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Aviation industry emissions assessment: Ukrainian perspectives

Atmospheric pollution, especially CO2, is a catalyst for climate change, which is a global challenge for the entire planet. One of the main sources of pollution is transport. Therefore, the issue of its decarbonization is extremely important and relevant, especially for the aviation industry.

Since the second half of the 18th century, mankind has lived through epochs of industrial revolutions. In the 19th century, the Industrial Revolution faced a gradual increase in carbon dioxide (CO2) emissions resulting from the combustion of a growing quantity of fossil fuels, particularly coal. However, it is not until the second half of the 20th century that CO2 emissions increased sharply, followed by an increase in average global temperatures (Fig.1). The world carbon emissions from fossil fuel burning was at the level of 2,000 million tons in the period from 1880 to 1955 (75 years), for the next 63 years it increased 5 times and reached the mark of almost 10,000 million tons.

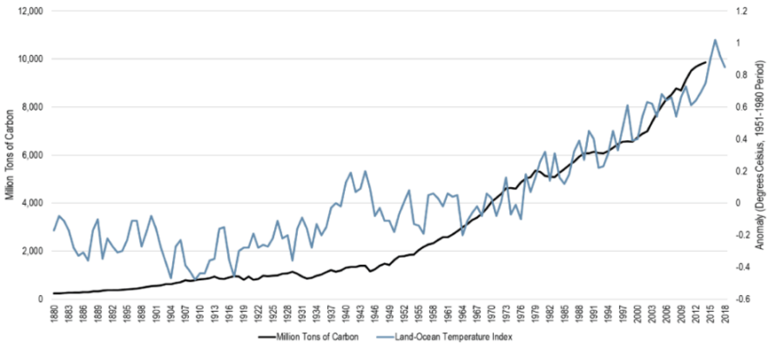

Fig.1. Average Global Temperature and World Carbon Emissions from Fossil Fuel Burning, 1880-2018 (Source: Adapted from National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Global Monitoring Division)

The fact that rising carbon emissions up to the mid-1970s did not appear to have been associated with global temperature changes underlines the potential existence of a threshold, after which additional emissions can trigger noticeable temperature variations, as shown by Rodrigue Jean-Paul (2020). This threshold may have been reached in the early 1980s went global temperature averages started to increase above long-term averages. The growth in carbon emissions continued in the early 21st century as global CO2 emissions continued to rise in relation to the fast growth taking place in economies such as China and India, which have become the world's largest carbon emitters.

Covid-19 pandemic, which has affected all spheres of life in all countries of the world and somewhat slowed down the projected growth rate of the economy and significant climate change. Its spread has left national economies and businesses counting the costs, as governments struggle with new lockdown measures to tackle the spread of the virus. The International Monetary Fund (IMF) estimates that the global economy shrink by 4.4% in 2020. However, it is predicting global growth of 5.2% in 2021 as Jones L., Palumbo D. & Brown D. (2020) mentioned. Thus, the quarantine restrictions related to Covid-19 only paused the issue of decarbonization measures, but did not exclude its urgency.

Summing up, the further development of all sectors of the economy cannot be built and developed without considering environmental factors (including the movement towards decarbonization). Besides that, decarbonization is not always lead to slowing economic growth, as since 2010, 41% of countries have grown their economies faster than their increase in carbon emissions while 16% have grown without increasing carbon emissions. Moreover, ecological factor is becoming more and more decisive criterion for the competitiveness of goods and services for both global and local supply chains.

The environmental factor becomes extremely important in the long-term planning of economic development of all countries and the world as a whole. Each sector of the economy must monitor, forecast and reduce the impact on the environment in order to maintain its competitive advantages in the long run (zero CO2 by 2050). If we consider the structure of emissions by the type of economic activity, the priority belongs to the energy sector (73.2% of all emissions), which includes both transport in general (16.2%) and aviation in particular (1.9%).

At the same time the role of air transport in the development of the world economy and in the level of pollution of the environment due to CO2 emissions should not be underestimated. As was shown by Air Transport Action Group and IATA, 2020, if aviation were a country, it would rank 20th in the world in terms of gross domestic product (GDP), generating USD 704.4 billion of GDP per year, considerably larger than some members of the G20 (and around the same size as Switzerland). By 2036, it is forecast that aviation will directly contribute USD 1.5 trillion to world GDP. Over 65 million jobs are supported worldwide in aviation and related tourism. Of this, 10.2 million people work directly in the aviation industry, partly indicators, from the work of which are presented below (Fig.2).

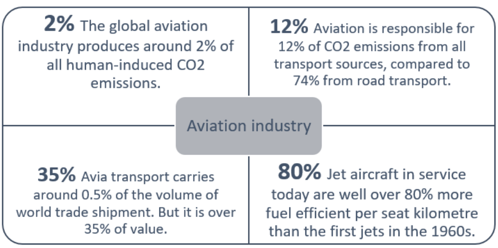

Fig.2. Aviation industry indicators. (Source: Developed by the authors on the basis of Air Transport Action Group data)

Air travel dominates a frequent traveler's individual contribution to climate change. Yet aviation overall accounts for only 1.9% of global CO_2 emissions, but specific indicator, carbon footprint (CO_2 grams equivalents per passenger kilometer), shows that aviation transport is the least eco-friendly: 255 g on domestic flights when even medium car on petrol produce 192 g (Hannah Ritchie, 2020).

At a time when other modes of transport are actively announcing new projects to reduce emissions and it is only a matter of large-scale, the aviation industry is mostly in the research and development stage. Such projects in aviation are expensive, have delayed visible result (the full cycle from idea to serial production takes an average of 20 years) and request public-private partnership. Nevertheless, world leading manufactures launched collaboration with industry partners and are working on the problem of transforming aviation into a more environmentally friendly mode of transport, using different approaches depending on available resources (Table 1).

