road transport in order to establish in which cases one of the two is more convenient than the other. In particular, these data are an estimate made by me and the engineering team of DESA srl, where I attended an internship from September 2021 to March 2022.

The term road transport refers to transportation by freight vehicles between hubs, terminals, warehouses, stores, and other locations. Freight vehicles include trucks, tractor-trailer combinations, and delivery vans.

Two types of vans with the following characteristics were considered for the purpose of this analysis:

- effective load capacity: 5.4 tons and 11 tons
- total vehicle weight: 12 tons and 23.5 tons
- average vehicle cost: 26000€ and 65000€.

The annual costs were then distributed into various categories as follows:

1) Fixed costs
2) Variable costs
3) Staff costs (on-board personnel)
4) Mode-specific costs
5) General operating costs

Fixed costs include four subcategories:

1) Road tax
2) Insurance
3) Interest on investment capital

Interest on the average annual capital investment was calculated using the following formula:

Annual interest cost = % interest * (depreciated replacement cost + residual value) / 2

4) Additional costs

Variable costs, on the other hand, consist of:

1) Fuel
2) Tires
3) Highway
4) Maintenance and repairs
5) Depreciation of capital equipment

The calculation of average depreciation was based on the following formula:

Depreciation per km = (replacement value - tires - residual value) / useful life in km"

Instead, the following subcategories are considered for personnel costs:

1) wages (including social security contributions)
2) reimbursement of accommodation and meals
3) additional costs

Under the heading of specific costs is insurance on goods transported.

As for operating costs, these are divided as follows:

1) salaries (including social contributions) for non-driving personnel
2) real estate
3) additional costs

The results were as follows for the two vehicles:

FIXED COSTS		2.841	€/year		0,03113	€/km
VARIABLE COSTS		45.885,98	€/year		0,50286	€/km
STAFF COSTS		51.868,00	€/year		0,56842	€/km
MODE-SPECIFIC COSTS		700,00	€/year		0,00767	€/km
OPERATING COSTS		23.500,00	€/year		0,25753	€/km
TOTAL OPERATIVE COSTS		**124.794,98**	**€/year**		**1,37**	**€/km**

Figure 30: truck 5 tons (Source: internal elaboration)

FIXED COSTS		4.515	€/year		0,049479	€/km
VARIABLE COSTS		78.738,83	€/year		0,862891	€/km
STAFF COSTS		57.528,00	€/year		0,630444	€/km
MODE-SPECIFIC COSTS		1.400,00	€/year		0,015342	€/km
OPERATING COSTS		24.500,00	€/year		0,268493	€/km
TOTAL OPERATIVE COSTS		**166.681,83**	**€/year**		**1,83**	**€/km**

Figure 31: truck 11 tons (Source: internal elaboration)

Considering that a truck travels an average of 91250 km per year for a total of 1300 hours per year, we obtain the following result:

COSTS PER KM		**1,37**	€/km
COSTS PER HOUR		**95,73**	€/h
COSTS PER KM PER TONNES		**0,3419**	€/km/tonnes
COSTS PER HOUR PER TONNES		**23,9333**	€/h/tonnes

Figure 32: truck 5 tons (Source: internal elaboration)

COSTS PER KM		**1,83**	€/km
COSTS PER HOUR		**127,87**	€/h
COSTS PER KM PER TONNES		**0,2030**	€/km/tonnes
COSTS PER HOUR PER TONNES		**14,2073**	€/h/tonnes

Figure 33: truck 11 tons (Source: internal elaboration)

The same type of analysis, with the necessary replacements and adjustments, was then performed for a Cessna Caravan and an SF600 e-power, an electrically powered cargo aircraft, obtaining these results:

TOTAL COST AND REVENUE		
fixed costs	**231.500,00**	**€/year**
	147,07	**€/h**
variable costs	**1.019.919,99**	**€/year**
	647,95	**€/h**
overhead cost (5%) per year	**62.571,00**	**€/year**
total expenditure	**1.314.786,02**	**€/year**

Figure 34: Cessna caravan (Source: internal elaboration)

TOTAL COST AND REVENUE		
fixed costs	186.500,00	€/year
	100,03	€/h
variable costs	676.055,02	€/year
	362,62	€/h
overhead cost (5%) per year	43.127,75	€/year
total expenditure	905.682,77	€/year

Figure 35: SF600 e-power (Source: internal elaboration)

Total direct costs per hour flight	
835,28	€/h
Total direct costs per hour flight per tons payload	
773,41	€/tons/h
Total direct costs per Km	
2,46	€/Km
Total direct costs per Km per tons payload	
2,27	€/tons/Km

Figure 36: Cessna caravan (Source: internal elaboration)

Total direct costs per hour flight	
485,79	€/h
Total direct costs per hour flight per tons payload	
449,80	€/h/tons
Total direct costs per Km	
1,69	€/Km
Total direct costs per Km per tons payload	
1,57	€/tons/Km

Figure 37: SF600 e-power (Source: internal elaboration)

It can be deduced that the annual cost of transporting goods is about

1) 125 thousand euros per year for trucks with a 5 tons load

2) 167 thousand euros per year for 11 tons trucks

3) 1mil 300mila€ per year for Cessna Caravans

4) 905 thousand Euros per year for SF600 e-power

There are also significant differences in the comparison between the costs calculated with respect to kilometers driven, hours of travel, and tons of load, a result derived mainly from the following information

- payload for a van: 5400 kg
- payload for a truck: 11000 kg
- payload for a Cessna Caravan: 1200kg
- payload for an SF600 e-power: 1400kg

- annual travel hours (van/truck): 1300h
- annual flight hours (Cessna Caravan): 1574h
- annual flight hours (SF600 e-power): 1860h

- km travelled annually (van/truck): 500,000
- km travelled annually (Cessna Caravan/SF600 e-power): 535.181km

Subsequently, the four means of transport were also compared on a common mission, i.e. the Marcianise - Ronchi dei Legionari route, with the following characteristics:

mission	833	km		
distance	833	km		
cruise speed	70	km/h		
trip time	714	min	11,900	h
spare time (rest, food,fuel,etc)	60	min	1,000	h
block time	774	min	12,900	h
block speed	65	km/h		

Figure 38: Truck 5 tons (Source: internal elaboration)

mission	833	km		
distance	833	km		
cruise speed	70	km/h		
trip time	714	min	11,900	h
spare time (rest, food,fuel,etc)	60	min	1,000	h
block time	774	min	12,900	h
block speed	65	km/h		

Figure 39: truck 11 tons (Source: internal elaboration)

mission	833	km		
distance	833	km		
cruise speed	344,47	km/h		
trip time	145	min	2,418	h
taxi time (15%)	21,76	min	0,363	h
block time	167	min	2,781	h
block speed	300	km/h		

Figure 40: Cessna Caravan (Source: internal elaboration)

mission	833	km		
distance	833	km		
cruise speed	287,06	km/h		
trip time	174	min	2,902	h
taxi time (15%)	26,12	min	0,435	h
block time	200	min	3,337	h
block speed	250	km/h		

Figure 41: SF600 e-power (Source: internal elaboration)

Results regarding cost per mission, cost per mission relative to tons transported, and travel time were as follows:

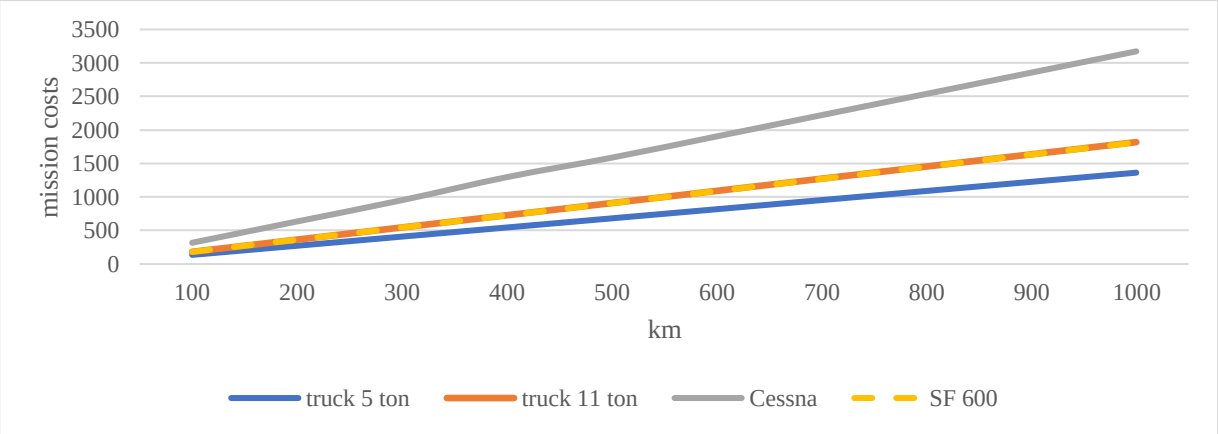

Figure 42: mission cost (Source: internal elaboration)

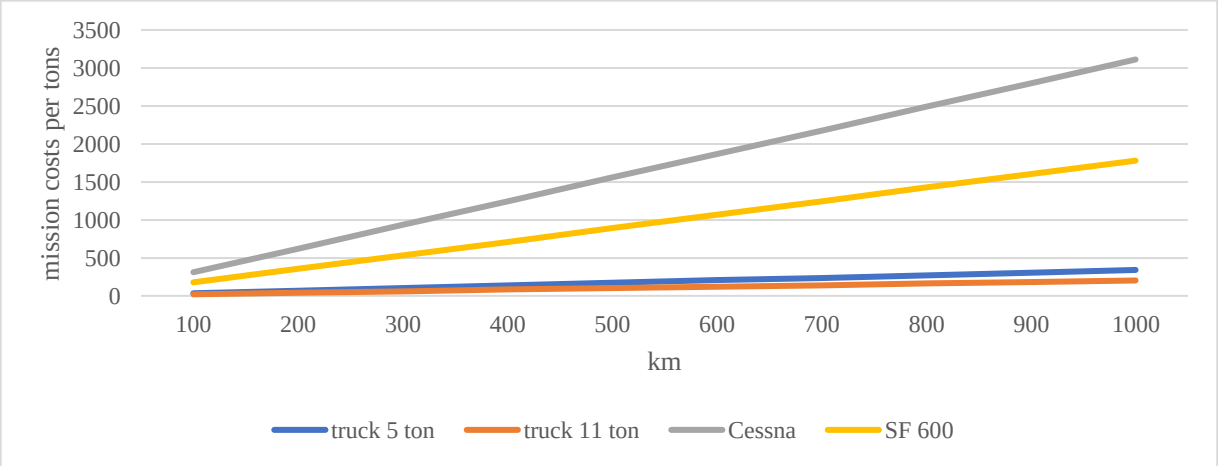

Figure 43: Mission costs per tons (Source: internal elaboration)

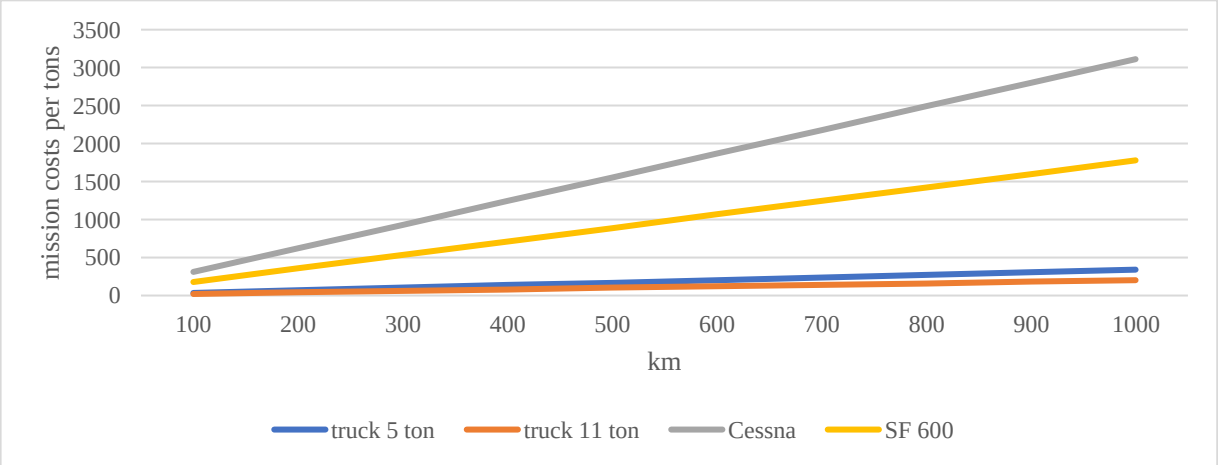

Figure 44: Block time (Source: internal elaboration)

As far as costs per mission are concerned, there is an overlap between the operating costs of the 11 tons truck and the SF600 e-power, which are, however, very similar to those of the 5 ton van. On the other hand, the growth in costs of the Cessna Caravan with respect to the increase in km is visibly higher than the other means of transport considered in the analysis.

On the other hand, taking into account the costs per mission with respect to the tons transported, these remain almost unchanged for the van and the truck and increase almost twice as much for the SF600 and about 4 times as much for the Cessna Caravan.

Finally, travel time, as tons carried increase, increases moderately and very similarly for both aircraft while it increases particularly for the truck and van.

It is therefore evident that the huge differences found in annual costs must be compared to hours of travel, kilometers travelled, and tons transported. In doing so, it can be seen that the costs per mission of the various means of transport are actually more similar than can be imagined and that therefore the choice between using air or road transport will depend on logistics needs.

CHAPTER 3
THE ENVIRONMENTAL IMPACT OF THE LOGISTICS SECTOR

3.1 –The environmental issue and the concept of sustainability

Climate change is a phenomenon that has been ongoing for many years now and for which there is big scientific evidence. There are increasingly recurring natural events that confirm the presence of global warming that political leaders and policy makers are called upon to consider to avoid reaching a point of no return with dramatic effects on the ecosystem and the survival of the human species in the coming decades.

The issue of sustainability is widely present in political and economic debates, and the public is participating by virtue of an increasing awareness of the relationship between human activities and environmental degradation. This is especially true in more industrialized states that, arguably more than others, are in the position to change their production structures to embrace a system that includes sustainability within the established logic of the market economy. Highly industrializing countries, such as China, appear to be engaged in an effort to strike a balance between the demands of economic development with those related to the need to preserve the ecosystem. At the same time, however, it is worth noting that it is specifically in rapidly developing countries that the energy mix for power generation still largely sees fossil sources prevailing. It is also true that even some countries of established industrialization struggle more than others to shift their energy mix in favor of renewables, as in the case of some areas of the United States where dependence on fossil fuels may stem from the state's mineral endowment and a more conservative political orientation.

Europe, the United States and more recently industrialized countries have set themselves short, medium and long-term decarbonization goals. Among the different sectors, the one that is of particular concern for carbon neutrality purposes is transporting, because in Europe it’s the only one that has seen its contribution in terms of CO_2 emissions to the atmosphere increase from 793.3 million tons in 1990 to 945.9 million tons in 2017 *(Giansoldati, Danielis, & Scorrano, 2021)*. It is therefore not surprising that technological, political, and economic efforts are being directed primarily toward defining the measures deemed most appropriate to prevent this trend from continuing into the future, and to ensure that, instead, it stabilizes and then gradually declines.

Although there have been numerous voices in the past that have denied a basis for concerns about the dangers of climate change, the scientific literature of the past decades reveals how the debate about human responsibility for recent and future climate change is more and more concerning.

Beyond the short-term variations in global atmospheric surface temperatures, which can be misleading, it is the massive body of experimental data and model simulations that motivates the broad scientific consensus that greenhouse gas emissions are still increasing, the planet is warming, ice is shrinking in extent and volume, and sea levels are rising. Indeed, the most alarming question is how much the planet may warm in the future in relation to human greenhouse gas emissions, what positive feedback on long time scales might amplify this warming, and, finally, the existence of possible "tipping points," which are critical thresholds that if crossed could abruptly change some climate parameters or prevent a return to previous conditions.

Global warming has been interfering with ecological systems and human activities for some time now. The damage and suffering that climate change has caused in the past and continues to cause are due to the climate becoming more extreme, with prolonged heat waves, more erratic and intense rainfall, with disruptions to water resources and reductions in agricultural yields. Despite this, only the most accurate research manages to break through the silence of the major media on the subject of climate change, which is only mentioned whenever occasional flood or exceptional heat wave happens. However, interest in the real dimension of the climate problem from a multi-century perspective, such as the beginning of processes that are dangerous since they are unstoppable once they are underway, remains quite low.

Moreover, as can also be seen from the following graph, since 1850 there has been a growing increase in CO_2 emissions caused by the rise of industrialization processes and the burning of fossil fuels; it is also true, however, that during the Covid-19 period, due to the closure of many companies and the decrease in travel, emissions have been lowered by about 5 %.

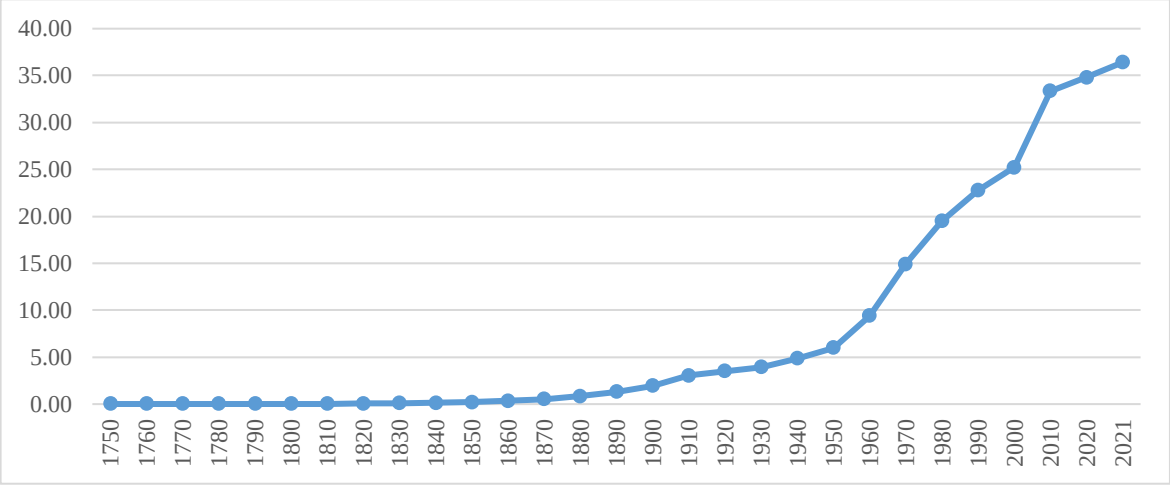

Figure 45: Historical carbon dioxide emissions from global fossil fuel combustion and industrial processes from 1750 to 2020 (in billion metric tons) (Statista)

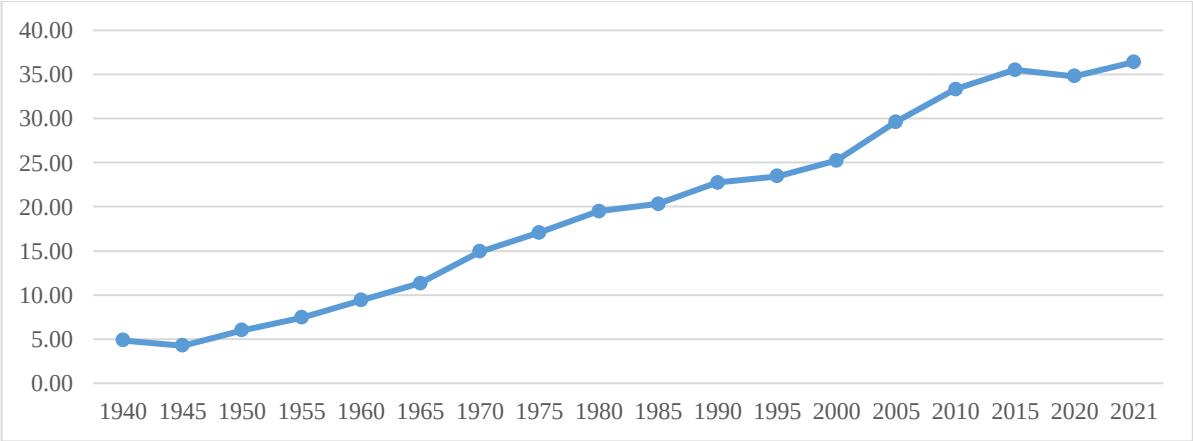

Figure 46: Annual CO_2 emissions worldwide from 1940 to 2020 (in billion metric tons) (Statista)

As for the concept of sustainability, this can be defined as: "*Meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and*

economic resources. Sustainability is not just environmentalism. Embedded in most definitions of sustainability we also find concerns for social equity and economic development." (McGill)

Although the concept of sustainability itself is fairly recent, in 1983 The United Nations together with the Prime Minister of Norway developed the concept of sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*.