Table 1. Aircraft manufactures' carbon emission reducing achievements

Manufacture	Carbon emission reducing achievement
Boeing	offers airline customers new airplanes with sustainable fuel, an option that reduces CO_2 emissions by up to 80%; ecoDemonstrator program-tested vortex generator could save an airline, flying 100 jets, up to 3 million gallons of fuel a year—enough to take about 3,800 cars off the road during that time; 777X will achieve 10% lower fuel use and emissions and 10% lower operating costs than the competition; 787 Dreamliners saved 48 billion pounds of fuel, compared to the airplanes they replaced—vastly reducing the amount of carbon our products emit.
Airbus	Has revealed three concepts for the world's first zero-emission commercial aircraft which could enter service by 2035: turbofan design (120-200 passengers) with a range of 2,000+ nautical miles, capable of operating transcontinentally and powered by a modified gas-turbine engine running on hydrogen, rather than jet fuel; turboprop design (up to 100 passengers) using a turboprop engine instead of a turbofan and also powered by hydrogen combustion in modified gas-turbine engines, which would be capable of traveling more than 1,000 nautical miles, making it a perfect option for short-haul trips; "blended-wing body" design (up to 200 passengers) concept in which the wings merge with the main body of the aircraft with a range similar to that of the turbofan concept. The exceptionally wide fuselage opens up multiple options for hydrogen storage and distribution, and for cabin layout.
Embraer	Embraer E2 aircraft use less than 3 liters of jet fuel per 100 passenger kilometers. This matches the efficiency of most modern compact cars; Embraer and General Electric performed a series of tests flights with the objective of establishing a reference for the operational characteristics of the airplanes with GE CF34-8E engines when filled with Hydro-processed Esters and Fatty Acids fuel, inside a wide range of specific flight conditions.
Bombardier	Leading the way to ensure that sustainable aviation fuels (SAF) become a standard for the industry, for customers and in day-to-day operations. Since 2017, they have been using SAF during demonstration flights as well as during flights to major air shows and events to raise industry awareness of SAF as a mainstream, drop-in alternative to traditional jet fuel for business aircraft. Increase R&D in clean products development and electrification.

The development of Ukrainian civil aviation does not stand aside from global trends (in terms of commitments under the CORSIA projects and the Paris Agreement, the prioritization of the aircraft industry as a priority sector of Ukraine's economy) and must meet modern challenges, including environmental issues.

The authors processed statistical data on cargo and passenger turnover of Ukraine for the last 15 years, on the basis of which forecasts for 2030 was based. Covid-19 impact was taken into account only for passenger traffic, as freight trends did not show significant changes during 2019-2020. Using the calculated data and standards of CO2 emissions per ton-kilometer and passenger-kilometer, the level of CO2 emissions from the aviation industry was predicted (Fig.2). The obtained forecast data have a clear trend of planned growth, which, in turn, does not meet the global target of zero emissions by 2050.

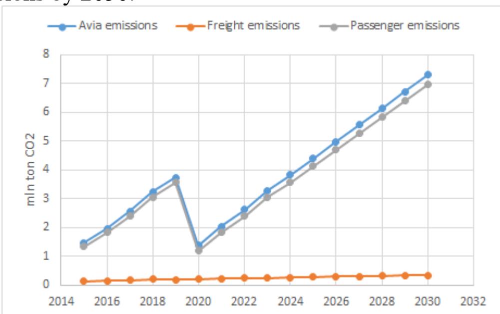

Fig. 2. Calculated CO2 emissions to 2030 from aviation industry

Europe's aviation sector has unveiled its flagship sustainability initiative, Destination 2050 - route to net zero European aviation. They have identified measures across four pillars: aircraft and engine technology, air traffic management and aircraft operations, Sustainable Aviation Fuels and smart economic measures. Their experts have calculated values on the reduction of CO2 emissions from the application of these measures, the result of which can be quantified and observed by 2030, were used to assess changes in the level of emissions from the Ukrainian aviation industry (table 2).

Table 2. Estimated changes in CO2 emissions in 2030 compared to 2019

Applied measures	Changes in CO2 emissions		CO2 emissions in 2030, mil.t
	%	mln.t	
Sustainable aviation fuels-induced demand impacts	2	0,1459	7,1484
Economic measures-induced demand impacts	1	0,0729	7,2214
Improvements in aircraft and engine technology	7	0,5106	6,7837
Improvements in ATM and aircraft operations	5	0,3647	6,9296
Sustainable aviation fuels	3	0,2188	7,0755
Economic measures	27	1,9695	5,3249
Total combined CO2 emissions reduction	**45**	**3,2824**	**4,0119**

It should be noticed that even the complete absence of measures to reduce CO2 emissions will lead to changes due to the so-called demand impacts. After all, complete or partial non-compliance with international standards and requirements of national legislation will lead to the use of financial instruments of influence (carbon pricing), which in turn will increase prices for services, reduce demand and, consequently, reduce emissions.

Conclusion. Ukraine as one of the seven aviation countries in the world should take into account the environmental factor while considering the strategies of the aviation industry development with the aim to increase competitive position in the world market in the long-term perspective. To reduce and mitigate the negative effects the following measures should be implemented:

- optimization of ground handling infrastructure at airports, to reduce the movement of aircraft and ground vehicles on taxiways and at idle at the gate;
- renewal of the land vehicle fleet;
- minimization of fugitive air emissions from aviation kerosene and other fuel depots and from fuel handling and others.

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