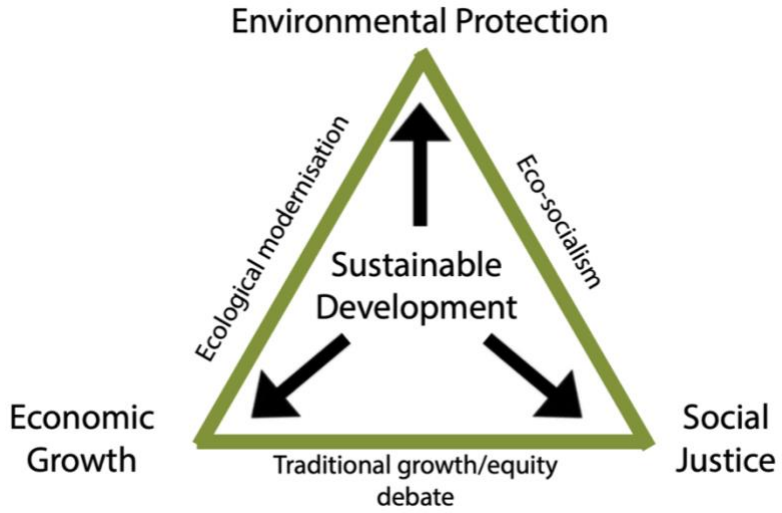

Figure 47: Mapping sustainable development as a contested concept (McGill)

This concept goes beyond just environmental impacts by including social and economic aspects; indeed, sustainable development is based on three main pillars:

1) Environmental Sustainability: it refers to the protection of the ecosystem; it aims to ensure the availability, quality and renewal of natural resources.
2) Economic Sustainability: it ensures economic efficiency and income for businesses. It corresponds to the ability of an economic system to produce income and jobs in the long run.
3) Social Sustainability: it focuses on the ability to ensure an equitable distribution of human well-being: it points to quality of life, security and services for citizens.

These are the differences between environmental, social and economic sustainability, although they are part of a single sustainability plan. Environmental protection, social cohesion and economic growth and equality will have to go hand in hand. Industrial development and capitalism have generated severe environmental damage and social poverty. Sustainable development must meet current needs without, however, compromising the needs of future generations.

Environment, economics and social equity which together constitute the “3-E rule” are inextricably linked. They must strike a balance, otherwise the overdevelopment of one area could lead to the decline of another. The development of the economy must respect environmental resources and, at the same time, minimize social inequality and poverty.

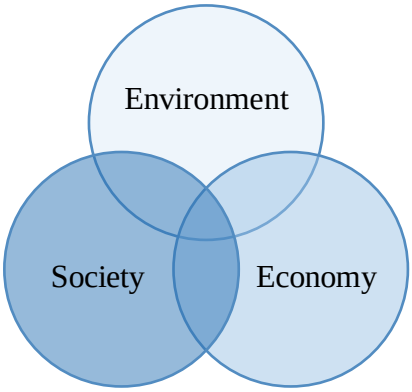

Figure 48: Common conceptual frameworks of sustainability (McGill)

3.2 –Regulations on environmental issues

As a global issue, climate change requires countries around the world to work collaboratively. Among the most important regulations in this area there are the Paris Agreement and the United Nations 2030 Agenda.

In 2015, world leaders agreed on ambitious new goals in the fight against climate change.

The Paris Agreement presents a plan of action to limit global warming. Its main elements are:

1) A long-term goal: governments agreed to keep global average temperature rise well below 2°C above pre-industrial levels and to continue efforts to limit it to 1.5°C
2) Contributions: before and during the Paris conference, countries submitted comprehensive national climate action plans (called Nationally Determined Contributions - NDCs) in order to reduce their emissions
3) Ambition: governments agreed to report their action plans every five years, each setting more ambitious targets
4) Transparency: countries agreed to communicate to each other and to the public, their achievements in implementing their respective targets in order to ensure transparency and monitoring
5) Solidarity: EU member states and other developed countries will continue to provide climate finance to developing countries to help them both reduce emissions and become more resilient to the effects of climate change

The Paris Agreement entered into force on November 4, 2016, following the fulfilment of the condition of ratification by at least 55 countries representing about 55 % of global greenhouse gas emissions. All EU countries have ratified the agreement. As stated earlier, the agreement requires parties to submit national plans aimed at reducing emissions and review these commitments every five years, giving rise to the following timeline:

- 2015: Signing and initial national plans.
- 2020: Updated strategy and plans
- 2023: Assessment of global progress.
- 2025: Updated plans

- 2028: Assessment of worldwide progress
- ...

In 2021, member states participated in the United Nations Climate Change Conference, which was concluded in Glasgow on November 13 after two weeks of negotiations among the parties to the United Nations Convention on Climate Change (UNFCCC).

Among the most important goals set by the European community are:

1) the increase of commitments to provide financial help to developing countries to contrast climate change
2) the adoption of the global commitment to reduce methane emissions
3) the development of the Paris Code.

However, further efforts will be needed in the coming years to reach the 1.5-degree Celsius target.

Specifically with regard to the European aviation sector, as compiled in the Report of the High-Level Group on Aviation Research *(European Commission, 2011)*, it is clear that aviation is a vital sector for society and economy.

As a matter of fact, on average, 12 % of aviation revenues, or nearly 7 billion euros per year for civil aviation alone, are reinvested in research and development (R&D) and support about 20 % of aerospace jobs. *(European Commission)*

Every euro invested in aeronautics R&D creates an equivalent value added to the economy each subsequent year. This means that aerospace technologies are drivers for innovations and spill over into other economic and technological sectors, thus contributing to the growth of the European economy as a whole.

The goals therefore set by the European community, created on the basis of the Paris agreements can be summarized in five main points:

1) "In 2050 technologies and procedures available allow a 75% reduction in CO_2 emissions per passenger kilometre to support the ATAG target[1] and a 90% reduction in NOx emissions. The perceived noise emission of flying aircraft is reduced by 65%. These are relative to the capabilities of typical new aircraft in 2000.
2) Aircraft movements are emission-free when taxiing.
3) Air vehicles are designed and manufactured to be recyclable.
4) Europe is established as a centre of excellence on sustainable alternative fuels, including those for aviation, based on a strong European energy policy.
5) Europe is at the forefront of atmospheric research and takes the lead in the formulation of a prioritised environmental action plan and establishment of global environmental standards."

   (European Commission, 2011)

Going on with the regulations on the topic there is the United Nations 2030 Agenda for Sustainable Development, signed on September 25, 2015, by 193 countries.

[1] The ATAG goal is to aim for carbon-neutral growth from 2020 and an overall reduction in CO_2 emissions of 50%.

The foundations of this Agenda are encapsulated in the so-called "5Ps," namely people, planet, peace, prosperity and partnership, and the main goals countries set to pursue are the achievement of universal peace and greater freedom for all people.

Figure 49: The five Ps (United Nations)

The 2030 Agenda identifies 17 Sustainable Development Goals (SDGs- Sustainable Development Goals), which are in turn broken down into 169 goals or targets.

The SDGs address issues common to all nations, which is precisely why it is important to collaborate and work together to achieve them without distinction between developed, emerging and developing countries

The 17 Goals can be summarized as follows:

Figure 50: Sustainable development goals (United Nations)

These are the goals that all countries will need to be guided by in their programs and public policies. These are goals that take more into account the issue related to climate change as can be seen by the presence of the thirteenth goal, called the climate action goal; moreover, the name "Sustainable Development Goals" denotes an awareness of the importance of rethinking the current development model so as to ensure the environmental, economic and social sustainability of human societies in the long run.

3.3 –Emission from the whole logistics and transportation sector

The sector that contributes most to CO_2 emissions is electricity and heat generation; substantially stable is the share attributable to transportation. The contribution of the manufacturing and construction sector also remains mainly unchanged, while there is a decline in the share attributable to heating and air conditioning of buildings, and the share attributable to land cultivation and forest exploitation.

In 2020, CO_2 emissions were distributed as follows:

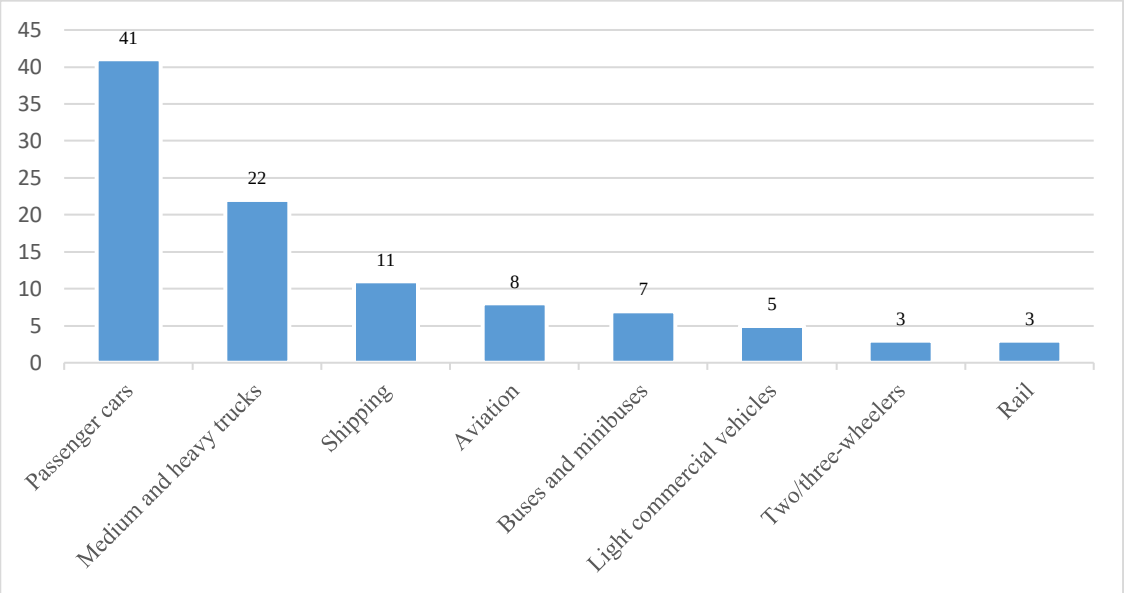

Figure 51: Distribution of carbon dioxide emissions produced by the transportation sector worldwide in 2020 by subsector in % (Statista)

Using the information provided by Eurostat (EUROSTAT), there can be compared the emissions data between 1990 and 2017 and show that although the level of CO_2 released into the atmosphere has fallen by 23 %, emissions from the transportation sector have instead increased, bucking the trend of other sectors. As a matter of fact, they increased from 14 % to 22 %, a result attributable to all types of transport, with particularly strong growth in vans and air transport, and with the exception of inland navigation and rail.

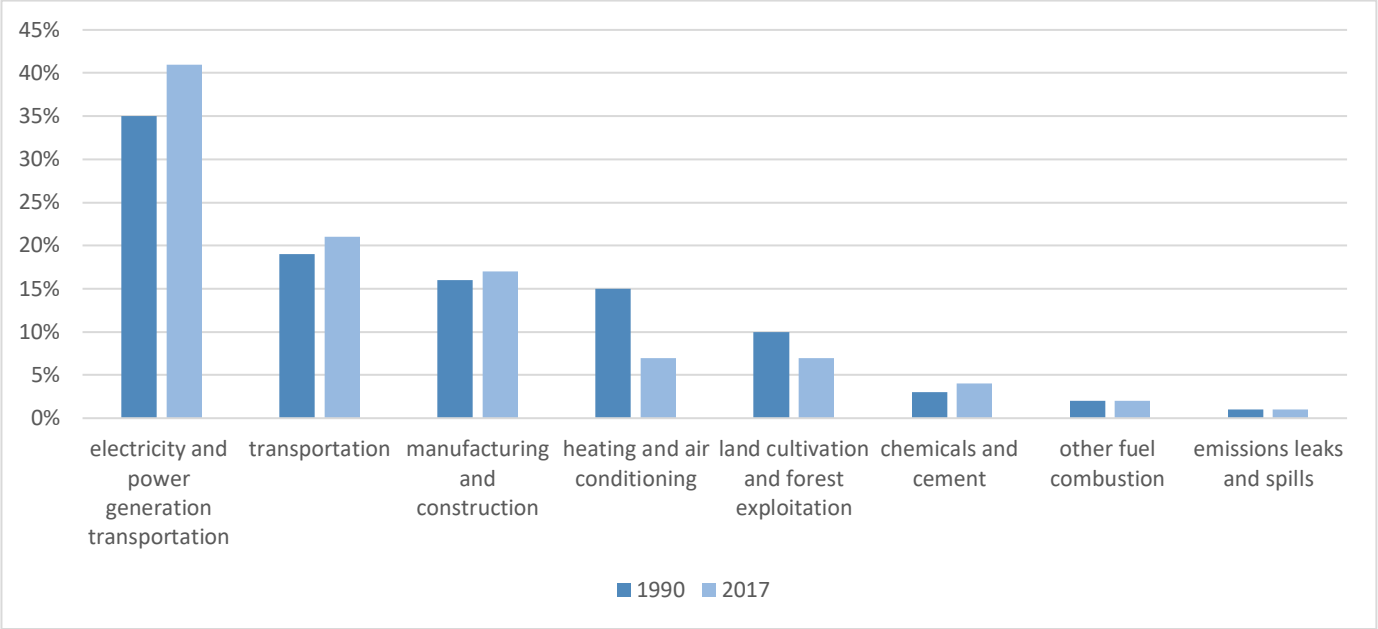

Figure 52: CO_2 emissions by sector (Giansoldati, Danielis, & Scorrano, 2021)

Focusing only on road transport and distinguishing between freight and passenger transport, car transport in Europe contributes 543 million tons (2017) or 13 % of total emissions and up from 8 % in 1990 *(Giansoldati, Danielis, & Scorrano, 2021*). This has occurred despite the fact that there have been improvements in the efficiency of cars, especially diesel cars, but it is a phenomenon that can be attributed to the increase in the motorization rate, especially in the new growing countries, but also to the increase in miles covered, resulting from increasing residential and commercial dispersion.

Moreover, cars represented the most widely used mode of transport in 2018 although slightly down from 2016, while walking was the second modal choice. This appears interesting in light of the comparison between active and motorized mobility. The former, which includes walking and bicycling, increased its share of total travel from 20.4 % in 2016 to 27.1 % in 2018, while the share attributable to motorized mode of travel, which includes travel via cars, motorcycles, and public transportation, declined slightly and stood at 72.9 % at the end of 2018. Within the category of motorized modes, the largest share is attributable to transportation via private car with a share of 81.5 %, essentially unchanged from 2008 to 2018 *(Giansoldati, Danielis, & Scorrano, 2021).*

Urban travel took place 31.3 % on foot, 5.6 % by bicycle, 53.8 % by private car or motorcycle, and only 9.3 % by public transportation, a situation as of 2018 that showed only a modest advance in active mobility (biking and walking) compared to 2008 when it accounted for about 33 % *(Giansoldati, Danielis, & Scorrano, 2021).*

In the suburban context in 2018, travel was by private car or motorcycle in 85.8 % of cases, by public transport in 11.7 %, by foot in 1 %, and by bicycle in 1.4 %, with the active mode (bike and walk) showing very modest growth compared to 2008 when it accounted for 1.3 %. *(Giansoldati, Danielis, & Scorrano, 2021)*

Thus, in both contexts, urban and suburban, the dependence on private means of transport appears quite evident, even in urban areas (although to a lesser extent if the size of the city grows), and an aspect of non-negligible relevance is evident, namely the substantial inaction of the mobility preferences of citizens over a

period of time that is certainly not very short.

At the European level on medium-to-long distances, data confirm the relevance (measured in passenger-km) of the private car evening for the EU, where it is used 82.9 % of the time compared to 9.4 % for buses or coaches and 7.7 % for rail. Although there are differences in the modal mix among different countries, the composition is not particularly different from that recorded in the previous years, when the modal share attributable to train, car, bus and courier was 7.1 %, 83.1 % and 9.8 %, *respectively (Giansoldati, Danielis, & Scorrano, 2021)*. As a result, it is clear that a modal shift has not been realized, although it has been and still is one of the most important goals of EU policy.

However, by shifting the perspective of observation to the non-European level, it is clear that international freight transport is carried out for 87 % of the volumes transported (in ton-kilometers) by sea, 5 % by rail, 8 % by road, and the remainder by air *(International Transport Workers' Federation)*.

Specifically, freight transport is included in the calculations for overall transport, which is estimated to emit about 9 Gton (billion tons of CO_2) annually *(International Transport Workers' Federation)*. Of these, 2/3 are attributable to passenger transport and 1/3 to freight transport (freight). The recent ITF estimate in its "Outlook 2019" states that the 2015 value of freight transport at 2.9 Gton CO_2, split between Road (62%), Sea (27%), Air (6%), Rail (3%) and River (2%), *(International Transport Workers' Federation)*.

But more importantly, it projects a value of 6.2 Gton CO_2 to 2050: a 114% increase, which goes against the EU reduction target but appears correct taking into account the transport dynamics to 2050.

Thus, the issue of "decarbonization" of transport needs to be addressed: to meet the targets and market trends we would have to reduce the carbon intensity of transport by 84% *(International Transport Workers' Federation)*

It is therefore clear that even in the face of possible future developments that contemplate the introduction of technological innovations, whether incremental or radical, the role of the public decision maker is crucial in defining the actual impact they may have on the transformation of the transportation system and, therefore, also on the emissions that this sector generates.

3.4 –The effects of the regulations on the aviation sector

Although the contribution of aviation is still modest, particularly compared to road transport, the growth rates of emissions from the aviation sector are steadily increasing, and forecasts of their future evolution are alarming. As a matter of fact, aviation fuel consumption in 2040 is expected to be four times the values recorded in 2010. *(Giansoldati, Danielis, & Scorrano, 2021)*

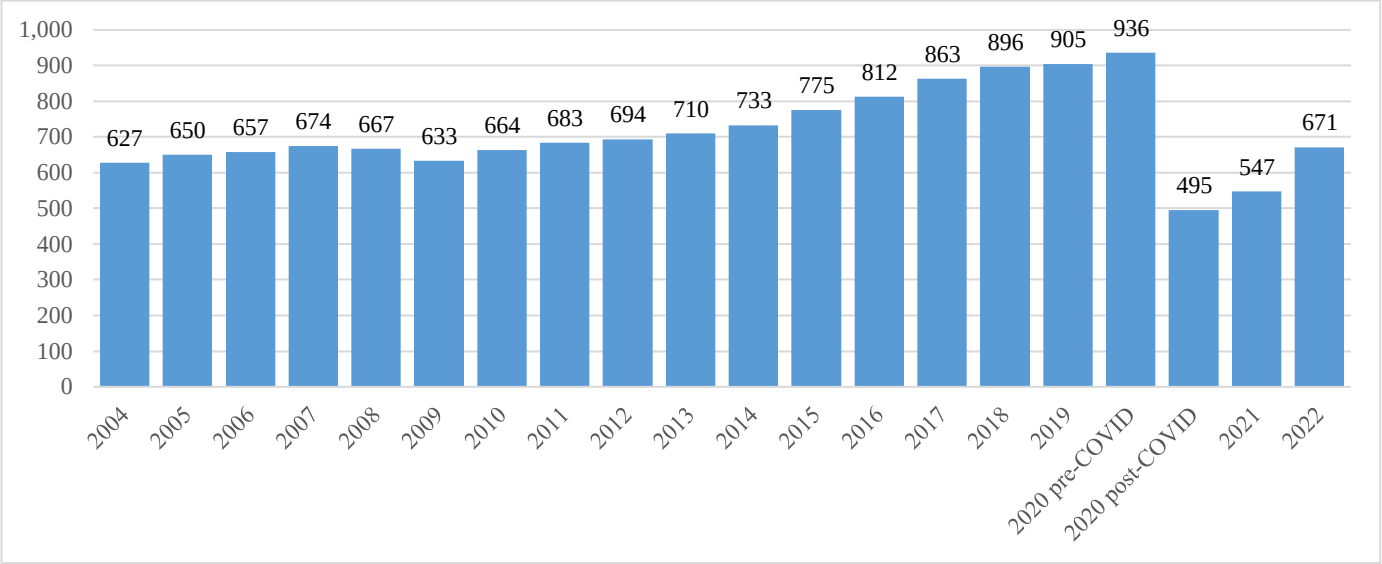

Figure 53: Carbon dioxide emissions from commercial aviation worldwide from 2004 to 2022 (in million metric tons) (Statista)

There are many reasons for such growth: the rise in per capita income, the intensification of globalization, the development of emerging markets and the changing consumption choices of their inhabitants, the particularly convenient commercial offerings of "low-cost" airlines, etc.

It is also true that public opinion is beginning to perceive the seriousness of the problem, as witnessed not only by the increased media coverage of extreme weather phenomena caused by climate change, but also by the emergence of movements devoted to boycotting air transport and promoting more responsible and environmentally sustainable consumption choices.

In the long term, the phenomenon is not expected to die out; indeed, annual passenger kilometres between now and 2035 are expected to increase at an average rate of between 4.5 % and 4.8 %. It will be the Asian, Middle Eastern, Latin-American and African markets that will experience the highest growth rates. In more mature markets, however, slightly lower values are expected: between 2.9 % and 3.1 % for North America and around 3.7 % for Europe *(European Union).*

The aviation sector has also changed due to significant technological advances that, with the development of more efficient twin-engine aircraft such as the Airbus A350 and Boeing B787, have enabled the multiplication of point-to-point flights and the expansion of connections offered to users.

In addition, new "low-cost" business models have emerged (e.g., Ryanair and EasyJet) based on the use of secondary airports that have revolutionized the geography of airports by expanding the area of the market served.

According to estimates published by the *Air Transport Action Group* (a non-profit association comprising 50 members ago including major aircraft manufacturers-Boing, Airbus, Bombardier-as well as major airline and airport associations), in 2018 the air transport sector produced 895 million tons of CO_2 out of total emissions generated by anthropogenic assets of 42 billion. In 2016, aviation produced 3.6 % of total greenhouse gas emissions in the 28-country European Union and 13.4 % of emissions in the entire transport sector, being the second largest source of emissions after road transport. In 2015, aviation emissions produced in Europe

accounted for 20 % of aviation emissions globally *(Air transport Action Group).*

The most worrisome aspect is that while emissions generated by productive sectors other than transportation are decreasing, those produced by aviation are growing and are doing so at very high rates. Indeed, even if the efficiency of avionics technology has increased significantly, emissions have continued to rise mainly due to increases in the number of flights, aircraft size, and distances flown.

As a matter of fact, assuming that the technology used does not vary from that used in the base year, 2010, and that no policies to tax or regulate the industry are acted upon, emissions produced in 2040 would be more than double those produced in 2010 *(Giansoldati, Danielis, & Scorrano, 2021).*

It is thus apparent that in order for aviation, both commercial and civil, to meet the goals set by the European community and the United Nations, the mere decrease in the use of fossil fuels is not enough; indeed, there is a much-needed advancement in aircraft component technologies as well.

S3.5 – Possible environmentally sustainable alternatives to the current cargo fleet

The aviation industry is moving toward electrification with two approaches, the first being the so-called More Electric Aircraft (MEA) based on a progressive evolution in which more electric equipment is introduced on new aircraft as they are put into service, thus gradually reducing the amount of mechanical, hydraulic or pneumatic components. The second approach is based on designing from scratch revolutionary all-electric aircraft. This approach known as Electric Propulsion tends to completely revolutionize air transportation in the coming decades, following what is already happening in the automotive industry.

3.5.1 – More Electric Aircraft (MEA)

Many conventional aircraft systems such as actuation systems, ice protection systems, and air conditioning systems are based on mechanical, hydraulic, or pneumatic energy sources. These systems receive basic energy by extracting it from the engine, which remains the primary energy source, which is converted into mechanical, electrical or hydraulic energy through a mechanical transmission (gear-box), while pneumatic energy is obtained by tapping high-pressure air from the engine's own compressors. On average

only 5 % of the engine's total energy, produced through combustion, is used for non-propulsive purposes, while the remaining 95 % remains to generate the thrust that propels the aircraft forward *(Roland Berger).*

Modern aircraft have unfortunately seen their complexity increase tremendously as their range per hour and distance performance has increased, mainly due to the increasing complexity of the on-board systems that have seen reduced reliability and consequently maintenance costs increase significantly. This has especially affected hydraulic and pneumatic systems, which are characterized by miles of complicated, heavy and difficult to control and repair piping and ducting. Any problems with these systems have serious consequences for the safety of the aircraft and thus can lead to aircraft grounding with major impacts on operating costs. In contrast electrical and avionic systems are characterized by greater light weight and reliability, and are more inclined to easy troubleshooting and repair, and the same is true for on-board avionic and electronic systems.

Despite the countless advances shown by electrical systems, there are however limitations mainly related to

the significant increase in power loads, resulting in an increase in other typical electrical quantities such as voltages and currents. Managing these issues requires the development of new cooling technologies to dissipate the heat generated by all equipment, and to keep under control any defects in distribution that could lead to safety hazards. This also requires significant advances in power electronics and the integration of electrical systems with other on-board systems dedicated to controlling and monitoring the health of the aircraft.

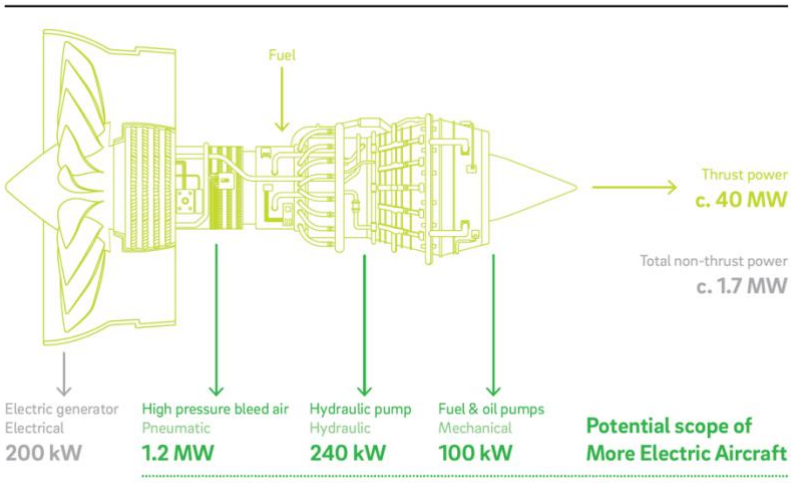

Figure 54: engine power output for a330-sized aircraft (Roland Berger)

However, it is clear that the benefits of on-board electricity generation, distribution and utilization in terms of weight, volume, reliability and maintenance costs far outweigh the problems encountered, and therefore the coming years will most likely see an increasing use of MEA (More Electric Aircraft) aircraft. It should also be considered that this will be especially the case for large commercial aircraft, i.e., for transporting at least 30 passengers, as this type of aircraft will be better able to absorb the increasing costs of electrical components and, above all, possesses safety standards such that a more gradual development of technologies is necessary.

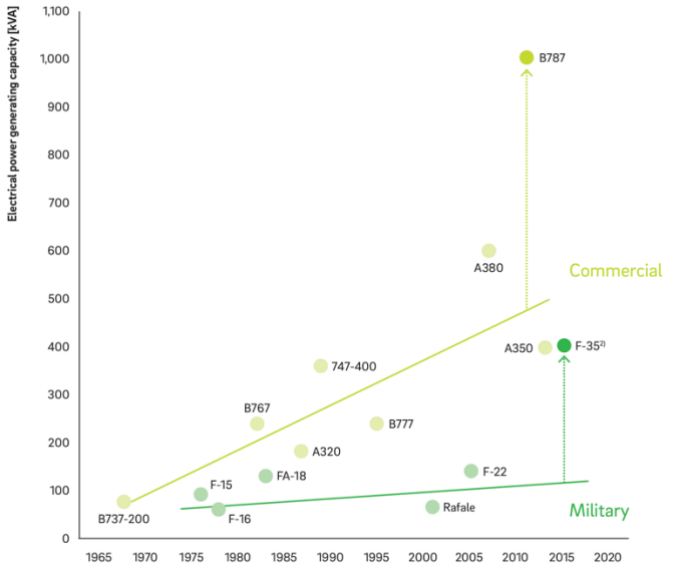

Figure 55: Increasing electrical power in fighters matches civil aviation (Roland Berger)

3.5.2 – Electric propulsion

In comparison with the gradual technological evolution that we have seen in MEA aircraft, some aircraft on the other hand are being designed with absolutely revolutionary criteria since they also use electric motors for propulsion instead of endothermic engines, turbine or piston. Electric propulsion is thus characterized as a source of energy other than fossil fuel (JETA1) being based on electric energy storage systems such as batteries or systems for producing electricity from hydrogen for example Fuel Cells. The electrical energy is then used to power both electric propulsion motors, which in turn drive propellers, and all other on-board systems.

It should be noted that electric motors have long attracted the attention of aircraft designers, but the real problem has always been and still is the amount of energy that can be stored in batteries. That is why the first real application of this technology was in 1973 when with NiCad batteries it was possible to power the MB E-1 aircraft, which can thus be considered the first electrically powered piloted aircraft. The flight lasted only 9 min but still represented an important demonstration and was only possible because of the higher energy density of Ni-Cad batteries compared to conventional lead-acid batteries.

Figure 56 (Source: Google images)

To date there are three electric aircraft architectures under development:

1) Hybrid Electric

2) Turbo-electric

3) All-electric.

1) Hybrid Electric can be further divided into 2 categories:

- Parallel Hybrid: Two motors, one electric and the other conventional, act together to drive the fan (or propeller) that generates the propulsive thrust. Power to the electric motor is supplied by battery packs of adequate power.
- Series Hybrid: the fan (or propellers) are driven only by electric motors, but in this case the electric motors receive electric power from both a battery pack and an electric generator in turn powered by a conventional endothermic motor.

2) A turbo-electric system is actually achieved by eliminating the battery-powered motor from the series hybrid architecture, so we have a generator powering two or more electric motors that drive the fans (or propellers).

The electricity generator is driven by a turbine engine or conventional endothermic engine, in which case the weight of the batteries is eliminated but a more powerful endothermic engine is required.

3) Finally, the last system consists of a battery pack that generates electricity to drive one or more electric motors to which fans or propellers are attached.

These architectures are very similar to those currently used on modern cars; indeed, even today most cars are electric hybrids, and only the most recent ones are full-electric without any endothermic engine but only with batteries. Moreover, there is currently a great ferment of activity in the aerospace world to identify and develop technologies, markets and competitive trends.

3.5.3 – Hydrogen

Many manufacturers consider hydrogen one of the most promising zero-emission technologies to reduce the environmental impact of aviation. This is because it overcomes the limitation of batteries due to low energy density and also the problem of rare earth and lithium resources needed to build the cells. Indeed, hydrogen cells have a specific energy potential per unit mass about 3 times higher than normal fossil fuel *(Roland Berger)*. In addition, if hydrogen is generated through the hydrolysis process, practically no CO_2 production takes place, and so it would make it possible to build even large aircraft that produce no harmful emissions to the atmosphere. Of course, the actual practical application of this technology presents other kinds of problems, many of which have not yet been resolved, due to the low volumetric energy density, which will result in the need for much larger volume tanks at very high pressures.

Two possible alternative uses of hydrogen have been identified:

- Hydrogen propulsion: in which hydrogen is combusted in a modified turbine that generates electricity that drives electric motors, in addition other electricity could be generated directly through fuel cells. This would result in a fully hydrogen-powered hybrid system.
- Synthetic fuels: hydrogen can be used to generate the so-called syngas, a mixture of carbon monoxide and hydrogen. Carbon monoxide is obtained from the atmosphere while hydrogen can be produced using renewable electricity, thus realizing a zero-impact energy cycle.

A decision on the best technological combination for the use of hydrogen is expected from 2025 with the possible goal of reducing aviation emissions by at least 50 % *(Roland Berger)*.

CHAPTER 4

THE APPROACH TO ENVIRONMENTAL SUSTAINABILITY OF THE MAIN CARGO OPERATORS IN EUROPE

Globally, 60% of logistics market revenues are generated by cargo companies *(Ernst & Young, 2019)*, which can be divided into companies that use cargo aircraft exclusively, passenger aircraft hold exclusively, or both. The remaining 40% of market revenues are generated by express companies, which mainly carry parcels and other urgent deliveries with fixed time frames. The three largest companies, FedEx, DHL, and UPS dominate the intercontinental express market, with shares of more than 90% of revenues, moving nearly 20% of the total air cargo market ton kilometers *(Boeing)*

In addition, as it has emerged before, most of the logistics sector's emissions are specifically from the cargo transport stages, and this is one of the reasons why major cargo companies are trying to revolutionize their vehicle fleets to be compliant with regulations on sustainability. Furthermore, nowadays, public opinion is increasingly insistent on social and environmental impact of companies and, very often, purchasing patterns are affected by this pressure. Thus, the sustainability programs of the three leading companies in transportation logistics will be presented.

4.1 – FedEx

FedEx, properly called FedEx Corporation, is a transportation company specialized in express shipping with overnight mail and parcel services, ground transportation, air transportation, and logistics services.

FedEx, headquartered in the Netherlands, connects more than 220 countries around the world with a fleet of more than 31,000 vans, trucks and trailers and about 700 aircraft, making it perhaps the world's largest airline operator and the largest operator of Airbus A300, ATR 42, Cessna 208, McDonnell Douglas DC-10/MD-10 and McDonnell Douglas MD-11 *(FedEx).*

Under the FedEx Feeder brand and through a number of smaller subcontracted operators it manages a sizable fleet of CESSNA 208B Cargomaster propeller-driven aircraft and recently ordered a new aircraft still in development, the CESSNA 408 SkyCourier *(FedEx)*.

Regarding the environmental commitment, FedEx is working toward a more sustainable future with the goal of totally eliminating its carbon emissions by 2040 with the Priority Earth project.

The initiative consists of three macro-objectives:

5) Innovate operations to reduce environmental impact;
6) Take action with research and development;
7) Inspire others to act more sustainably.

These goals have been outlined and are constantly adjusted with special consideration to corporate ESG (Environment, Social, Governance) reports, through which it is possible to identify the topics that are most relevant to FedEx, its stakeholders, society and the planet as a whole.

Specifically, considering governance in the area of sustainability, FedEx has established a council (FESC) to

oversee its actions. The FESC is composed of managers with expertise in law, finance, communications, and human resources whose purpose is to set, oversee, and improve business decisions regarding sustainability. In addition, FedEx has an Impact Teams (SITs), composed of experts who have specific expertise in different functional areas such as transportation, vehicles, etc.

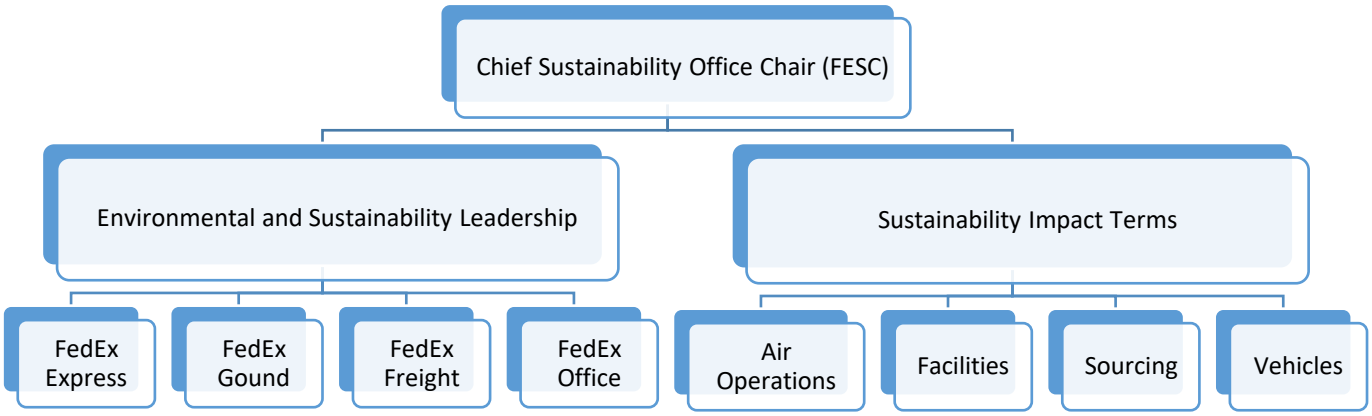

Figure 57: Environmental sustainability governance structure (FedEx)

As for the company's general approach to sustainability, this is mainly based on three basic aspects: reduce, replace, and revolutionize. Indeed, FedEx claims that they are reducing emissions and waste, replacing older technologies and vehicles, and revolutionizing fleets and facilities. Under this approach there is a desire to use resources efficiently and responsibly.

FedEx recognizes that the implications of climate change, such as severe weather events, greenhouse gas emission regulations, and increased social awareness about the impacts of climate change, create strategic risks for the company and its stakeholders. At the same time, some of these risks also present opportunities that can be exploited with achieving the main goal of carbon neutral operations by 2040.

To achieve carbon neutrality, FedEx has drawn up a series of milestones that include switching to green fuels or electric vehicles and adapting facilities and operations in a sustainable manner:

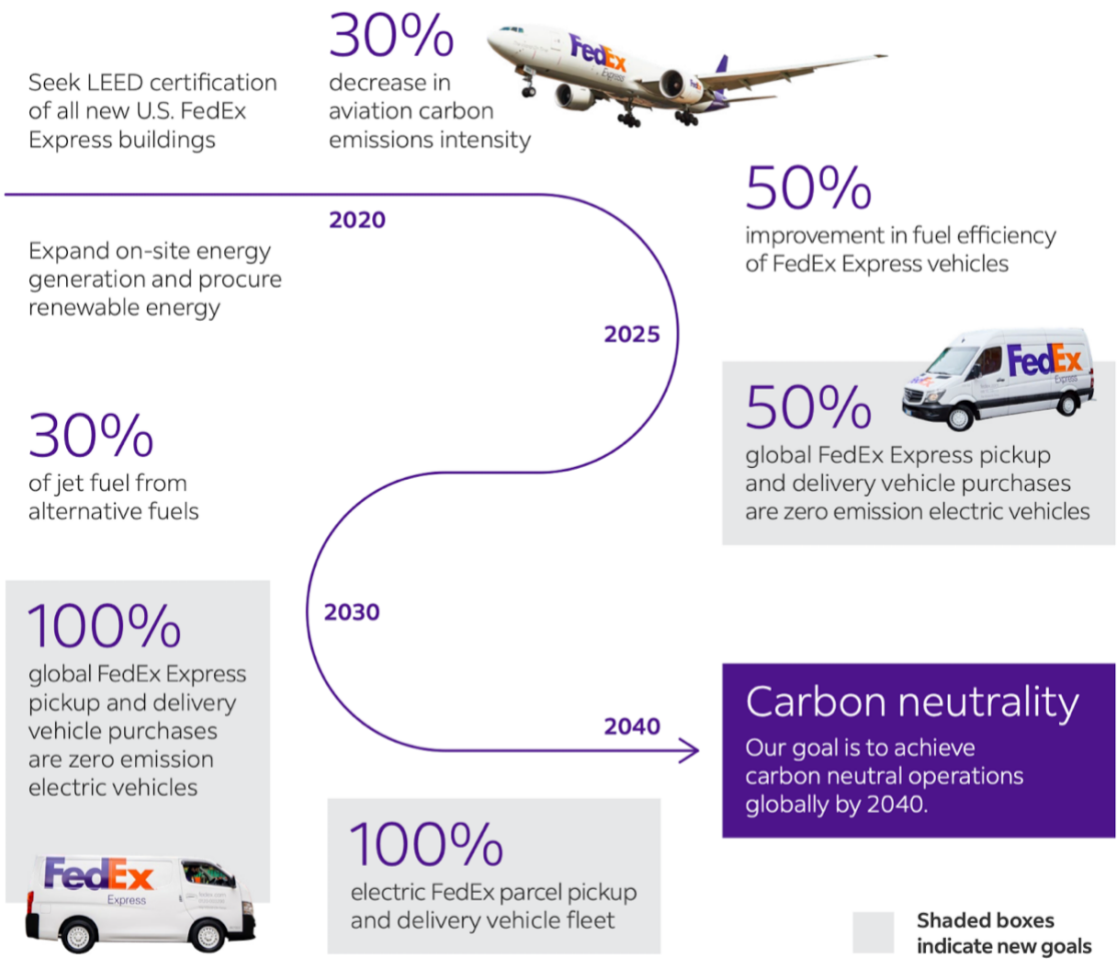

Figure 58: Roadmap of goals to carbon neutrality (FedEx)

Specifically, FedEx's goals can be summarized in five key points:

1) "Pledging $100 million to help establish the Yale Center for Natural Carbon Capture, where researchers will focus on ways to remove and store Earth's excess carbon.

2) Converting our entire parcel pickup and delivery fleet to zero-emission electric vehicles

3) Building on our FedEx® Fuel Sense initiatives to continue working to reduce aircraft fuel consumption

4) Continuing to invest in alternative fuels which could reduce aircraft and vehicle emissions

5) Investing in efficient facilities, renewable energy, and other energy management programs." (*FedEx*)

Furthermore, regarding the air fleet, FedEx estimated that about 60 % of overall corporate emissions are caused by aircraft (*FedEx*). Indeed, always following the pattern of reduction, replacement, and revolution, FedEx has reduced fuel consumption with "FedEx Fuel Sense," replaced aircraft with more efficient aircraft, specifically retiring eight MD-10-10s and purchasing 13 Boeing 767Fs and five Boeing 777Fs, and innovated biofuels.

4.2 – UPS

UPS (United Parcel Service) is an American parcel and international shipping company that, with a fleet of 238 vehicles, is the world's eighth largest carrier in terms of tons per kilometer transported (*UPS*).

The company operates globally and has about 495,000 employees and one of the most inclusive governance structures in place at the moment; indeed, with appointments over the past year, the Board of Directors now

includes 31% of members of different ethnicities and 46% of women (*UPS*).

In terms of environmental focus, as of 2016 UPS has set 10 goals to reduce its environmental impacts and to increase industry-leading safety programs:

1) $117 million in annual charitable contributions by 2020: annual charitable contributions reached $123.8 million in 2019, reflecting a long-standing commitment from UPS, The UPS Foundation (the corporate citizenship arm) and UPS employees and retirees.

2) 20 million volunteer hours by 2020 (from 2011): UPS employees, their families and friends contributed 3 million volunteer hours in 2019 and quickly surpassed the target with 21.7 million total volunteer hours.

3) 15 million trees planted by 2020 (from 2012): 2.8 million trees were planted in 2019, exceeding the target ahead of schedule by one year with 15.4 million trees planted.

4) 3% reduction in motor vehicle accidents by 2020 (per 100,000 driving hours). The company's first four goals were achieved one year ahead of schedule.

5) 2% improvement in employee engagement by 2020: a target was set in 2016 to improve the employee engagement index by 2 % by 2020. The index is derived from UPS's annual Employee Engagement Survey or EES.

6) 1 % reduction in injury absenteeism in 2020 (per 200,000 hours): the Lost Time Injury or LTI (Lost Time Injury) frequency index rose to 2.07, an increase of 13.7 % over baseline, mainly due to the continued increase of new hires to meet the capacity needs of growing e-commerce demand. To this end, sharing of best practices was improved, the on-board safety mentoring program was expanded, and the internal audit process was developed to better assess facility safety.

7) 12% reduction in absolute GHG (greenhouse gasses) emissions in all ground operations by 2025 (2015 baseline): in 2019, absolute emissions decreased by 0.8% from 2018 performance, but total emissions remain 5.4% higher than the 2015 forecast. Impacts from the growth of e-commerce and the total number of shipments we make have been addressed.

8) 25% renewable energy by 2025: the installation in the United States of 10 MW of rooftop solar panels was completed in 2019, and UPS's operations in 10 European countries have nearly zeroed emissions through the use of electricity from renewable sources. Investments in renewable energy are producing 3.9% of UPS's total electricity needs

9) 40% alternative fuels as a percentage of total business fuels by 2025: in 2019, UPS continued its investment in alternative fuels for the fleet by purchasing 511 million liters of alternative fuels, accounting for 24% of total consumption. 946 million liters of biogas equivalent will also be purchased in the coming years.

10) 25% of fuel and advanced technology vehicles as a percentage of total vehicles purchased in 2020: in 2019, the company continued to increase the vehicle fleet with more than 10,300 alternative fuel operated and advanced technology vehicles, including a commitment to purchase 6,000 biogas vehicles. In the first quarter of 2020, a major investment in Arrival was also announced, expanding the fleet by another 10,000 all-electric vehicles.

Specifically, the company works with almost 1.6 kilometers driven in a workday, thus making the electrification of its fleet a key step toward achieving zero emissions.

As a matter of fact, UPS has invested $1 billion in alternative fuels and vehicles since 2009. Indeed, the company has 10,300 vehicles that day by day accumulate data on alternative fuels and advanced technologies that work best in different routes and work areas (*UPS*).

In addition, between 2020 and 2022, 6,000 heavy-duty gas-powered trucks, tractor-trailers, and long-wheelbase vans for medium and heavy-duty services equipped with CNG fuel supplied by Agility Fuel Solutions will be purchased.

Thereafter, by 2026, UPS aims to purchase 946 million liters of biogas equivalent (RNG).

The purchase of 644 million liters of biogas equivalent from Clean Energy Fuels Corp. marked the largest purchase of biogas ever made by a company in the United States; this purchase is expected to reduce lifecycle greenhouse gas emissions by about 70 % compared to the use of diesel or gasoline (*UPS*).

Next, also starting in 2016, UPS and Arrival are collaborating to experiment with electric vehicle (EV) concepts of different sizes. As a matter of fact, their intention to jointly develop a test fleet of 35 EVs for delivery in London and Paris was announced, and Arrival is the first manufacturer to provide EVs specifically designed to UPS specifications.

In 2019, UPS Ventures, the venture capital arm, completed a minority investment in Arrival and announced a commitment to purchase 10,000 customized electric vehicles.

Figure 59: Electric vehicle of Arrival for UPS (UPS)

The UPS CEO also states in his sustainability report that "As a global leader in logistics, we provide a broad range of solutions that transport packages and freight, facilitate international trade, and deploy advanced technology to more efficiently manage the world of business. We input the assets and capital that comprise our global logistics network in order to output the deliveries and services enabled by that network. Our service offerings include Global Small Package, Insurance & Financing, Logistics & Distribution, and Freight

Forwarding. We measure impact through the economic, social, and environmental difference made by our global logistics networks." (*UPS*)

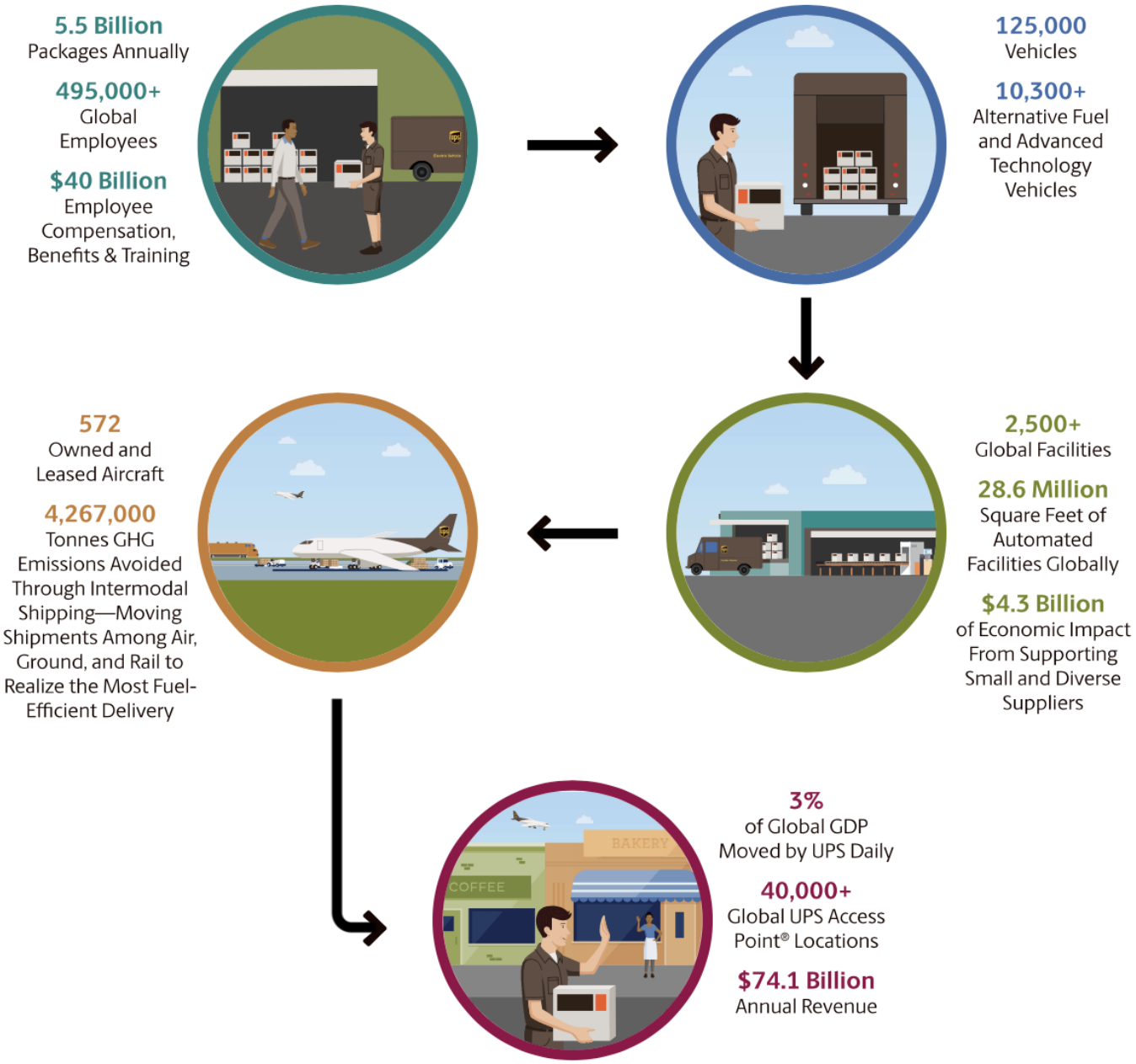

Figure 60: UPS Global Value Chain (UPS)

4.2.1 – The partnership with Beta Technologies

In addition to the abovementioned solutions used by UPS for sustainable transport, the company recently signed a contract with Beta Technologies for the purchase of 150 electric aircrafts.

The vehicle born from this collaboration takes the name of ALIA-250c and has a design inspired by the Arctic Tern, the bird that migrates the most, visiting every continent and flying over every ocean on earth. The vehicle, actually available both for cargo and passengers, has been presented by Beta after three years of study and development and has the following characteristics:

Propulsion	**Distributed, Direct-Drive Electric**
Type	**EVA, Lift + Cruise**
MTOW	**6,999 lbs**
Wingspan	**50 ft**
Range	**250 NM**
Recharge Time	**50 minutes**
Cargo Volume	**200 Ft ^3**

Figure 61: ALIA-250c (Beta Technologies)

The fleet will be operational from 2024 and UPS has also announced that it has reserved Beta's recharging stations for rapidly charging the aircrafts in less than an hour and, that the batteries of the vehicle will have two life cycles: the first one on the plane and after that, they will be fitted to the charging station to recharge the aircraft's onboard batteries as well as UPS's fleet of electric ground vehicles.
In addition to the standard characteristics of the aircraft, Beta has a specific design for the plane that will be provided to UPS.

Figure 62: ALIA-250c for UPS (UPS)

4.3 – DHL

Among international freight companies, DHL can be considered one of the most climate conscious.
As its CEO Frank Appel also stated, as a leading freight transport and logistics company, DHL aspires to connect people and improve their lives while contributing to environmental protection.
Thus, was born Mission 2050: zero emissions; "with our mission to achieve net-zero emissions by 2050, we strive for clean operations for climate protection. We have set ourselves the target of reducing our

greenhouse gas emissions by 2030. We will do this by committing to set an emissions target in line with the Paris Agreement through the Science-Based Targets initiative (SBTi) and investing Euros 7 bn to reach it. With this investment, we will increase our use of sustainable aviation fuels, design all new buildings carbon neutral, offer a comprehensive portfolio of green products and electrify 60% of our last-mile delivery. By 2030, we will have more than 80,000 e-vehicles on the road." (*DHL*).

Figure 63: DHL sustainability commitments (DHL)

Although there is a long way to go by 2050, DHL has set 4 main goals to be achieved by 2025:
1) 50% increase in carbon efficiency over 2007 levels (for the planet);
2) operating 70% of its last and first mile delivery services with green delivery and pickup solutions, such as bicycles and electric vehicles (for the community);
3) inclusion of "Green Solutions" on more than 50% of sales (for consumers);
4) training 80% of employees to become certified "GoGreen" specialists and actively including them in environmental and climate protection activities. This also includes creating partnerships to plant one million trees each year (for the company).
DHL's GoGreen solutions include both standardized products and customized solutions to help consumers take advantage of green logistics in developing business models aimed at preserving environmental resources. Specifically, the means used are:
- "carbon reports" to identify emissions generated by logistics,
- "climate neutrals" products to offset essential emissions in the logistics chain with internationally certified climate protection projects;
- "green optimizations" which, on the other hand, are customized solutions designed to help DHL customers identify methods for reducing emissions, waste and other activities that impact the environment
Regarding the mobility concept, electric is one of the key resources for DHL, which has invested in cargo bicycles and electric vehicles to reduce air pollution in urban areas.
With respect to long-distance travel, on the other hand, which accounts for 80% of DHL's transportation

(*DHL*), sustainable fuels, such as biofuels, hydrogen, and synthetic fuels, are currently being used since the full transition to electric is still unimaginable.

4.3.1 – The partnership with Eviation

Although there is still a long way to go, the company recently entered into a collaboration with Eviation, a global aircraft manufacturer, in order to develop 12 all-electric cargo aircraft by 2024.

Regarding the technical characteristics of Alice, the aircraft born from this collaboration is presented as follows:

"Alice can be flown by a single pilot and will carry 1,200 kilograms (2,600 lbs). It will require 30 minutes or less to charge per flight hour and have a maximum range of up to 815 kilometers (440 nautical miles). Alice will operate in all environments currently serviced by piston and turbine aircraft. Alice's advanced electric motors have fewer moving parts to increase reliability and reduce maintenance costs. Its operating software constantly monitors flight performance to ensure optimal efficiency." *(Eviation)*

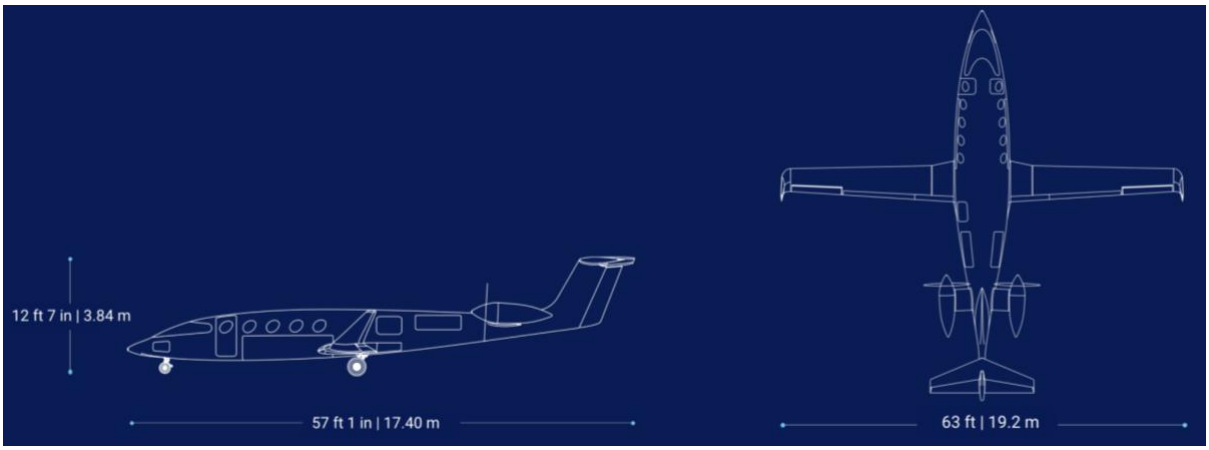

Figure 64: Alice (Eviation)

Regarding the engine Alice is powered by two magniX magni650 electric propulsion units (2x 640 kW) with the following characteristics:

magni650 EPU

The magni650 electric propulsion unit (EPU) is a 850 SHP / 640kW / 3000 Nm – class EPU. Each EPU includes a magni650 motor, 4 X magniDrive-100, and the closed-loop integrated thermal management system.

Max TO power	640 kW
Nominal continuous power	560 kW
Output RPM	1200 to 2300 RPM
Max continuous torque	3020 N.m
Nominal torque	2820 N.m
magni650 EPU dry weight	200 kg / 440.9 lbs
Max operational altitude	35000 ft
Environmental qualification	DO-160G
Max operational voltage	800 Vdc
Min operational voltage	500 Vdc

Figure 65: magniX's complete electric propulsion unit (EPU) (Eviation)

The aircraft was also first presented in 2019 at the 53rd annual Paris Air Show, as a 9-passenger all-electric aircraft. To date, Eviation produces three different types of interiors, divided into commuter and executive, both for passengers, and cargo.

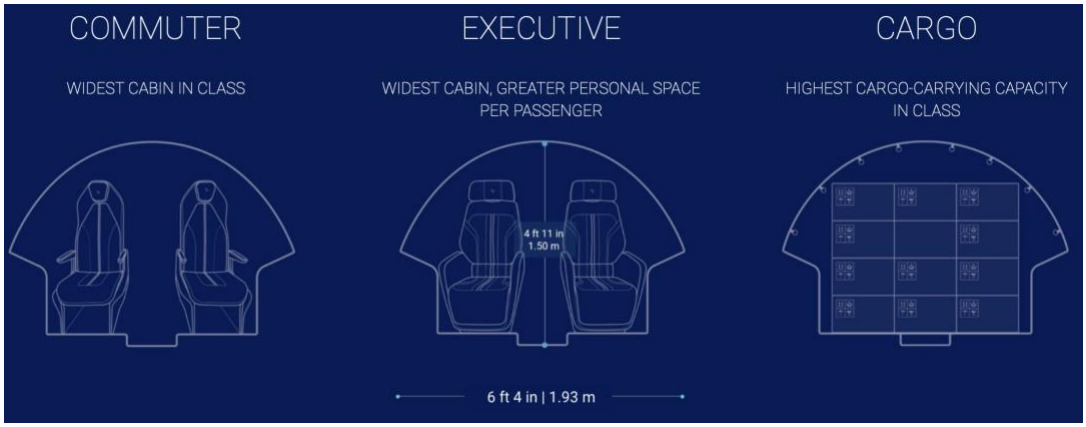

Figure 66: Alice's interiors (Eviation)

As for the 12 vehicles ordered by DHL these will have a custom design and will most likely look like this:

Figure 67: Alice, interior (DHL)

Figure 68: Alice, sky side (DHL)

As can thus be inferred from the size and power, Alice will be a vehicle used for regional deliveries; indeed, with the technologies and prototypes that are in circulation and/or under study at the moment, it is unimaginable to transform classic cargo planes such as the Boeing 777 or the Airbus A350 into electric. Indeed, as it is evident from all the relevant scientific literature, the number of electric batteries that would be needed to power an aircraft of that size would be so heavy that they would not even allow it to take off.

So, DHL, and any company that decides to use aircraft of this type, will obviously not be able to reduce all of its emissions to zero; nevertheless, the synergy between green operations, last-mile solutions that are already almost entirely electric, and e-cargo planes will still be enough to reduce them significantly.

CONCLUSION

In conclusion, it can therefore be inferred that the global air cargo market calculated in terms of RTK (revenues per tonne-km) will surely have an estimated annual growth of around 4%.

This growth will indeed be influenced mainly by changes regarding the spread of e-commerce that Covid-19 has inevitably accelerated and the need to deliver progressively more products in larger quantities and shorter times.

Indeed, it has been seen how studies estimate growth in the world cargo aircraft fleet of about 60 % in the next two decades; thus, 1250 more aircraft will be put in the air, but, the actual production of new vehicles will be about 2430 aircraft since part of the existing vehicles will have to be replaced due to obsolescence. About 60% of these new aircraft will be a conversion of existing passenger aircraft (1458), while the remaining 40% (972) will be newly produced cargo aircraft.

Moreover, consequent to the growth of attention concerning climate change, all means of transportation, including cargo aircraft will have to be upgraded.

Indeed, among the main goals pursued by National, European and World governance is to achieve climate neutrality by 2050. Moreover, as seen during this study, aviation is currently the largest cause of emissions in the logistics sector but also the most challenging to become sustainable.

On the other hand, the analysis conducted regarding the costs of air and road transport shows that their annual costs are very different, counting about one million euros per year for aircraft and 150 thousand euros per year for trucks. The study was, of course, conducted excluding sea transport, which generally deals with the transfer of bulky materials and raw materials, and rail transport, which was not deemed comparable.

After comparing the absolute results and actualizing them against fixed parameters such as annual km travelled and annual tons transported, the most unexpected revelation that emerged was that on the same route the costs of road vehicles and electric aircraft are almost equal, but that the travel time is almost halved. The difference between the two means becomes evident when comparing the costs versus the tons transported, obviously making the costs of the electric vehicle higher since as the tons increase, the trips made to the aircraft increase.

Moreover, another relevant finding for the purpose of the investigation is that, whichever way they are compared, it is always cheaper to have the SF600 (electric cargo plane) than the Cessna Caravan, whether in terms of total operating costs, or costs discounted to kilometers and tons.

Thus, to draw conclusions from this analysis, one must take into account that the approach to e-commerce has been disrupted by Covid-19 and that nowadays almost all online shopping platforms guarantee increasingly shorter delivery times. In these cases, therefore, from a logistics point of view, it will no longer be possible to rely only on the most cost-effective means of transportation, but there will be a need for a trade-off between cost and guaranteed delivery time.

The vehicle that is then best suited for anyone with short time requirements and efficient transportation is therefore the SF600 e-power, which not only cuts down on the costs of the classic cargo plane and the travel

time of vans but also helps all logistics operating companies to adhere to the standards imposed by the EU and the government regarding CO2 emissions.

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